ABSTRACT

DUVERNAY, WILLIAM HAUSER. Conversion of Industrial Sweetpotatoes for the Production of Ethanol. (Under the direction of Mari S. Chinn.)

Starch is a renewable complex carbohydrate currently being used to produce ethanol from corn. Although corn starch to ethanol is a mature process, corn production is not feasible for every region of the United States. Sweetpotatoes (*Ipomoea batatas*, Morning-glory family) are a low-impact crop grown primarily in the southeast region of the U.S. and offer a viable, alternative starchy raw material that can be converted to useful sugar feedstocks needed for production of ethanol and other value added products. The process of converting sweetpotato starch into ethanol can be described in three basic steps: liquefaction using α-amylase or some other liquefying agent to gelatinize available starch, saccharification using saccharifying enzymes to convert gelatinized starch into soluble sugars, and fermentation of the sugars into ethanol. The overall goal of this project was to generate the information necessary to define an environmentally friendly process for conversion of industrial sweetpotatoes (ISPs) into simple sugars and ethanol. Specific objectives included: 1) Examining liquefaction, saccharification, and fermentation of FTA-94 ISPs using α-amylase and glucoamylase for the production of ethanol; and 2) Examining the enzymatic hydrolysis and fermentation of ISPs with the addition of pullulanase for ethanol production. The significance of enzyme loading rate, incubation time, and temperature on changes in starch content and sugar concentrations during each hydrolysis step was evaluated. Ethanol production potential from produced sugars was also determined.

α-Amylase (Liquozyme SC) at different loading rates (0.045, 0.45, and 4.5% KNU-S/g dry ISP) was tested during liquefaction over time at 85°C; three glucoamylases (Spirizyme Fuel, Spirizyme Plus Tech, and Spirizyme Ultra) were tested during saccharification at 65˚C at different loading rates (0.5, 1.0, and 5.0 AGU/g dry ISP) over time. Results showed that the majority of available starch, 47.7 and 65.4% of dry matter, was converted during liquefaction of flour and fresh sweetpotato preparations, respectively, with the addition of 0.45 KNU-S/g dry ISP of Liquozyme SC after 2 hours incubation (66.4 and 80.1% initial starch contents, respectively). Saccharification was able to increase the breakdown of starch, but its primary function was conversion of short chain carbohydrate polymers to fermentable sugars. The addition of 5.0 AGU/g of Spirizyme Ultra after 48 hours was able to produce 795.4 and 685.3 mg of glucose/g of starch with flour and fresh preparations, respectively. Yeast fermentation on hydrolyzed starch was examined over time with and without the addition of salt nutrients. Yeast were able to produce 62.6 and 33.6 g/L of ethanol for flour (25% w/v substrate loading) and fresh (12.5% w/v) ISP, respectively, after 48 hours without salts.

Pullulanase (Promozyme) was added to the saccharification step to enhance hydrolysis of α-1,6 bonds in ISP starch polymers and increase glucose yields. The addition of Promozyme after 48 hours of saccharification with 5.0 AGU/g Spirizyme Ultra at 45, 55, and 65ºC showed no consistent increase in the change in starch content. Adding 0.5 NPUN/g of Promozyme to 5.0 AGU/g Spirizyme during saccharification at 55ºC slightly increased the amount of recovered glucose, producing 828.7 and 869.7 mg/g starch for flour and fresh ISP.

Fermentation of sugars produced from this treatment combination yielded 310.7 and 333.3 mg ethanol/g dry ISP for flour and fresh preparations.

Results of these experiments show that sweetpotatoes can be converted to glucose through enzymatic methods, hydrolyzing up to 88% of available starch, and that produced sugars are fermentable by yeast. Based on the data and ISP production yields in North Carolina, it is possible to generate at least 700 gallon of ethanol per acre of ISPs. However, challenges still need to be addressed related to improved conversion efficiency, scale up, and planting and storage methods.

Conversion of Industrial Sweetpotatoes for the Production of Ethanol

by
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BIOGRAPHY

William “Billy” Hauser Duvernay was born on March 23, 1984, in the great city of New Orleans, Louisiana. He is the second son of Thomas and Sarah Duvernay, and the younger brother of Matthew Duvernay. Billy spent the first half of his life in New Orleans, playing baseball, basketball, and football at Lakeview playground just about every free second that wasn’t spent in school. The remainder of his time was split up between fishing, family vacations, and basically doing everything his older brother told him to do.

Just before Billy entered high school, the Duvernay family made the 26 mile move north above Lake Pontchartrain to the wooded suburbs of the city (less football and basketball; more baseball and fishing). Billy graduated from St. Paul’s High School second in his class in 2002, where he went on to study Biological Engineering at Louisiana State University. His competitive edge was kept satisfied on the Ultimate Frisbee Team at LSU. Performing undergraduate research under the guidance of Dr. Cristina Sabliov, Billy realized the importance of renewable resources, and decided that he wanted to spend more time researching solutions to the world’s energy problems. That’s when he met Dr. Mari S. Chinn at North Carolina State University, and after graduating from LSU in 2006, he left his family and friends to pursue a Master’s Degree in Raleigh, North Carolina, trying to find alternate methods for producing ethanol. He’s been eating, sleeping, and breathing sweetpotatoes ever since.

After graduate school, Billy plans on moving back to Louisiana where he can be closer to his family and friends. He intends to pursue a career in the ethanol or bioprocessing industry.

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Dad, thanks for all of your support over the last two years and for all of my life. Your Monday morning conversations about "what's goin' on", though sometimes a little earlier than I would have hoped, have kept me in line and focused and provided me with the motivation to finish my work not only to impress you but to enable me to put our name on something that I am proud to call my work. And I'm sure you never tired of answering my distressed calls about my countless problems, including, "what do I do when a tree falls on my car." Anyway, thank you, for everything. Now let's go fishing!

Mom, there's nothing that I can really say to express my thanks to you for all of your help, but I'll try. Your numerous letters and care packages over the last two years have kept me closer to home than I ever thought I could be living over 850 miles from your doorstep. And I don't know what I would have done without our weekly conversations keeping me up to date on the family news. You have been nothing but understanding and encouraging, and I can't thank you enough.

Matt, all my life I have tried to live up to what I thought your expectations of me might be. As my older brother, you've always provided me with something to live up to and given me the encouragement (and sometimes the tutoring) to not only perform, but to excel at everything I do. As my best friend we've been through the best and worst times together, but always come out on top and stronger because of it. And now I can finally say I finished something before you: grad school.

Lisa, thanks for all of your encouragement and support. You have provided me with the love and encouragement to work every day so that I could one day come home and start my life with you. Without you there to complain to about what was going wrong and brag to about what was going right, I wouldn't have had the motivation to continue. Thank you for always being there.

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The world's consumption of energy has steadily risen every year and continues to increase on an international level. By the year 2030, the Federal Energy Management Program expects consumption to grow 71% over that of June 2006 (EERE, 2006). Eight countries have 81% of the world's oil reserves, six countries have 70% of all natural gas reserves, and 89% of the world's coal reserves lay in eight countries (Sayigh, 1999).

On a national level, the United States consumed 19.7 million barrels of petroleum per day in 2002, totaling one-quarter of world's entire oil production. More than half of this oil, 62%, was imported (EERE, 2006). The Energy Information Administration (EIA) projected total petroleum consumption in 2025 to reach 28.3 million barrels per day, having to depend on 70% from foreign imports (EIA, 2004). This increasing dependency on foreign oil as domestic supplies lessen threatens the economic and energy security of America.

To compete with this ever growing trend, an economy based on carbohydrates has been introduced. It focuses on the production of biobased products derived from renewable biomass. Bioproducts are products created from plant based resources such as agricultural crops and forestry residues, dedicated energy crops, trees and grasses. Many of the same products made from petroleum can be made from these biomass resources. The basic molecules of petroleum being used for production are hydrocarbons. The basic molecules of plants, however, are carbohydrates, proteins, and oils. Both can be used to produce a wide variety of products, including plastics, adhesives, and fuel (EERE, 2006).

1.1 Nonrenewable and renewable resources

Nonrenewable resources are resources which cannot be remade. Fossil fuels like coal, crude oil, and natural gas are considered to be nonrenewable resources since they do not naturally reform at a rate fast enough to be sustainable in our society. In 2002, 86% of all energy consumed in the United States was from fossil fuels (EERE, 2006). These nonrenewable resources are being utilized as the world's main source of energy and are therefore depleting at an alarming rate.

In addition to providing the world's energy, nonrenewable resources are also used in some way to manufacture many products on the market today. Some common products derived from fossil fuels include detergents, synthetic fibers (nylon, polyester, acrylic), plastics, paints, garden hoses, food additives, cleaning products, pesticides, nail polish, lipstick, and shampoo (EERE, 2006).

Another cause for concern associated with nonrenewable resource-based fuels is their high carbon content. When these fuels are burned they release carbon back into the atmosphere as carbon dioxide. Because the demand for energy has risen so rapidly in the past and continues to increase, the burning of these fuels is thus resulting in a rise in the concentration of carbon dioxide in the atmosphere, a major cause of the greenhouse effect.

The increasing demand of energy and depleting nonrenewable resources has led to a shift of focus to use renewable resources as a main source of energy and product generation. Power derived from hydro, geothermal, wind, and solar resources as well as biomass-derived energy could provide national energy security, economic growth, and environmental benefits (EERE, 2006).

As of 2003, production of biobased textile fibers, polymers, adhesives, lubricants, soy-based inks, and other products was estimated at 12.4 billion pounds per year (6.2 million tons) (Pastor et al., 2003). However, the total production of all biobased and non-biobased products is in the hundreds of billions of pounds (more than 50 million tons). This provides incredible opportunity for growth of biobased products both on a national and international level (EERE, 2006).

In 2003 biomass was the leading source of renewable energy in the United States, mostly coming from industrial heat and steam production by the pulp and paper industry and electrical generation with forest industry residues and municipal solid waste (MSW). It provided 2.9 quadrillion Btu (13.61 kJ) of energy and was the source for 47% of all renewable energy or 3% of the total energy produced in the United States (EERE, 2006).

1.2 Trends in ethanol consumption and use

The US Energy Policy Act of 2005 (FERC, 2005) stated that by the year 2012, the oil industry will be required to blend 7.5 billion gallons of renewable fuels into gasoline. A new mandate issued in December of 2007 stated that this Renewable Fuel Standard (RFS) has increased to require the production of 36 billion gallons of renewable fuels per year by 2020 (EERE, 2008). The most common renewable fuel is ethanol. Currently, gasoline is blended with oxygenates. The only two oxygenates currently available are ethanol and methyl tertiary butyl ether (MTBE). MTBE was used to replace lead in gasoline as an oxygen enhancer in 1979. Now ethanol is replacing MTBE as a fuel additive because MTBE has been known to contaminate groundwater in California (Mielenz, 2001).

When ethanol is blended with gasoline, fuel combustion has been known to improve tailpipe emissions of CO and unburned hydrocarbons that form smog have been reduced (Wyman, 1996). Also, by using bioethanol, a net reduction of 60-90% in the levels of carbon dioxide compared to gasoline-consuming vehicles is possible (Brown et al., 1998). The performance of an ethanol fueled vehicle is also superior to that of gasoline. Ethanol enables combustion engines to run at higher compression ratios because of its higher octane rating, causing an increase in net performance (Wyman, 1996). In addition, the vapor pressure and heat of vaporization of ethanol are both greater than that of a gasoline engine, resulting in higher power outputs (Zaldivar et al., 2001). However, because of its oxygen content, pure ethanol has 33% less energy than gasoline (Kosaric, 1996). Ethanol can be blended with gasoline at levels of 10%, 20%, and 85%, or used as 100% pure. All gasoline vehicles can use E10 (10% ethanol). E85, however, must be burned in Flex-fueled vehicles, which have an oxygen sensor in the fuel line and can adjust the engine timing and fuel injection (Alternative Fuel Education Review).

In 2005, Brazil produced 4.2 billion gallons of ethanol, increasing from 4.0 billion gallons in 2004. This ethanol is being produced from the feedstock sugar cane. It is used as either 22% ethanol blends with gasoline or as neat ethanol fuel containing 100% ethanol (Mielenz, 2001). Brazil has found amazing success using this feedstock, which is grown all over the country. Sugarcane is an excellent feedstock; however it can only be grown in select areas of the Unites States due to its limited climate adaptation and can therefore not be considered a substantial resource for ethanol fuel.

The United States produced 3.9 billion gallons of ethanol in 2005. This increased from 3.4 billion gallons in 2004 (USDA, 2006). There were 101 ethanol plants operating in 21 states as of June 2006 with a total production capacity of 4.8 billion gallons of ethanol per year, and there are 33 ethanol plants currently under construction. The United States has the capacity to build enough ethanol production facilities to support its citizens. However, problems surface when the availability of feedstocks and economics for ethanol production are analyzed.

The primary limiting factors affecting the commercial production of ethanol are the availability of biomass and the cost of ethanol. An analysis done by Oak Ridge National Laboratory indicated that the maximum amount of agricultural residues that could be collected today is roughly 144 million dry tons per year (EERE, 2006). This translates to a supply of only 10% of our light duty transportation needs. Because these numbers do not meet our national demands, new resources for the production of ethanol must be discovered and implemented.

Recently, the price of ethanol in the United States has followed the price of gasoline plus the 51 cents per gallon Federal excise tax credit. Spot prices of ethanol, however, have increased to over 4 dollars per gallon as the demand has increased. But ethanol prices are eventually expected to decrease as the production increases. Also, as ethanol production increases to fully replace MTBE and meet the requirements set by the government, the price of ethanol should reflect its value as a gasoline extender and fluctuate up and down with the price of gasoline (USDA, 2006).

In the United States, the primary feedstock being used in ethanol production, accounting for approximately 97%, is corn (EERE, 2006). Although this starch-based resource is an excellent source of feedstock to produce ethanol, there is not enough corn produced in the United States to provide sufficient ethanol fuel to meet the energy demand. Another problem associated with using corn as the only feedstock to produce ethanol is that the main corn producing states, and hence most of the ethanol plants, are located in the Midwestern states. This creates a transportation cost for the corn deficient states, because it cannot grow everywhere in the country. In addition, there are environmental, social and food and feed market issues surrounding the sustainability of corn as a feedstock for US ethanol production needs. Negative environmental impacts arise when fertilizer application and acreage usage is considered. Corn is an inherently inefficient user of nitrogen, where 40-60% of the nitrogen is not absorbed by the crop, and N levels in downstream aquatic ecosystems from corn-dominated landscapes are typically 20 to 40 kg N ha^{-1} yr^{-1} (Balkcom et al., 2003; Randall et al., 2003). Therefore, increases in the acreage of corn and the fertilizer application rates due to rising corn prices leads to increased N and P losses to rivers, lakes streams, and coastal waters, particularly those located downstream of expanding production areas (Simpson et al., 2008). Corn being used as a feedstock for ethanol production also competes with the food industry. Because of the demand for corn, a recent increase from 2 to 5 dollars a bushel has occurred (Cohen, 2008). Relying completely on the production of ethanol from corn starch is insufficient due to the competition which arises between the corn cultivation and the limited agricultural land for both food and feed production (Sun and Cheng, 2002). As a result, the RFS in the Energy Independence and Security Act of 2007 requires that

renewable fuels come from four different categories: conventional biofuel (corn starch), advanced biofuel (renewable fuel other than corn starch), biomass-based diesel, and cellulosic biofuel (derived from any cellulose or lignin from renewable biomass) (EERE, 2008). *Additional feedstocks suitable for conversion to renewable fuels need to be identified for other regions of the United States in order to increase advanced biofuel production*.

1.3 Lignocellulosic Materials/Feedstock

Lignocellulosic biomass as a potential feedstock for the production of ethanol can be obtained from two potential sources: waste material from processes other than fuel production such as agriculture and forest products industries, or from energy crops which are grown specifically for the purpose of fuel production (Lynd, 1996). Most lignocellulosic biomass is composed of the same three major components: cellulose (30-50%), hemicellulose (20-30%), and lignin (20-30%). Lignocellulosic biomass is a valuable resource for a future bioindustry. However, problems emerge when cost effective recovery of these components is attempted (Pastor et al., 2003).

Cellulose is a chain of six-carbon sugars called glucose joined by β-1,4-glycosidic linkages. Hydrogen bonds between the chains lead to the formation of sheets lying on top of one another in a staggered position. This makes cellulose very chemically stable, insoluble, and difficult to break down (EERE, 2006).

Hemicellulose is a highly branched heteropolymer containing sugar residues such as hexoses (D-galactose, L-galactose, D-mannose), pentoses (D-xylose, L-arabinose), and uronic acids (Zalvidar et al., 2001). It strengthens the plant wall by forming a short-chain polymer that interacts with cellulose and lignin.

Lignin is the most abundant aromatic polymer in nature, and is what makes up the woody part of the lignocellulosic biomass. It is composed primarily of carbon ring structures interconnected by polysaccharides, which are very valuable chemical intermediates. Separation and recovery of these lignin structures is also very difficult to accomplish (Pastor et al., 2003).

The compactness and complexity of lignocellulose makes it much more challenging to enzymatically degrade to fermentable sugars than is the case for starch. Therefore, the cost of producing a gallon of ethanol from biomass is higher than producing it from starch (Wyman, 2003).

The effort taken by the U. S. Department of Energy's Biomass Program focuses on the feedstock supply of lignocellulosic biomass such as corn stover, straw, and wood that can be converted into energy products (i.e. fuels, chemicals, and power) through sugar or thermochemical platforms. Analysts for the biomass program estimate that 512 million dry tons of biomass, equivalent to 8.09 quads of primary energy, could initially be available at less than $50/dry ton delivered (Walsh et al., 2003).

1.3.1 Sugar platform

The conversion of lignocellulosic material to ethanol includes three basic steps: pretreatment of lignocellulosic materials, hydrolysis of cellulose to fermentable sugars, and fermentation of sugars to ethanol. Researchers working on the sugar platform of the are currently focusing on developing technology to remove lignin and break down cellulose and hemicellulose to their component sugars, including glucose, xylose, mannose, galactose, rhamnose, and arabinose. The lignin portion of the biomass can either be converted to fuel

and chemicals by itself or be burned for electricity. Proposed biorefineries can then biologically process produced sugars to fuel ethanol or chemical building blocks (EERE, 2006).

The pretreatment step alters the structure of the lignocellulosic material by removing the lignin and reducing cellulose crystallinity, thus exposing the cellulose for hydrolysis (Mosier et al., 2005). There are three major approaches for pretreating the biomass: 1) acid prehydrolysis (low temperature/ concentrated acid and high temperature/dilute acid), 2) alkaline pretreatment, and a 3) high pressure/high temperature treatment. In the low temperature, concentrated acid hydrolysis, concentrated acid disrupts the hydrogen bonding between the cellulose chains. This "decrystallization" forms a homogeneous gelatin with the acid, and causes the cellulose to be extremely susceptible to hydrolysis (Sheenan and Himmel, 1999). Research and development of this process has been around since the early 1900's, but in the last 20 years it has become increasingly active. At Purdue University and at Tennessee Valley Authority, researchers have made improvements on the recycling of concentrated sulfuric acid (Tsao et al., 1982; Broder et al., 1992). However, analysis of commercialization of these processes proves to be uneconomical due to the high volumes of acid required (Wright and d'Agincourt, 1984). Even more recently, Arkenol has developed a patented process in which the decrystallization is followed by an additional hydrolysis with diluted acid (EERE, 2006). A triple effect evaporator is required to reconcentrate the acid (Farone and Cuzens, 1996). This process, however, uses excessive amounts of acid which is not completely recovered and must be disposed of as wastewater.

The dilute acid hydrolysis process in the sugar platform attempts to optimize sugar yields with two stages of hydrolysis. The first and milder stage of hydrolysis breaks down the hemicellulose, while the second stage focuses on the more stable cellulose portion of the lignocellulose (Harris et al., 1985). In 2000, British Columbia International and the DOE's Office of Fuels developed a plan to construct a biomass-to-ethanol plant capable of producing 20 million gallons of ethanol a year using a dilute acid hydrolysis process (EERE, 2006). Also, Tembec and Georgia Pacific are both operating sulfite pulp mills in North America, which utilize this dilute acid hydrolysis process to dissolve hemicellulose and lignin from wood, and produce specialty cellulose pulp (EERE, 2006).

The alkaline pretreatment process involves the addition of a strong base to the lignocellulosic biomass, causing disruption of the intercellular bonds which crosslink hemicelluloses, lignin, and cellulose. This results in decrystallinity and separation of the three components (Sun and Cheng, 2002). The most widely studied base is sodium hydroxide. Research has shown that at 120°C, lignin content can be reduced by over 55% within 30 minutes of pretreatment when using 0.5 % NaOH solution (Soto et al., 1994). The use of lime (calcium hydroxide) as an alkali pretreatment has also been used due its low cost. Research has shown that compared to an untreated sample, samples treated with lime increased the rate of enzymatic hydrolysis of corn stover by almost ten times (Kaar and Holtzapple, 2000). As in acid pretreatment, however, the recovery of reagents is necessary and adds cost to the overall process.

Once the three main components of lignocellulosic biomass are separated, enzymatic hydrolysis is performed to break down cellulose and hemicelluloses into component sugars

using different enzymes. The three cellulase enzymes used are endoglucanase, exoglucanase, and β-glucosidase (Sun and Cheng, 2002). To break down the hemicelluloses, xylanases and β-xylosidases are used. The key economic barrier in this process is the high cost of enzymes needed to hydrolyze the celluloses. The Biomass Program is currently working with Genencor International and Novozymes to achieve a 10 to 50 fold reduction in the cost of these enzymes to enable this platform to be economically competitive with fermentation of starch or sugar crops (EERE, 2006). Because environmentally friendly enzymes are used, subsequent fermentation is ideal due to minimal side products produced. However, acid from the lignin pretreatment process still creates disposal issues.

1.3.2 Thermochemical Platform

The thermochemical platform of the DOE's Biomass Program describes biomass gasification as an approach to producing fuels and chemicals. If biomass is heated with little or no oxygen, less than needed for combustion, it reduces into a mixture of carbon and hydrogen in the form of CO_2 and H_2. The resulting gaseous components are called syngas. This syngas burns more efficiently than biomass and can also be burned in gas turbines (EERE, 2006). Moreover, if these gasifiers are placed in series, researchers have shown that they can burn biomass to produce mixtures of gases including the single-carbon gases carbon dioxide and carbon monoxide, which can be fermented by select microorganisms or mixed with chemical catalysts for conversion to valuable fuels and chemicals (Huhnke et al., 2002; Cotter, 2006). The Fischer-Tropsch process uses syngas to create valuable products, specifically fuels needed for transportation. It uses a transition metal catalyst to convert CO and H_2 to liquid hydrocarbons. The catalytic processes to convert biomass to ethanol,

however, are relatively inefficient, and must be further researched to decrease unwanted byproducts such as methane and methanol (EERE, 2006).

1.4 Starch-based Feedstocks

Starch is the most widespread carbon reserve stored in plants and is of significant importance in the industry for food, chemical, and enzymatic uses (Geigenberger, 2003). It is synthesized in plants as a result of photosynthesis, and its composition varies with different species. While research and development of lignocellulosic biomass conversion processes is essential to this country's movement towards replacing fossil fuels with renewable energy, *more near-term emphasis should be placed on finding alternate and abundant starch sources that can be implemented within the next three to five years.*

1.4.1 Starch Crops

The four main industrial sources of starch today are corn, tapioca, potato, and wheat (van der Maarel., 2002). As previously stated, corn is the most widely grown source of starch in the United States for the production of ethanol, but it is concentrated in the Midwestern states. Steps need to be taken in order to utilize land in other parts of the country. Root and tuber crops contain on average 70-80% water, 16-24% starch, and trace quantities of proteins and lipids (Hoover, 2001). Sweetpotatoes (*Ipomoea batatas*, Morning-glory family) are another major starch-based crop grown in the United States which offers an alternative material that can be converted to sugars needed for ethanol production and/or value added products. They are grown primarily in the Southeastern region of the United States and offer up to a 30% yield in starch, and could be used in addition to corn for renewable sugar feedstocks (Zhang and Oates, 1999). North Carolina, Mississippi, Louisiana, and Alabama

alone produced over 80% of the country's sweetpotatoes in 2007, growing over 100,600 acres (NASS, 2007). High starch industrial sweetpotatoes (ISPs) have been bred for higher dry matter content to generate up to 50% higher starch yields than the common orange-fleshed sweetpotato and are not intended for use as a food crop (Nichols, 2007).

Sweetpotatoes rank as the fifth most important food crop on a fresh-weight basis in developing countries, after rice, wheat, corn and cassava (Huntrods, 2008). Yet because they are a low impact crop which is resistant to drought, typhoons, pests and diseases, and can grow in poor soils, there is greater potential for growing them in various regions and for purposes outside of food, like the ISP (Noda et al., 1992). Sweetpotatoes have been considered a good substrate for alcohol fermentation since they have a higher starch yield per unit land cultivated than grain, and continue to increase in weight during its long growing season until harvested (Sachs, 1980; Wu and Bagby, 1987).

1.4.2 Starch Composition

Starch is a well-known polymer of glucose, linked by glycosidic bonds. The two major types of molecules in starch are amylose and amylopectin (van der Maarel et al., 2002). Amylose, the minor linear polymer in sweetpotatoes, consists mainly of α-1,4 linked D-glucopyranosol residues (Hoover, 2001). It contains up to 6000 glucose units. Amylopectin, the major polymer in sweetpotatoes, is composed of short α-1,4 linked linear chains of 10-60 glucose units and α-1,6 linked side chains containing 15-45 glucose units. Amylopectin contributes to the side branching of starch. One molecule of amylopectin usually contains around 2,000,000 glucose units, making it one of the largest molecules existing in nature

(van der Maarel et al., 2002). The structure of amylose and amylopectin allow starch to be converted to glucose, a major sugar feedstock in ethanol conversion.

1.4.3 Starch Conversion

Starch, unlike lignocellulose biomass, is more easily convertible to ethanol and can be described in three basic steps. Initially, the starch must be converted to a useable fermentable sugar. This can be achieved through a variety of different processes, including acid hydrolysis, high temperature and pressure extrusion, and enzymatic hydrolysis. Once the starch is converted to simple sugars, it must then be fermented using biocatalysts such as yeast or bacteria to produce ethanol (EERE, 2006). Finally, the aqueous ethanol solution must be distilled to extract its pure form.

Currently, there are two processes used to create ethanol from corn, the wet milling and the dry milling processes. Wet milling accounts for about 21% of ethanol production and dry milling accounts for about 79% of production (USDA, 2006). In the wet milling process, corn is separated into starch, protein, fiber, and corn germ. Only the pure starch is used for ethanol production. The rest of the corn is used to make various byproducts, such as corn oil, corn gluten meal, corn gluten feed. In the dry milling process, corn kernels are ground and mixed with water. This is then cooked in a process called liquefaction, and enzymes are added to convert the starch in the corn to glucose in a process called saccharification. The glucose is then converted to alcohol through fermentation (USDA, 2006). Although there are fewer useful byproducts produced when using the dry-milling process, it is more efficient.

The need for alternative starch crops will create a demand for the development of processes to efficiently convert different forms of starch to ethanol. *In North Carolina, there*

is a potential to develop this process using sweetpotatoes as the starch source to produce fermentable sugars for ethanol and valuable chemicals.

1.5 Acid hydrolysis

Acid hydrolysis of starch uses different concentrations of common acids, primarily HCl, to hydrolyze starch into fermentable sugars. This is one of the oldest forms of conversion but has problems with disposal because of the high concentrations of acid used. If all of the acid is not recovered, it is disposed of with the wastewater runoff. Lee et al. (1985) hydrolyzed raw cassava starch using a combination of acid hydrolysis (HCl) and commercial enzymes (pectin depolymerase, α-amylase, glucoamylase) and showed that treating the starch with 0.5 N HCl for 12 hours in addition to saccharifying the starch with α-amylase and glucoamylase yielded the maximum alcohol production (95% ethanol yield) and converted 65% of the starch to sugar. Further increases in acid concentration resulted in decreased ethanol yields. This was attributed to increased production of hydroxymethylfurfural (HMF), a dehydration product of D-glucose known to inhibit growth and alcohol fermentation by yeast from acid hydrolysis. Acid hydrolysis of sweetpotatoes at various temperatures (97, 110, and 129.4ºC) showed that reducing sugars up to a dextrose equivalent of 84% were quickly formed with elevated concentrations of HCl (1N, 1.5N, 2N HCl) and increased temperature, but this also significantly increased the HMF concentration and destroyed the reducing sugars (Kim and Hamdy, 1985; Azhar and Hamdy, 1981).

1.6 Temperature and pressure

Temperature treatments and high pressure extrusions have been researched to determine if they effectively hydrolyze starch without the addition of commercial enzymes. There are

native alpha and beta amylase enzymes found within sweetpotato starches that have been known to have important effects on the processing of sweetpotatoes (Doebald et al., 1969). One study using heat treatments during hydrolysis of sweetpotato mashes found that a temperature of 70°C produced 18.4% maltose and 12.7% sucrose, however only 3.5% glucose and 2.0% fructose was recovered (expressed as a percentage of dry matter). In addition, 35.7% of AIS remained after hydrolysis (McArdle and Bouwkamp, 1986). Depolymerization of starch using high pressure extrusion by Kim and Handy (1987) showed that high pressure alone, up to 20,000 psi, produced a dextrose equivalent of only 1.15 (measured as a reducing power of dextrose). Also, this study showed no traces of either glucose or maltose in the solution containing depolymerized starch, indicating that a very small concentration of starch was hydrolyzed to fermentable sugars. When high pressure was combined with heat (97ºC) and acid (3N HCl), 17.1% glucose and 26.1% of total sugars were recorded, however production of HMF was also detected.

1.7 Enzyme hydrolysis

Enzymatic hydrolysis of starch can offer a simpler and more environmentally friendly method to produce ethanol. Several commercial enzymes can be used to convert starch into its simple sugars, including α-amylase, β-amylase, and glucoamylase, α-glucosidase, and pullulanase. The enzyme α-amylase acts on the inner portions of amylose and amylopectin to form glucose chains of varying length. Conversely, β-amylase breaks the external glucose units of amylose and amylopectin to produce maltose and shorter glucose chains. Glucoamylase produces free glucose by cleaving both α-1,4 and α-1,6 glycosidic bonds on longer chains of amylose and amylopectin. Pullulanase breaks the α-1,6 bond in

amylopectin, and α-glucosidase cleaves short maltose chains to produce glucose (van der Maarel, 2002).

The enzymatic hydrolysis of starch can be described in two basic steps: liquefaction and saccharification. Initially, an aqueous slurry of starch is heated at a temperature high enough to induce gelatinization and liquefied using a liquefying agent (α-amylase, β-amylase) to produce short chain sugars (dextrins). The liquefied starch is then saccharified at a lower temperature in the presence of at least one saccharifying enzyme (glucoamylase, pullulanase, α-glucosidase) to provide an aqueous solution containing 60-80% weight of the original starch in the form of fermentable sugars (Muller and Miller, 1981).

Liquefaction

$$Starch + H_2O \longrightarrow Dextrins + Maltotriose + C_{12}H_{12}O_{11}\,(\text{Maltose})$$

Saccharification

$$Dextrins + Maltotriose + C_{12}H_{12}O_{11} \longrightarrow C_6H_{12}O_6\,(\text{Glucose})$$

One issue which arises during the breakdown of this starch is increased viscosity during gelatinization. Gelatinization is a transition which is caused by heating a starch source in the presence of excess water, and causes a radial swelling and diffusion of the excess water into the starch granule (Hoover, 2001; Stevens and Elton, 1981; Donovan, 1979; Evans and Haismann, 1982; Biliaderis, 1991). The gelatinization temperature for sweetpotatoes (*Ipomoea batatas*), occurs at a temperature of 84.6°C (Collado et al., 1999). A solution to this problem, which is necessary for the breakdown of the starch into its simple sugars, is to add enough water to overcome the increased viscosity and keep the sample in liquid form. Though sometimes causing problems with viscosity and sample mixing, the gelatinization of

starch is expected and encouraged during enzymatic hydrolysis. This process is known to disrupt the double helices of amylopectin in the amorphous region of the starch granules. This increases the accessibility of unraveled chains to for diffusion by the enzyme during continued heating of hydrolysis (Gunaratne and Hoover, 2002).

Studies on enzymatic hydrolysis have been performed testing different enzymes and starch sources and have revealed promising results. The conversion of cooked sweetpotato varieties to ethanol using pectinase, α-amylase, and glucoamylase showed that viscosity reduction with pectinase (0.1ml/100g of ground, wet, Jewel sweetpotato) is important in ethanol recovery, and produced 15.8 g glucose/100 ml of solution with a theoretical ethanol yield of 90% using the HiDry variety (Wu and Bagby, 1987). A study of alcohol fermentation of uncooked sorghum using glucoamylase preparations from *A. niger* and *Rhizopus* sp. resulted in a 91.9% alcohol yield based on the theoretical value of the starch content and using 30-35% (w/v) (Thammarutwasik et al., 1985). Finally, when hydrolysis of sweetpotatoes at 100°C for 30 minutes (autoclaved) followed by saccharification at 66ºC for 60 min using a malt containing α-amylase, β-amylase, and α-glucosidase was studied, starch conversion was 88% . However, viscosity of the samples was very high due to the high loading rates (0.3-0.5 solid/liquid), and resulting sugars were also low (5.6%). When malt was then added prior to cooking, corresponding starch conversion increased to 96% conversion of total starch content and reducing sugars increased to 10.7% (Hosein and Mellowes, 1989). However, this required the uneconomical addition of 8.9% malt both before and after autoclaving the samples.

Many enzyme based studies focus on conversion of starch for use in food (Ridley et al., 2005; Koehler and Kays, 1991; Vanden et al., 1986). *It is necessary to further examine key amylase enzymes at different loading concentrations and incubation times to determine a more efficient method to convert starch, specifically industrial sweetpotato starch, to useable sugars that can then be fermented into bioethanol and high value chemicals.*

1.8 Ethanol Fermentation

Once starch is converted to simple sugars, it is fermented using biocatalysts such as yeast or bacteria to produce ethanol (EERE, 2006).

Fermentation

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH \text{ (Ethanol)} + 2CO_2$$

The most common strain of yeast used to complete this process is *Saccharomyces cerevisiae,* due to its high ethanol tolerances. Strains of *Saccharomyces* can generate up to 10-15% v/v ethanol (Boulton, 2001, 109). This process is an additional step following enzymatic hydrolysis in the overall production of ethanol. It typically requires an additional vessel for hydrolysate removal and yeast addition as well as the added time to allow complete fermentation to occur.

However, recently an alternative process called simultaneous saccharification and fermentation (SSF) has been developed which combines the enzymatic hydrolysis of starch to glucose and the conversion of this glucose to ethanol by fermentation into one operation (Sree et al., 1999). SSF has several advantages over separate hydrolysis and fermentation. Capital investments are reduced due to the elimination of an entire step. In addition, SSF significantly reduces the effects of glucose inhibition of the enzymes, since the glucose is

immediately fermented after hydrolysis (Pastor et al., 2003). One challenge that SSF creates is the fact that optimum temperatures for the yeast (35ºC) and enzymes (40-90ºC) are different. This restricts temperature variation of hydrolysis and fermentation and may limit effectiveness (activities) of select enzymes.

1.9 Objectives

The effectiveness of different enzyme treatments on glucose and ethanol production from industrial sweetpotatoes needs to be fully examined. The overall goal of this project is to effectively generate the information necessary to define a process for conversion of North Carolina industrial sweetpotato variety FTA-94 (ISPs) into ethanol. This will enable further improvements to be made in enzyme function and cost, processing, scale up, and breeding.

Specific objectives will be to: 1) Examine the effects of different enzyme loadings on sugar production during liquefaction with α-amylase; 2) Investigate the effects of solid loading and different enzyme treatments on sugar production during saccharification with glucoamylase and pullulanase; 3) Determine ethanol production yields from separate hydrolysis and fermentation (SHF); and 4) Compare the sugar and ethanol production between fresh and flour (dried) ISP preparations.

The project is supported by Novozymes North America, Inc. as part of their interest in defining new uses for enzymes within the fuel ethanol industry. The data collected will allow research to begin to improve process efficiency/cost and large scale development. Characterization of a practical process for converting sweetpotatoes to ethanol has potential to improve economic and environmental sustainability of North Carolina communities.

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Chapter 2: Liquefaction, Saccharification, and Fermentation of FTA-94 Industrial Sweetpotatoes using α-Amylase and Glucoamylase for the Production of Ethanol

2.1 Introduction

Corn is the predominant feedstock used to produce ethanol in the United States, accounting for nearly 97% of total ethanol production in 2006 (EERE, 2006). In an attempt to improve biofuel production and deflect the nation's dependence on corn as a sole ethanol producer, a movement has been made to convert lignocellulosic biomass as a potential feedstock for the production of ethanol. Lignocellulosic biomass can be obtained from two potential sources: waste material from processes such as agriculture and forest products industries, or from energy crops which are grown specifically for the purpose of fuel production (Lynd, 1996). Lignocellulosic biomass is composed of three major components: cellulose (30-50%), hemicellulose (20-30%), and lignin (20-30%). Lignocellulosic biomass is a valuable resource for a future bioindustry. However, problems emerge when cost effective recovery of these components is attempted (Pastor, 2003). While research and development of lignocellulosic biomass conversion processes is essential to US progress towards replacing fossil fuels with renewable energy, emphasis can also be placed on finding alternate and abundant starch sources that are more near term and will not limit interference with food and feed production.

Sweetpotatoes (*Ipomoea batatas*, Morning-glory family) are a major starch-based crop grown in the United States which offers an alternative material that can be converted to sugars needed for ethanol production and/or value added products. They are a drought and

pest resistant crop which can be grown in poor soils, and are predominantly grown in the Southeastern region of the United States. In 2007, 100,600 acres of sweetpotatoes were planted in the United States, with over 82% of that land in North Carolina, Louisiana, Mississippi, and Alabama alone (NASS, 2007). High starch industrial sweetpotatoes (ISPs) are not intended for use as a food crop and have been bred for higher dry matter content to generate up to 50% higher yields in starch than the common orange-fleshed sweetpotato (Nichols, 2007). These traits of ISPs offer potentially greater fermentable sugar yields from a sweetpotato crop for industrial conversion processes.

Starch conversion practices have involved three primary approaches to generating fermentable sugars: acid hydrolysis, temperature and pressure extrusion, and enzymatic hydrolysis. Acid hydrolysis offers an effective means to convert starch; however recovery of the acid is not efficient and as a result must be disposed of as wastewater (Farone and Cuzens, 1996). Another problem associated with acid hydrolysis is the production of hydroxymethylfurfurals (HMF), a dehydration product of D-glucose, which is known to inhibit growth and alcohol fermentation by yeast (Kim and Hamdy, 1985). High pressure extrusion significantly stabilizes conversion against temperature-induced inactivation. However, in a study done on the activity of α-amylase from barley malt at different temperatures, increasing pressure hindered the catalytic activity of α-amylase and a deceleration of the conversion rate was detected at all investigated temperatures (Buckow et al., 2007). Enzymatic hydrolysis of starch is biologically-based, and can offer a simpler, more environmentally friendly method to produce useful sugars and ethanol. The enzymatic hydrolysis of starch can be described in two basic steps: liquefaction and saccharification.

Initially, an aqueous slurry of starch is liquefied using a liquefying agent or enzyme to produce a sterile, liquefied starch. When heated in the presence of excess water over a temperature range characteristic of the starch source, starch undergoes an order-disorder phase transition called gelatinization (Hoover, 2001). The gelatinization temperature for sweetpotatoes (*Ipomea batatas*), occurs at a temperature of 84.6°C (Collado et al., 1999). During gelatinization, the excess water is diffused into the starch granule causing a radial swelling, loss of crystalline order, and uncoiling and dissociation of the double helices (Stevens and Elton, 1981; Donovan, 1979; Evans and Haismann, 1982; Biliaderis, 1991). The swelling acts to destabilize the amylopectin crystallites facilitating enzymatic conversion of starch into sugars. After liquefaction, the solution is saccharified in the presence of at least one saccharifying enzyme to provide an aqueous solution containing 60-80% weight of the original starch in the form of fermentable sugars (Muller and Miller, 1981). Fermentable sugars can then be used by yeast or bacteria to produce ethanol or by other microorganisms to produce high value chemicals.

Several enzymes can be used to convert starch into its simple sugars, including α-amylase, β-amylase, glucoamylase, α-glucosidase, and pullulanase. The enzyme α-amylase acts on the inner portions of the two main polymers of starch, amylose (α-1,4 bonds) and amylopectin (α-1,6 bonds), to form glucose chains of varying length. Conversely, β-amylase breaks the external glucose units of amylose and amylopectin to produce maltose and shorter glucose chains. Glucoamylase produces free glucose by cleaving both α-1,4 and α-1,6 glycosidic bonds on longer chains of amylose and amylopectin. Pullulanase breaks the α-1,6

bond in amylopectin, and α-glucosidase cleaves short maltose chains to produce glucose (van der Maarel, 2002).

The process for enzymatic hydrolysis of corn starch has been optimized and is widely used for bioethanol production in the US. However, the starch in sweetpotatoes is considered more complex than cereal starches (corn, rice), containing 19.1% amylose (Collado et al., 1999). Root and tuber starches also contain longer and more complex amylopectin chains, making it more difficult to hydrolyze into fermentable sugars (Hoover, 2001; Srichuwong et al., 2005). Previous research on sugar production from sweetpotatoes has been limited to enhancing the sweetness and taste as a food commodity (Ridley et al., 2005; Koehler and Kays, 1991; Vanden et al., 1986) and few studies using acid-based methods (Azhar and Hamdy, 1981; Kim and Hamdy, 1985; Shin et al., 2004). There is a need to establish a biologically-based approach to sweetpotato starch conversion and evaluate the enzymes and processing conditions suitable for effective sugar and ethanol production. This study investigated processing parameters of liquefaction, saccharification, and fermentation of FTA-94, an industrial sweetpotato (ISP) developed by NC State University for the production of glucose and ethanol. The effects of α-amylase and glucoamylase loading rates, glucoamylase source and incubation time on extent of starch hydrolysis and sugar production (maltotriose, maltose and glucose) from fresh and flour preparations of FTA-94 ISPs were evaluated. The most promising treatment combinations were implemented to determine the need for supplemental nutrients to support yeast fermentation of ISP hydrolysates and potential ethanol yields.

2.2 Materials and Methods

2.2.1 Enzymes

2.2.1.1 α-Amylase

The α-amylase used for liquefaction of the starch-containing mashes was Liquozyme SC (Novozymes, North America, stored at 4ºC, density 1.25 g/ml). It has an optimal pH of 5.5 with a broad pH tolerance, an optimal temperature of 85ºC, and an activity of 120 KNU-S/g enzyme. KNU-S/g (kilo novo units) of α-amylase is the amount of enzyme that breaks down 5.26 grams of starch per hour according to Novozymes standard method for α-amylase determination.

2.2.1.2 Glucoamylase

The three different glucoamylase enzymes chosen for saccharification studies with the ISPs were Spirizyme Fuel (750 AGU/g protein), Spirizyme Plus Tech (400 AGU/g protein), and Spirizyme Ultra (900 AGU/g protein). All three enzymes were produced from submerged fermentation, have an approximate density of 1.15 g/ml, and have activities based on amyloglucosidase units (AGU/g), which represents the amount of enzyme able to hydrolyze 1 μmol of maltose per minute at 37°C and a pH of 4.3. The optimal temperature of the enzymes is 65ºC.

2.2.2 Industrial Sweetpotato Preparation

FTA-94 ISPs were grown on the Horticultural Crops Research Station in Clinton, NC (35.023°N; 78.278°W). They were planted on May 23, 2007, and harvested on October 11, 2007. Two sweetpotato preparations were examined, fresh and flour (dry). Sweetpotatoes

that were used for fresh preparations were refrigerated at 58ºC until use. They were then washed, diced into chunks, and ground in a food processor to produce 3-5 mm pieces just prior to use in experiments. Sweetpotatoes were washed, cut into slices, and dried at 70ºC for 60 hours for flour preparations. The slices were then broken into smaller pieces and ground through a 3 mm screen using a Wiley mill. Flour was stored in an air tight container until use in experiments.

2.2.3 Experimental Design and Statistical Analysis

For liquefaction, the effects of incubation time (1, 2, and 3 hours), substrate preparation (fresh and flour sweetpotato), and α-amylase loading rate (0.03, 0.3, and 3.0% volume of enzyme per gram of dry ISP) on the change in starch content and the change in reducing sugars was investigated during liquefaction over time. Sweetpotato only controls (no enzyme) and no incubation controls (to determine initial sweetpotato condition) were prepared. All treatment combinations and controls were completed in triplicate. Main and interaction effects of incubation time (hour), substrate preparation (prep), and enzyme loading (load) were evaluated using analysis of variance (ANOVA) of the General Linear Model (GLM) in SAS (version 9.3.1, SAS Inc, Cary, NC). Also, pairwise t-test comparisons were performed to determine if each treatment effect was significantly different. Assessments of statistical significance were made at an α value of 0.05. The SAS code and output for Liquefaction experiments are presented in Appendix A.

For saccharification, the effects of incubation time (0, 24, 48, and 72 hours), substrate preparation (fresh and flour sweetpotato), type of glucoamylase (Spirizyme Fuel, Spirizyme Plus Tech, and Spirizyme Ultra) and enzyme loading rate (0.5, 1.0, and 5.0% volume of

enzyme per gram of dry ISP) on the change in starch content and sugar production (maltotriose, maltose, and glucose) were investigated over time. No enzyme, no incubation controls (to determine initial sweetpotato condition) and liquefaction only controls were also prepared. All treatment combinations and controls were completed in triplicate. Main and interaction effects of incubation time (hour), substrate preparation (prep), enzyme type (enzyme), and enzyme loading (load) were also evaluated using analysis of variance (ANOVA) of the General Linear Model (GLM) in SAS (version 9.3.1, SAS Inc, Cary, NC). Pairwise t-test comparisons were performed to determine if each treatment effect was significantly different. Assessment of statistical significance were made at an α value of 0.05. The SAS code and output for Liquefaction experiments are presented in Appendix A.

2.2.4 Liquefaction

Liquefaction was performed on both fresh and flour sweetpotato preparations. For flour preparations, 3 grams of dried sweetpotato and 12 ml of distilled deionized water (ddH_20), resulting in a 25% weight/volume ratio, were placed into 50 ml Falcon tubes. For fresh preparations, 10.3 g of fresh sweetpotato (3 dry grams, initial moisture content 70.9% wet-basis) and 17 ml of ddH_20 were placed into the tubes, resulting in a 12.5% weight/volume ratio. A 12.5% w/v ratio was used for fresh preparation to allow for sufficient supernatant collection after liquefaction. Liquozyme SC was added at levels of 0, 0.03, 0.3, and 3.0% volume of enzyme/g dry ISP (0, 0.045, 0.45 and 4.5 KNU-S/g dry ISP, respectively). Samples were then incubated at 85ºC for 3 hours and sampled destructively at 0, 1, 2, and 3 hours. At each hour interval, appropriate samples were centrifuged at 4000 rpm and 4ºC for 15 minutes. After centrifugation, the pH of each sample was recorded and 2 ml of

supernatant was removed and stored at -80°C until reducing sugar analysis. The solids remaining in the Falcon tubes were immediately analyzed for starch content as alcohol insoluble solids.

2.2.5 Saccharification

Considering results from liquefaction experiments, Liquozyme SC was added at a level of 0.3% volume enzyme/g dry ISP to both flour (3 g dry; 25% w/v) and fresh (9.6 g fresh~3 g dry; initial moisture content 68.8% wet basis; 12.5% w/v) preparations in 50 ml Falcon tubes and incubated at 85ºC for 2 hours. The three glucoamylase enzymes, Spirizyme Plus Tech, Spirizyme Fuel, and Spirizyme Ultra, were added to appropriate samples at levels of 0.5, 1.0, and 5.0 AGU/g dry ISP, based on their specific amyloglucosidase activities. Sodium azide was then added at a loading of 0.2% weight sodium azide/volume of treatment to prevent contamination. Treatments were incubated at 65ºC for 0, 24, 48, and 72 hours. At each 24 hour interval, appropriate treatments were destructively sampled by centrifugation (4000 rpm, 4ºC, 15 min), pH was recorded, and 2 ml of supernatant was removed and stored at -80ºC prior to sugar analysis

2.2.6 Starch Quantification

Quantification of initial starch and the remaining starch after both liquefaction and saccharification was determined using a modified Alcohol Insoluble Solids (AIS) method (Ridley et al., 2005). Initially, 8 ml of 80% ethanol (4 ml for every 1.5g of initial dry ISP) was poured into each sample and homogenized for 2 minutes using a PowerGen 700 homogenizer (Model # FGLH, Fisher Scientific, Chicago, IL). Samples were then poured into 30 ml Kimax Gooch medium porosity filtering crucibles with 1.5 g of Celite No. 219

(diatomite functional filler, Celite Corp., Lompoc, CA), which was used as a filtering agent. The homogenizer and tubes were then rinsed twice with 8 ml of 80% ethanol. All liquids were removed through the filter until contents no longer dripped through using a vacuum pump. The filter apparati were then dried for 24 hours at 70ºC and weighed. The difference in weight minus the ash content of the celite and sweetpotato was equivalent to the AIS content. Ash content of the sweetpotato was determined by drying the apparati for 24 hours at 105ºC and 600ºC for 5 hours and removing ash content contributions from the Celite 219 (1.45 grams). Protein and fibrous fractions of the sweetpotato dry matter were not measured so final results report the change in starch content as a fraction of dry matter, assuming the enzymes are not degrading protein and fiber (difference between initial and final AIS values).

2.2.7 Fermentation

Fermentation of the sweetpotato sugar hydrolysates was carried out to study the need for supplemental nutrient addition and measure ethanol production over time. Using the most promising conditions found from analysis of both liquefaction and saccharification experiments, 0.3% volume enzyme/g dry ISP of Liquozyme SC was added to both flour (5 g dry ISP; 25% w/v) and fresh (14.91 g fresh~5 g dry ISP; initial moisture content 66.5% wet basis; 12.5% w/v) preparations (exposed to UV light for 30 minutes) in sterile 50 ml Falcon tubes and incubated for 2 hours at 85ºC, followed by saccharification with Spirizyme Ultra for 48 hours (5.0 AGU/g dry ISP, 65ºC, added aseptically). Sodium azide was not added to minimize the possibility of growth inhibition of yeast during fermentation. Saccharification tubes were centrifuged (4000 rpm, 15 minutes) and 9 ml of supernatant was aseptically removed and added to Borosilicate glass disposable culture tubes (18 x 150 mm, Fisherbrand,

Fisher Scientific, Chicago, IL). Culture tubes with hydrolysates were then autoclaved (121ºC, 15 psig, 15 minutes) and allowed to cool. Depending on the treatment (salt, no salt), either 1 ml sterile ddH2O or 1 ml of sterile salt solution was added to the tubes in triplicate. The salt solution contained (per L): 1.32 g NH_4Cl, 0.11 g $MgSO_4$, 0.069 g $CaCl_2$, and 8.5 g yeast extract. Tubes were then inoculated with dried yeast (Ethanol Red Yeast, *Saccharomyces cerevisiae,* Lesaffre) at a concentration of 0.1% weight of yeast/total volume of sample. Controls with and without yeast were completed in duplicate for each ISP preparation. Culture tubes were capped and incubated at 35ºC and sampled every 24 hours for a period of 72 hours. Samples were stored at -80ºC until HPLC analysis.

2.2.8 Sugar Analysis

2.2.8.1 Reducing Sugars

Reducing sugars for liquefaction samples were quantified using a modified colorimetric dinitrosalicylic acid assay method (Chinn, 2003). Dilutions were made for all samples, including controls, based on preliminary trials. One ml of 0.1 M Sodium Acetate buffer, 3 ml of DNS reagent [per L: 150 ml of 2.67 M NaOH, 300 g of Potassium Sodium Tartrate, ddH_20 (adjusted to 1 L)], and 0.5 ml of each sample were combined and boiled in a waterbath (100°C) for 5 minutes. Glucose calibration standards (0-2 g/L) were also completed to estimate reducing sugars as glucose equivalents. Absorbencies were read at 540 nm using a Pharma Spec UV-1700 UV-Visible Spectrophotometer (Shimadzu Corporation, Kyoto, Japan). A calibration curve was generated using absorbance results from the glucose standards and absorbance values for samples were converted into milligrams of reducing sugars per gram of dry ISP.

2.2.8.2 Saccharification Sugars and Ethanol Concentrations

Individual sugars and ethanol concentrations for each sample were quantified using a Shimadzu LC-20AT HPLC system. The HPLC was equipped with a Biorad Aminex HPX-87H ion exchange column (column temp. 65ºC) with a guard column (Micro-Guard Refill Cartridge, Biorad, Richmond, CA), an automated sampler (SIL-20A), a gradient pump (LC-20AT) with degaser (GDU-20A) and a differential refractometric detector (RID-10A) (Shimadzu Corp., Columbia, MD). The mobile phase used was 5mM H_2SO_4 at a flow rate of 0.6 ml/min). All samples were diluted (10x) and filtered through 0.2 µm Nylon syringe filters before analysis. Samples were analyzed for maltotriose, maltose, glucose, fructose, and ethanol.

2.3 Results

2.3.1 Liquefaction

2.3.1.1 Starch Quantification

Alcohol insoluble solids (AIS) for both fresh and flour sweetpotato preparations represent the decrease in starch percentage relative to the initial starch dry matter content. The analysis of variance for AIS for flour preparations after liquefaction is presented in Table 2.1 The main effects of incubation time (hour) and enzyme loading (enzyme) were statistically significant (p-value < 0.05), while the interaction did not show a significant effect.

Table 2.1 ANOVA table of flour FTA-94 industrial sweetpotato liquefaction for incubation time and enzyme loading on change in starch content and reducing sugars

		AIS			Reducing Sugars		
Source	**DF**	**Mean Square**	**F-value**	**Pr > F**	**Mean Square**	**F-value**	**Pr > F**
Hour	2	17.27	6.77	0.0046	3864.60	4.09	0.0297
Enzyme	3	1216.39	477.25	<.0001	14379.92	15.21	<.0001
Hour*Enzyme	6	4.00	1.57	0.1994	1242.42	1.31	0.2890

The change in starch content of flour preparation treatments during liquefaction ranged from 23.3% to 52.7% loss in dry matter as starch, seemingly increasing with increased enzyme loading (Figure 2.1a). The average initial starch content, however, was 66.4%, leaving at least 14% of available starch not converted. Incubation for two hours produced statistically higher changes in starch than one hour, resulting in the most effective change among all enzyme loadings (42.64%, p-value < 0.05). Three hours of incubation time produced slightly higher changes in starch content, but the difference on average was not statistically greater than two hour incubation treatments. The main effect of enzyme loading suggested that on average across all incubation times, each increase in enzyme loading was significantly different than the other, with a loading of 3.0% volume enzyme/g dry ISP of Liquozyme SC producing the highest average starch change of 51.22% (p-value < 0.05). The interaction between hour and enzyme, though not significant, showed that the highest average change in starch of 52.7% was found with 3.0% volume enzyme/g dry ISP at three hours of incubation (Figure 2.1a). This was not statistically different than the change that resulted from the same enzyme loading at 2 hours, but was significantly higher than the change found at one hour. At an enzyme loading of 0.3% volume enzyme/g dry ISP, all incubation times produced significantly similar changes in starch values. For a loading of 0.03% volume enzyme/g dry ISP, however, the highest loss of dry matter (as starch) occurred at 2 hours of incubation (46.44%) and was significantly higher than the loss at 1 and 3 hours of incubation with the same enzyme loading. In addition, as enzyme loading increased within each level of incubation time, the percent loss of dry matter increases significantly.

The analysis of variance for AIS of fresh sweetpotato preparations after liquefaction is presented in Table 2.2. Similar to flour preparations, the main effects of incubation time (hour) and enzyme loading (enzyme) were statistically significant (p-value < 0.05) and the interaction was insignificant.

Table 2.2 ANOVA table of fresh FTA-94 industrial sweetpotato liquefaction for incubation time and enzyme loading on change in starch content and reducing sugars

		AIS			Reducing Sugars		
Source	**DF**	**Mean Square**	**F-value**	**Pr > F**	**Mean Square**	**F-value**	**Pr > F**
Hour	2	111.45	13.06	0.0001	4444.64	2.67	0.0901
Enzyme	3	504.73	59.14	<.0001	17860.98	15.21	<.0001
Hour*Enzyme	6	16.88	1.98	0.1089	1639.15	0.98	0.4584

Fresh sweetpotato treatments during liquefaction resulted in starch content changes that ranged from 48.9% to 68.3% loss in dry matter as starch (Figure 2.1b). The initial starch percentage was considerably higher for fresh sweetpotato preparations than flour at an average of 80.1% starch in dry matter. However, similar to results observed for flour, the fresh treatments did not convert all available starch to sugars, leaving at least 13% of available starch unhydrolyzed. On average across all enzyme loading rates, three hours of incubation produced statistically higher changes in starch percentage than both the one and two hour factor levels, with a change of 63.86% (p-value < 0.05). Considering the average of each enzyme loading across all incubation times, the 3.0% volume enzyme/g dry ISP Liquozyme SC loading was higher than both no enzyme (0%) and 0.03% volume enzyme/g dry ISP, but not statistically different than 0.3% volume enzyme/g dry ISP (64.4% dry matter loss as starch; p-value > 0.05). Figure 2.1b shows that the most starch was converted using 0.3% volume enzyme/g dry ISP α-amylase loading after three hours of incubation, which produced a 68.3% loss in dry matter that was starch. Review of the interaction effects,

however, revealed a statistically insignificant difference between the change in starch content observed with 0.3% volume enzyme/g dry ISP after three hours of incubation and incubation after two hours at loadings of 0.03, 0.3, and 3.0% v/w.

In terms of starch conversion, fresh samples performed considerably better than flour. The interaction of hour, enzyme, and preparation of the FTA-94 industrial sweetpotatoes showed that the flour preparation treatment with the highest change in starch content (3.0% Liquozyme SC, 2 hours incubation) of 51.2% was significantly less than all fresh treatments excluding those with no enzyme added. Fresh preparations at the same loading rate and incubation time converted 14.1% more of the starch dry matter, while fresh preparations at a loading of 0.3% v/w and 3 hours of incubation hydrolyzed over 17% more available starch than flour samples. Differences in starch degradation may have been related to the initial starch contents. The average initial starch content for both flour and fresh were 66.6 and 81.7%, respectively, making more starch available in all fresh samples.

2.3.1.2 Reducing Sugars

When deciding which treatment combination would be more suitable to use, it is important to consider both response variables (change in starch and reducing sugars) because each variable may show different levels of significance due to differences in measurement sensitivity. Loss of starch dry matter shows how much starch is being converted, but it doesn't show how well the starch is being converted. Analysis of the reducing sugars shows whether the starch is being converted to fermentable sugars and the relative size of those sugars (more reducing sugars means smaller sugars which are easier to ferment).

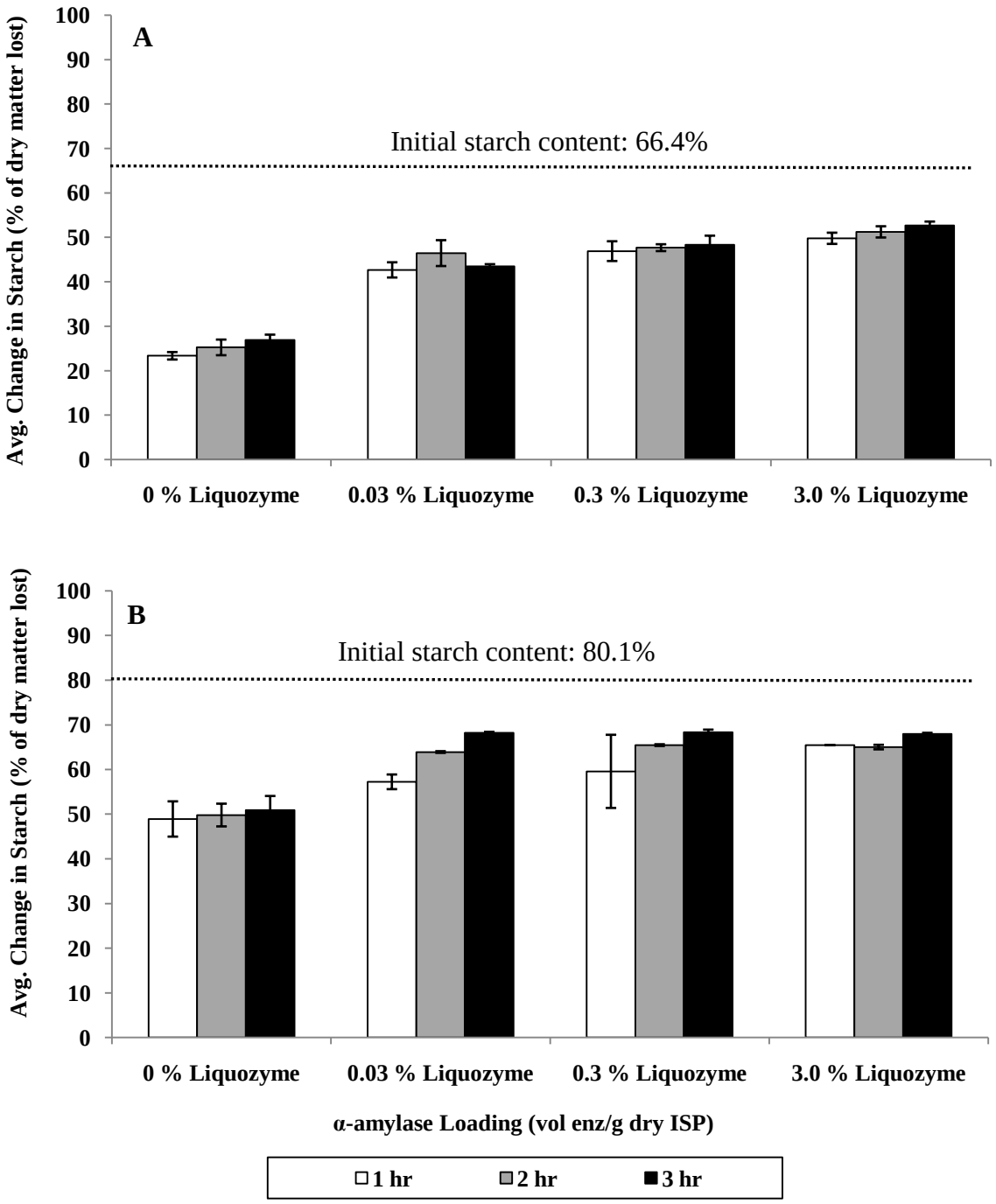

Figure 2.1 Average change in starch (% of dry matter lost) over time during liquefaction of flour and fresh FTA-94 industrial sweetpotatoes using Liquozyme SC: A) flour preparations B) fresh preparations.

Reducing sugars for both flour and fresh sweetpotato samples were measured as a change in milligrams of sugars per gram of dry ISP. The change in reducing sugars represents the increase in sugars from time zero to each respective incubation time. The analysis of variance for reducing sugars generated from flour treatment combinations during liquefaction showed significant main effects of incubation time (hour) and enzyme loading (p-values < 0.05) and an insignificant interaction of hour and loading (Table 2.1). The flour treatments produced changes in reducing sugars ranging from 18.5 to 160.8 mg/g dry ISP (Figure 2.2a). The main effect of incubation time averaged across all enzyme loadings showed an insignificant change in reducing sugars between hours two and three. Incubation for three hours, however, was significantly greater than hour 1 (p-value < 0.05). Observing the main effect of enzyme loading showed that the 0.3% volume enzyme/g dry ISP loading produced the most reducing sugars, with significantly higher values than both 0.0 and 0.03% v/w treatments (p-values < 0.05). A high variance existed among each combination with unusually large standard deviations (Figure 2.2a), making it difficult to identify the most promising interaction effect of incubation time and enzyme loading rate based on reducing sugar content. An increase from 0.3 to 3.0% v/w enzyme during 2 hours of incubation caused an increase in reducing sugars of 20 mg/g dry ISP, whereas that same increase in enzyme caused a reduction in sugars of 70 mg/g dry ISP for 3 hours of incubation and a drop of 25 mg/g dry ISP with only one hour of incubation.

Results for change in reducing sugars from fresh sweetpotato preparations during liquefaction ranged from 120 to 287.1 mg/g dry ISP, and were significant only for the main effect of enzyme loading (p-value < 0.05) as shown in the analysis of variance table (Table

2.2). Statistically, a loading of 0.3% volume enzyme/g dry ISP of Liquozyme SC produced higher values than both 0 and 0.03% v/w loadings and an insignificantly lower value than the 3.0% v/w loading. The interaction effects between hour and enzyme showed that the greatest amount of sugars, on average, was produced after three hours incubation time with a loading of 0.3% v/w (287.1 mg/g dry ISP, Figure 2.2b). This reducing sugar value was not significantly different than the 3.0 v/w loading at both 1 and 2 hours of incubation (p-values > 0.05), and only slightly larger than the same loading rate after only 2 hours of incubation (216.2 mg/g dry ISP; p-value < 0.05). Reducing sugars in fresh preparation treatments were statistically higher for every enzyme loading and incubation time than flour preparations (Figure 2.2).

2.3.2 Saccharification

2.3.2.1 Starch Quantification

Changes in starch content during saccharification studies were quantified using alcohol insoluble solids and represent the percent of starch dry matter that was hydrolyzed to soluble sugars. Both fresh and flour ISP saccharification treatments showed slight improvements in the amount of starch converted into sugars beyond conversion during liquefaction. The analysis of variance for AIS in saccharification flour preparations is presented in Table 2.3. The main effects of both incubation time (hour) and glucoamylase source (enzyme) and the interaction of hour and type of enzyme were statistically significant (p-values < 0.05).

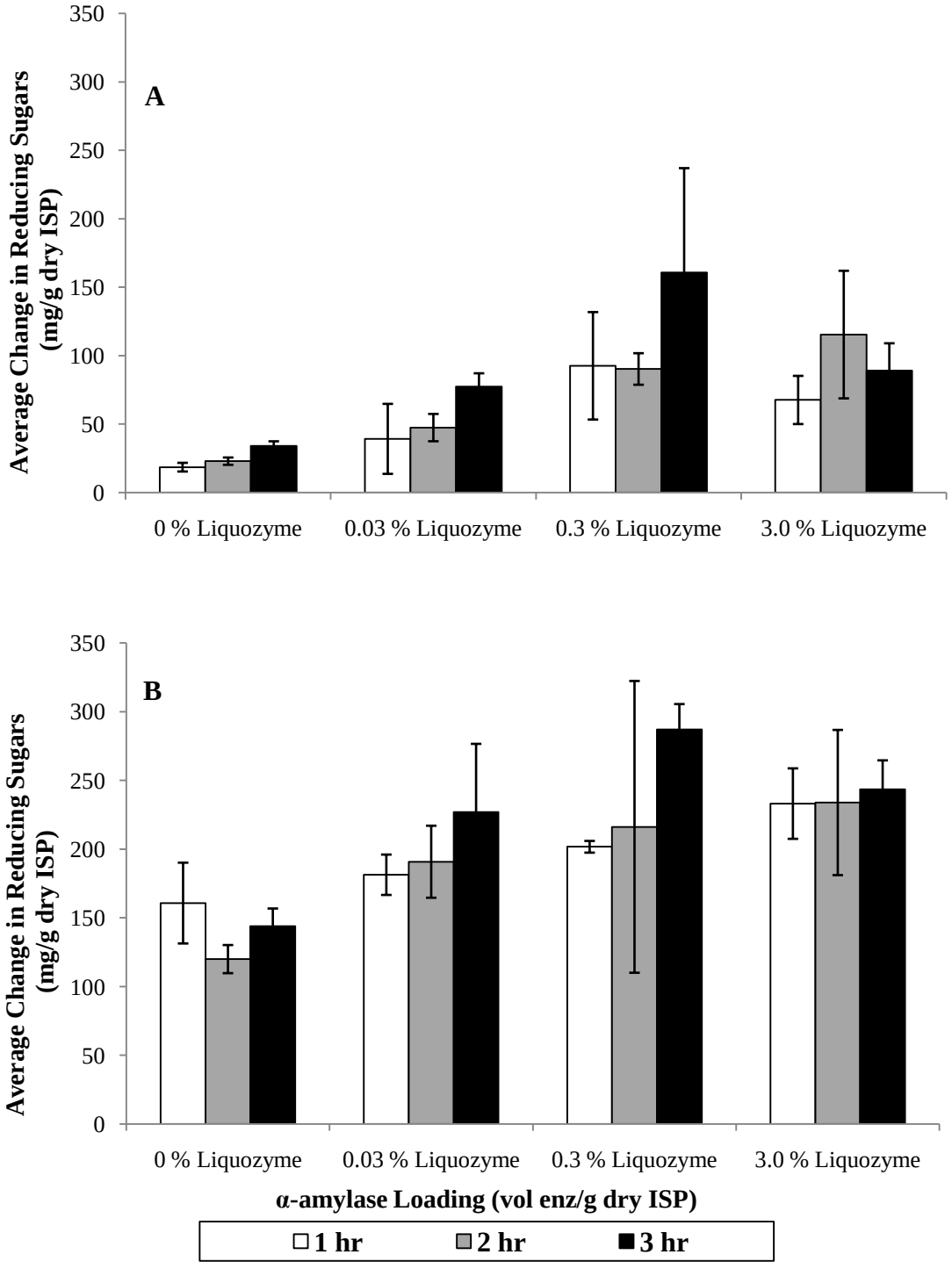

Figure 2.2 The average change in reducing sugars over time during liquefaction of flour and fresh FTA-94 industrial sweetpotatoes using Liquozyme SC A) flour preparations B) fresh preparations.

Change in starch as a percent of dry matter lost for flour treatments during saccharification ranged from 48.6 to 53.3%. Liquefaction treatments completed as controls in this experiment containing 0.3% v/w Liquozyme SC and no glucoamylase converted up to 1.3% less starch than treatments with 0.5 AGU/g dry ISP among all three types of glucoamylase. The initial starch contents measured for Spirizyme Fuel, Spirizyme Plus Tech, and Spirizyme Ultra were on average 64.72, 63.50, and 64.61%, respectively, indicating that after liquefaction approximately 11% of insoluble starch remained to be converted. Across all enzyme loadings, the average change in starch for each type of enzyme fluctuated as incubation time increased as observed with the interaction of incubation time and type of enzyme. The change in starch for each enzyme at time 0 was statistically lower than 24, 48, and 72 hours of incubation. The highest change in starch content for Spirizyme Fuel occurred at hour 72 (53.1%), which was statistically different than hours 24 (51.4%) and 48 (52.5%). Spirizyme Plus Tech achieved its highest change in starch at hour 48 (51.7%), which was statistically higher than hour 72 (49.9%) but statistically similar to hour 24 (51.6%). Spirizyme Ultra produced statistically similar changes for hours 24, 48, and72. Within this same interaction, reviewing all enzyme types showed that 24 and 48 hours of incubation produced significantly higher losses of dry matter as starch than 0 hours of incubation (p-values <0.05). For Spirizyme Fuel and Spirizyme Ultra, the change in starch content at 72 hours was significantly higher than values at time zero (53.1 and 52.2%, respectively p-values <0.05). The interaction effects of glucoamylase source, loading rate, and incubation time did not have a statistically significant effect on change in starch content. As loading rate increased for each glucoamylase source at each time interval, change in

starch content fluctuated. The highest average change in starch content was 53.3% and was achieved with Spirizyme Fuel at a loading of 0.5 AGU/g dry ISP and an incubation time of 72 hours (Figure 2.3a).

Table 2.3 ANOVA table of flour and fresh FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on change in starch (% of dry matter lost)

		Flour			**Fresh**		
Source	DF	Mean Square	F-value	Pr > F	Mean Square	F-value	Pr > F
Hour	3	37.81	78.03	<.0001	152.65	422.23	<.0001
Enzyme	2	19.94	41.13	<.0001	194.89	539.04	<.0001
Load	3	0.745	1.54	0.2100	1.24	3.44	0.0200
Hour*enzyme	6	6.39	13.19	<.0001	9.51	26.30	<.0001
Hour*Load	9	0.60	1.23	0.2872	0.32	0.89	0.5352
Enz*Load	6	0.50	1.03	0.4078	0.49	1.35	0.2409
Hour*Enz*Load	18	0.44	0.91	0.5677	0.29	0.81	0.6831

Hour = incubation time: Enzyme = type of glucoamylase: Load = amount of enzyme loading

The analysis of variance for saccharification of fresh sweetpotato preparations is presented in Table 2.3. The main effects of incubation time (hour), glucoamylase source (enzyme), and enzyme load were statistically significant (p-values <0.05) as well as the interaction of hour and enzyme (p-values <0.05). Fresh sweetpotato treatments saccharified with glucoamylase produced a broader range of starch content changes from 53.3 to 61.8% than flour sweetpotato treatments. This extent of change was not observed from the liquefaction controls that did not contain glucoamylase. Liquefaction converted at most 1.1% less starch than those treatments with 0.5 AGU/g dry ISP among all three types of glucoamylase. The change in starch as a percent of dry matter for each treatment combination is presented in Figure 2.4. Within each glucoamylase source, incubation for 24 hours converts up to 5.3% more starch beyond liquefaction for each glucoamylase loading rate. For fresh treatment preparations the average initial starch contents were 68.61, 74.17,

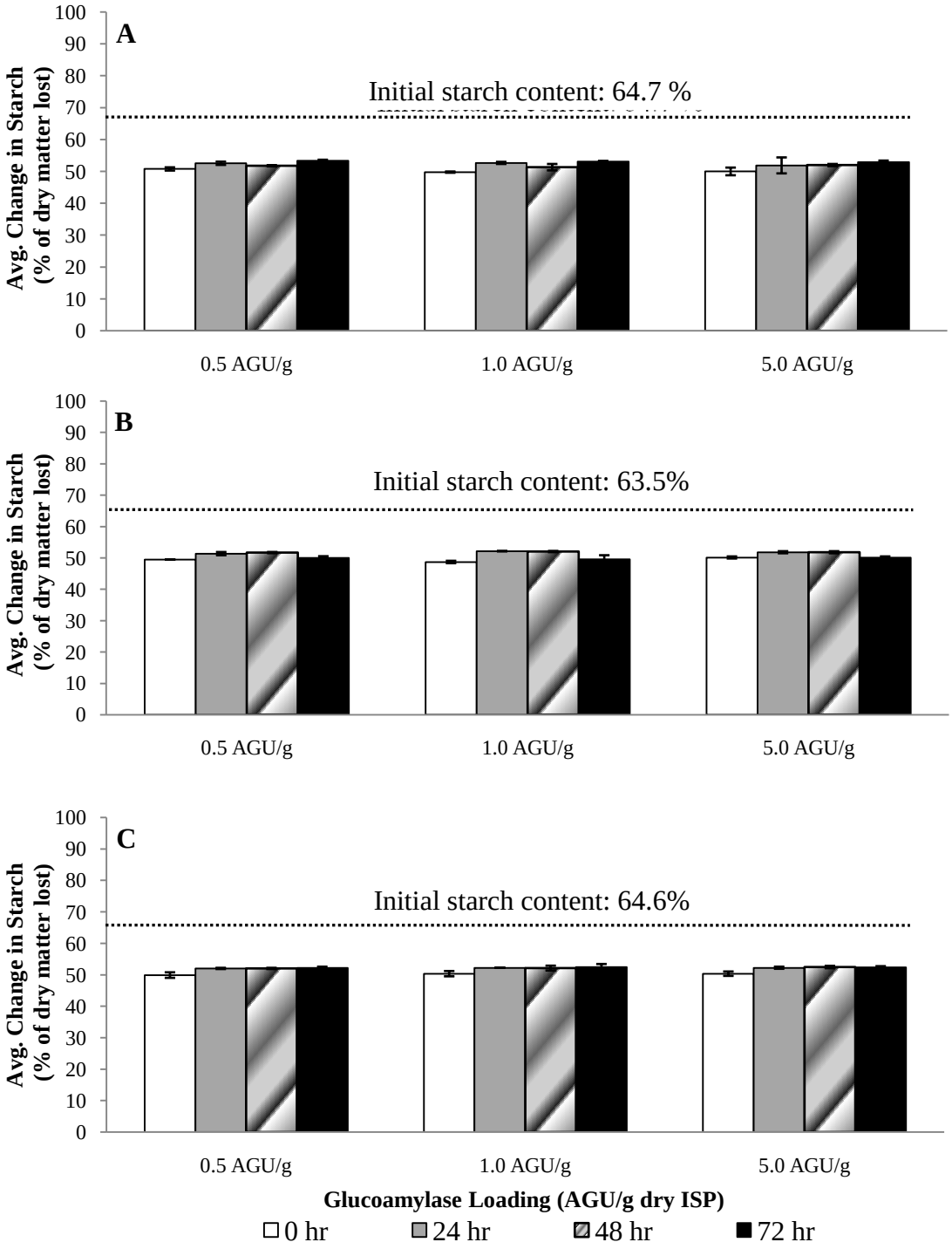

Figure 2.3 Average change in starch (% loss of dry matter) over time during saccharification of flour FTA-94 industrial sweetpotatoes using three different glucoamylase enzymes: A) Spirizyme Fuel. B) Spirizyme Plus Tech. C) Spirizyme Ultra.

and 74.17% for Spirizyme Fuel, Spirizyme Plus Tech, and Spirizyme Ultra, respectively. This amount of initial starch was considerably less than the starch content observed during liquefaction studies, and influences the amount of starch that is converted as measured by AIS. If there is less initial starch available to convert, samples will produce a smaller change in starch content (% of dry matter lost) than samples with a higher initial starch content (as seen in liquefaction results). For the interaction of type of enzyme and incubation time across all enzyme loading levels, Spirizyme Fuel, which had the lowest initial starch content, produced statistically lower changes in starch content (53.8 to 56.5% loss of dry matter) than Spirizyme Plus Tech and Spirizyme Ultra at all incubation times (55.0 to 61.4% loss of dry matter; p-value <.0001). Within the same interaction effect, Spirizyme Plus Tech produced 1.4 to 2.3% higher changes in % dry matter than Spirizyme Ultra for all incubation times except time 0 (p-values <.05). Examination of the interaction of enzyme, loading, and incubation time showed that the highest change in dry matter (61.8%) occurred with Spirizyme Plus Tech at a loading of 5.0 AGU/g dry ISP and an incubation time of 72 hours. This value was significantly higher than all combinations of enzyme type, enzyme loading, and incubation time for both Spirizyme Fuel and Spirizyme Ultra (Figure 2.4). Similar to liquefaction, fresh sweetpotato preparations converted more starch on average than flour samples when comparing each respective treatment combination of time, enzyme, and loading. Fresh samples again had higher levels of initial starch content than flour, with an average of more than 8% starch available to be converted.

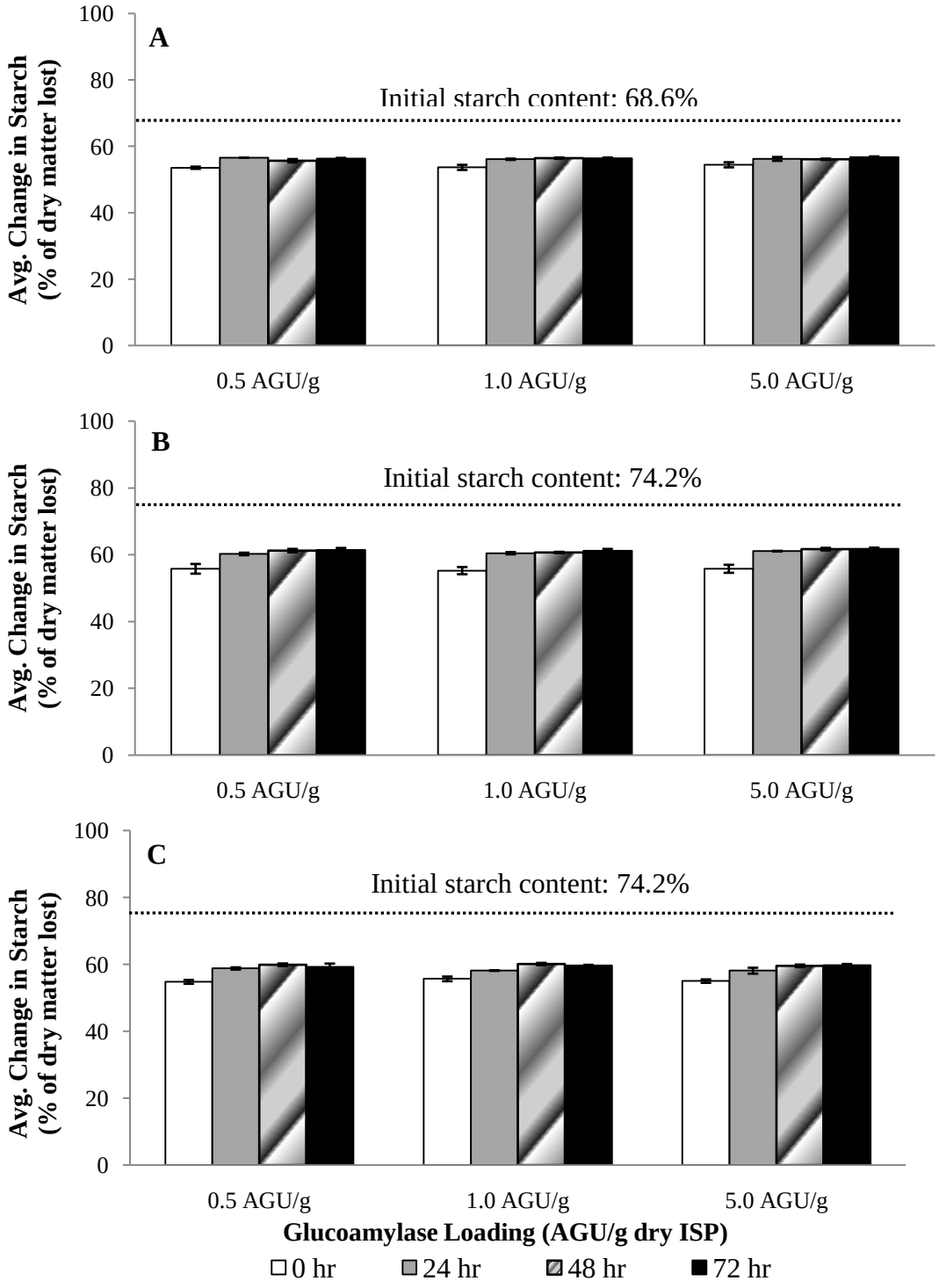

Figure 2.4 Average change in starch (% of dry matter lost) over time during saccharification of fresh FTA-94 industrial sweetpotatoes using three different glucoamylase enzymes: A) Spirizyme Fuel. B) Spirizyme Plus Tech. C) Spirizyme Ultra.

2.3.2.2 Soluble Sugars

Soluble sugars resulting from liquefaction and enzymatic saccharification with glucoamylase of flour industrial sweetpotato preparations over time are presented in Figure 2.5. Maltotriose, maltose, and glucose concentrations are presented as milligrams of sugar per gram of dry ISP to allow comparisons to be made between fresh and flour treatments (different initial substrate loading rates). An ideal conversion process would successfully convert available starch to simple glucose units for subsequent fermentation processing. The analysis of variance tables for glucose, maltose and maltotriose produced from flour during saccharification are shown in Tables 2.4, 2.5, and 2.6. All main and interaction effects of incubation time (hour), glucoamylase source (enzyme) and glucoamylase loading (load) were statistically significant for glucose, maltose and maltotriose (p-values <0.05) except for the main effect of hour for maltose conversion (p-value 0.6835). Saccharification of flour samples using all three glucoamylase enzymes successfully converted available starch to sugars. Glucose production during saccharification of flour sweetpotato treatments ranged from 80.0 to 549.6 mg/g dry ISP (123.6 to 865.5 mg/g starch) with the addition of glucoamylase. Without the addition of glucoamylase, levels of glucose remained below 50 mg/g dry ISP throughout the 72 hour incubation (data not shown).

Spirizyme Fuel at all loadings converted flour-based starch to glucose with concentrations ranging from 80 to 493 mg/g dry ISP (Figure 2.5a). When only 0.5 AGU/g dry ISP was added, glucose levels rose from 80.0 to 209.6 mg/g dry ISP as time increased from 0 to 72 hours; however 48 hours was not statistically different than 72 hours of incubation (p-value > 0.05). The 1.0 AGU/g dry ISP loading increased glucose levels to

316.2 mg/g dry ISP after 48 hours, but fell to 269.9 mg/g at 72 hours of incubation. The 5.0 AGU/g dry ISP loading level also produced its highest levels of glucose at 48 hours (514 mg/g dry ISP; 794.2 mg/g starch). This was significantly higher than any other glucose value produced by Spirizyme Fuel.

Spirizyme Plus Tech produced glucose concentrations from flour preparations that ranged from 237.2 to 549.6 mg/g dry ISP (Figure 2.5b). With the 0.5 and 1.0 AGU/g dry ISP loading rates, there was no statistical increase in glucose as incubation time increased from time zero. The 5.0 AGU/g dry ISP loading rate after 72 hours of incubation produced a statistically higher level of glucose than any treatment combination of time and loading for Spirizyme Plus Tech with 549.6 mg/g dry ISP (865.5 mg/g starch; p-value < 0.05).

Glucose released after saccharification with Spirizyme Ultra ranged from 116.0 to 513.8 mg/g dry ISP (Figure 2.5c). For every enzyme loading, glucose levels increased with time from 0 to 48 hours followed by a decrease after 72 hours incubation. Glucose levels at hours 24 and 48 for 0.5 and 5.0 AGU/g enzyme loadings were not statistically different. On average, the most glucose produced by Spirizyme Ultra was 513.8 mg/g dry ISP (795.4 mg/g starch) and resulted after 48 hours of incubation at an enzyme loading of 5.0 AGU/g dry ISP. This value was the most glucose produced from any treatment combination using Spirizyme Ultra and was statistically higher than any other treatment except for 5.0 AGU/g dry ISP incubated for 24 hours, which produced 495.7 mg/g dry ISP.

Comparing each treatment combination within each glucoamylase type, an enzyme loading of 5.0 AGU/dry ISP produced significantly higher levels of glucose that any other enzyme loading (p-values < 0.05). At time 0, 5.0 AGU/g dry ISP Spirizyme Plus Tech

samples had already produced 485.2 mg/g dry ISP of glucose, which was significantly higher than any other combination at that time. At 24 hours of incubation, Spirizyme Plus Tech with a loading of 5.0 AGU/g dry ISP had again produced the most glucose with 499.9 mg/g dry ISP, yet this was not statistically higher than glucose produced at the same loading of Spirizyme Ultra (495.7 mg/g dry ISP). After 48 hours of incubation, all three enzymes produced significantly similar levels of glucose at loadings of 5.0 AGU/g dry ISP (Figure 2.5). After 72 hours of incubation, glucose concentrations for Spirizyme Fuel and Spirizyme Ultra had significantly decreased to 493.2 and 463.5 mg/g dry ISP, respectively.

Over the course of 72 hours of sweetpotato flour saccharification, maltose production values ranged from 0 to 275.9 mg/g dry ISP. At a loading rate of 5.0 AGU/g dry ISP maltose concentrations increased up to 63.2 mg/g dry ISP for all three glucoamylases. This 5.0 AGU/g dry ISP loading rate for all glucoamylases produced maltose values which were significantly smaller than any other enzyme loading (p-values < 0.05), suggesting that the glucoamylase activity played an important role in digesting maltose into glucose.

Maltotriose concentrations were very small for all treatment combinations of incubation time, glucoamylase source and loading for sweetpotato flour preparations. Nearly half of the values observed were zero, with others only reaching a high concentration of 23.3 mg/g dry ISP at time 0 with a Spirizyme Plus Tech loading of 0.5 AGU/g dry ISP. The highest values of maltotriose at each incubation time were produced with no addition of glucoamylase.

Conversion of fresh sweetpotato starch into sugars using glucoamylase during saccharification was successful for all three enzymes (Figure 2.6). However, the sugars were not broken down as extensively as with flour. The analysis of variance tables for glucose,

Table 2.4 ANOVA table of flour FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of glucose

Product	Source	DF	Mean Square	F value	Pr > F
Glucose	Hour	3	31715.68	86.10	0.0011
	Enz	2	69578.99	188.88	<.0001
	Load	3	1293970.36	3512.69	<.0001
	Hour*Enz	6	8460.31	22.97	<.0001
	Hour*Load	9	2494.37	6.77	<.0001
	Enz*Load	6	12866.11	34.93	<.0001
	Hour*Enz*Load	18	2101.11	5.70	<.0001

Table 2.5 ANOVA table of flour FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of maltose

Product	Source	DF	Mean Square	F value	Pr > F
Maltose	Hour	3	228.57	0.50	0.6835
	Enz	2	39076.05	85.40	<.0001
	Load	3	448072.26	979.26	<.0001
	Hour*Enz	6	3071.71	6.71	<.0001
	Hour*Load	9	1616.57	3.53	0.0008
	Enz*Load	6	9814.40	21.45	<.0001
	Hour*Enz*Load	18	1090.18	2.38	0.0036

Table 2.6 ANOVA table of flour FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of maltotriose

Product	Source	DF	Mean Square	F value	Pr > F
Maltotriose	Hour	3	114.83	5.80	0.0011
	Enz	2	598.75	30.22	<.0001
	Load	3	18376.81	927.59	<.0001
	Hour*Enz	6	133.59	6.74	<.0001
	Hour*Load	9	130.30	6.58	<.0001
	Enz*Load	6	78.05	3.94	0.0015
	Hour*Enz*Load	18	35.40	1.79	0.0379

maltose and maltotriose for fresh sweetpotato preparations are shown in Tables 2.7, 2.8, and 2.9, respectively. The main and interaction effects of incubation time (hour), glucoamylase source (enzyme) and glucoamylase loading (load) were statistically significant for glucose and maltose response variables (p-values < 0.05). The main and interaction effects of hour,

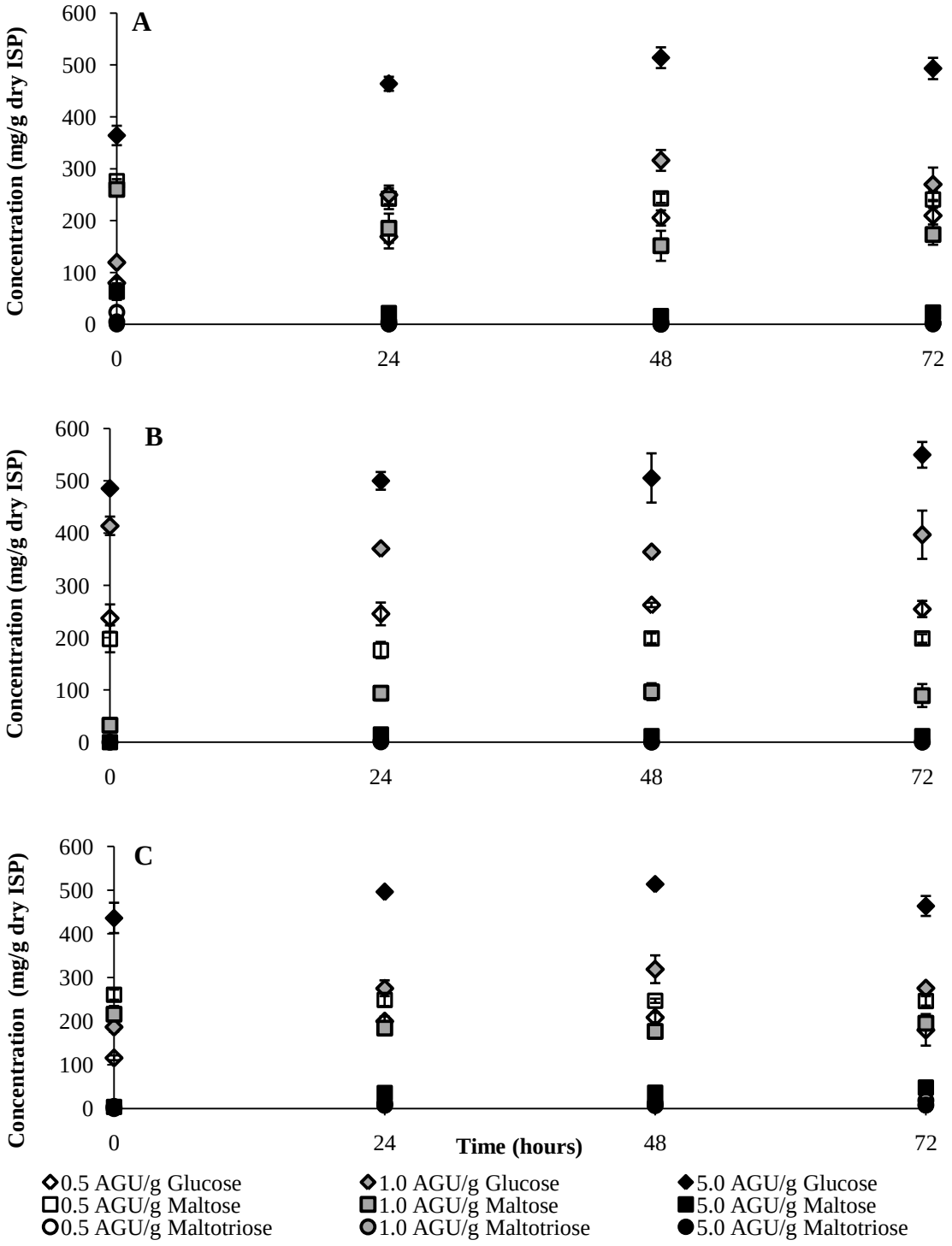

Figure 2.5 Concentration of HPLC sugars during saccharification of flour FTA-94 industrial sweetpotatoes over time using three different enzymes: A) Spirizyme Fuel, B) Spirizyme Plus Tech, C) Spirizyme Ultra.

enzyme and load were all statistically significant for maltotriose (p-values < 0.05) with the exception of the full three way interaction (p-value > 0.05). Considering all factors, glucose concentrations for all incubation times with the addition of glucoamylase (0.5, 1.0, and 5.0 AGU/g dry ISP) ranged from 70.5 to 398.5 mg/g dry ISP (102.8 to 537.1 mg/g starch), with the exception of one treatment which reached an average value of 508.6 mg/g dry ISP (685.3 mg/g starch; 5.0 AGU/g dry ISP Spirizyme Ultra, 0 hour). Without the addition of glucoamylase, glucose levels ranged from 0 to only 47.4 mg/g dry ISP for all incubation times, with most of the values remaining below 30 mg/g dry ISP (data not shown).

Looking at the interaction effect of type of enzyme, loading rate, and incubation time, for all three enzymes on fresh sweetpotato at each time interval, most glucose levels significantly increase as enzyme loading increases. For all treatments with Spirizyme Fuel at all time points, glucose values for enzyme loadings of 0.5 and 1.0 AGU/g dry ISP were statistically similar while an enzyme loading of 5.0 AGU/g dry ISP produced a significantly higher level of glucose (p-values <0.05). Glucose values for Spirizyme Fuel loadings of 5.0 AGU/g dry ISP were 384.6 mg/g dry ISP at time zero and ultimately decreased to 302.4 mg/g dry ISP at 72 hours. For Spirizyme Plus Tech at time 0, glucose levels significantly increased as enzyme loading increased from 0 to 5.0 AGU/g dry ISP (p-values < 0.05). At 24 and 48 hours of incubation, 0.5 and 1.0 AGU/ g dry ISP of Spirizyme Plus Tech were statistically similar to each other, however 5.0 AGU/g dry ISP produced a significantly higher glucose values (308.5 and 303 mg/g dry ISP, respectively. Spirizyme Ultra performed similar to Spirizyme Plus Tech, with significantly higher glucose values as enzyme loading increased at

hours 0 and 72, and statistically similar values for loadings of 0.5 and 1.0 AGU/g dry ISP at hours 24 and 48. All glucose values with 5.0 AGU/g dry ISP of Spirizyme Ultra at each sampling time during the 72 hour saccharification were significantly higher than any other enzyme loading at each respective time. Interestingly, the highest value of glucose for each type of glucoamylase for all enzyme loadings and incubation times was recorded at time 0 with a loading of 5.0 AGU/g dry ISP (Figure 2.6).

Maltose concentration values during saccharification of fresh sweetpotatoes ranged from 0 to 377.2 mg/g dry ISP (Figure 2.6). The interaction of enzyme loading, type of enzyme, and incubation time showed that as enzyme loading increased from 1.0 to 5.0 AGU/g dry ISP for all three enzymes within each time step, the levels of maltose decreased significantly by as much as 140 mg/g dry ISP (p-values < 0.05). However, over time maltose levels increased for each enzyme loading and source treatment combination. For Spirizyme Ultra loadings of 0.5, 1.0, and 5.0 AGU/g dry ISP, specifically, from 0 to 24 hours, maltose values increased significantly (p-values < 0.05).

Levels of maltotriose for fresh sweetpotato treatments remained low throughout the entire 72 hour saccharification, increasing from 0 to only 28.7 mg/g dry ISP (Figure 2.6). Results showed that for all incubation times when no glucoamylase was added, values for maltotriose ranged from 26 to 32 mg/g dry ISP, while at each corresponding incubation time values for treatments with glucoamylase were significantly lower and ranged from 0 to 20.2 mg/g dry ISP (p-value < 0.05). Maltotriose concentrations for all incubation times, though not all significant, also decreased with increases in enzyme loading.

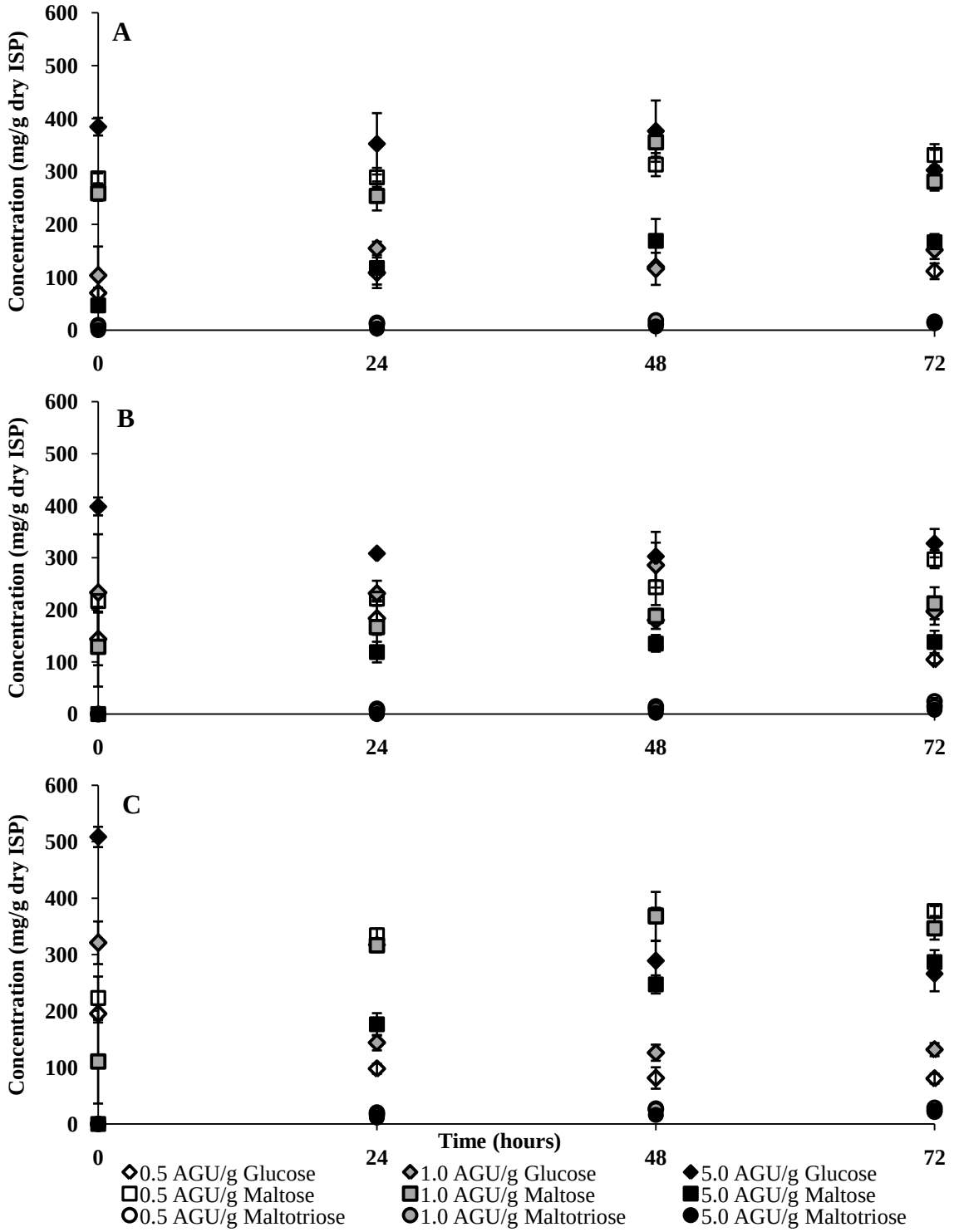

Figure 2.6 Concentration of HPLC sugars during saccharification of fresh FTA-94 industrial sweetpotatoes over time using three different enzymes: A) Spirizyme Fuel, B) Spirizyme Plus Tech, C) Spirizyme Ultra.

Table 2.7 ANOVA table of fresh FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of glucose

Product	Source	DF	Mean Square	F value	Pr > F
Glucose	Hour	3	15749.53	17.83	<.0001
	Enz	2	18404.84	20.84	<.0001
	Load	3	617642.66	699.31	<.0001
	Hour*Enz	6	17166.38	19.44	<.0001
	Hour*Load	9	13439.57	15.22	<.0001
	Enz*Load	6	11274.25	12.76	<.0001
	Hour*Enz*Load	18	6753.02	7.65	<.0001

Table 2.8 ANOVA table of fresh FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of maltose

Product	Source	DF	Mean Square	F value	Pr > F
Maltose	Hour	3	101365.42	147.87	<.0001
	Enz	2	83951.56	122.47	<.0001
	Load	3	249489.70	363.95	<.0001
	Hour*Enz	6	11815.19	17.24	<.0001
	Hour*Load	9	7593.56	11.08	<.0001
	Enz*Load	6	6236.71	9.10	<.0001
	Hour*Enz*Load	18	3014.05	4.40	<.0001

Table 2.9 ANOVA table of fresh FTA-94 industrial sweetpotato during saccharification for incubation time, type of glucoamylase, and enzyme loading on levels of maltotriose

Product	Source	DF	Mean Square	F value	Pr > F
Maltotriose	Hour	3	1473.68	87.57	<.0001
	Enz	2	407.75	24.23	<.0001
	Load	3	5346.52	317.71	<.0001
	Hour*Enz	6	145.01	8.62	<.0001
	Hour*Load	9	49.75	2.96	0.0038
	Enz*Load	6	103.14	6.13	<.0001
	Hour*Enz*Load	18	26.10	1.55	0.0894

Comparing glucose production levels between flour and fresh sweetpotato preparations it is evident that the extent of hydrolysis of flour was greater than that seen in fresh sweetpotato treatments over the course of the 72 hour incubation. Examining glucose, maltose and maltotriose sugars on a molar basis (mmol/g dry ISP) and their molar composition totals

between fresh and flour samples, results showed that fresh sweetpotato was comparable to flour. Fresh sweetpotato with 5.0 AGU/g dry ISP of Spirizyme Ultra at time 0 produced 2.8 mmol/g dry ISP of composite sugars (685.3 mg total sugars/g starch). Flour sweetpotato with the same enzyme loading after 48 hours produced 3.0 mmol/g dry ISP of composite sugars (862.2 mg total sugars/g starch). Reviewing all data for both fresh and flour sweetpotatoes and considering enzyme cost, enzyme activity, and energy requirements for incubation times, Spirizyme Ultra at a loading of 5.0 AGU/g dry ISP incubated for 48 hours showed the most promise for the saccharification step of the conversion process.

2.3.3 Fermentation

Results for glucose, ethanol and fructose concentrations over time during fermentation of flour and fresh sweetpotatoes are shown in Figure 2.7. Sugars from both preparations were successfully converted into ethanol. Small amounts of glycerol were also detected in all samples inoculated with the Ethanol Red Yeast during HPLC analysis, excluding time 0 (data not shown).

Flour-based sweetpotato sugars fermented with and without salt supplementation produced similar changes in glucose, fructose, and ethanol concentration over time and the presence of salts did not significantly improve the fermentation. Samples without salts reached an average of 17.9 g ethanol/L of solution after 24 hours and quickly rose to 62.6 g/L after 48 hours, and only increased by 4.6% more after 72 hours of fermentation. Samples with salts produced an average of 13.9 g/L of ethanol after 24 hours, and rapidly increased to its peak value of 67.8 g/L after 48 hours. Glucose values for samples without and with salt supplementation were 116.7 and 117.5 g/L, respectively, at the beginning of the fermentation

period. After 48 hours, levels of glucose significantly decreased to 7.1 g/L for samples without salts, and completely disappeared to 0 g/L for samples with salt. No glucose was observed after 72 hours. Fructose values for samples without salts increased to 17.1 g/L after 24 hours, and decreased to 8.6 g/L at 48 hours before being completely converted by hour 72. Samples with salts showed an increase in fructose concentration up to 17.8 g/L after 24 hours. No fructose was found at 48 and 72 hours.

Fermentation of fresh sweetpotato sugars with and without salt supplementation produced similar ethanol, glucose, and fructose concentrations over time relative to flour treatments, where the presence of salts did not significantly improve the fermentation yields (Figure 2.7b). Samples without salt produced 20.1 g/L of ethanol after 24 hours and reached the highest level of ethanol by 48 hours of fermentation (33.6 g/L). Fermentation samples with salt reached slightly higher values of ethanol after 24 hours with an average of 23.0 g/L, increasing to 34.9 g/L by 48 hours. Ethanol production did not increase after 48 hours. Initial glucose levels for fresh sweetpotato sugars were 63.1 and 61.2 g/L, respectively, for samples without and with salts. These values dramatically decreased to 28.9 and 23.1 g/L at hour 24, and by hour 48 no glucose was detected. No fructose was initially observed for the fresh sweetpotato fermentations. At 24 hours, samples without salts had produced 6.4 g/L of fructose, and an average of 5.3 g/L was created in samples with salts. No fructose was detected at hours 48 and 72.

Ethanol production rates for fresh sweetpotato sugar fermentations were higher than those for flour sweetpotato sugar fermentations, reaching an average of 63% of the total ethanol recovered in 24 hours compared to 24% for flour. Although the initial sugar

concentrations for fresh and flour preparations were different (due to difference in initial liquefaction and saccharification substrate loadings, 25% w/v flour, 12.5% w/v fresh), the yeast performance in terms of ethanol yields were similar between the fresh and flour preparations. By 48 hours, ethanol yields for flour sweetpotato fermentation treatments were 0.57 and 0.58 g/g glucose for samples without and with salts, respectively and 0.55 and 0.59 g/g glucose for fresh sweetpotato fermentation treatments. Overall, the addition of salts did not affect ethanol product yields.

2.4 Discussion

2.4.1 Enzymatic hydrolysis of starch

Based on AIS values for liquefaction and saccharification, flour sweetpotato preparations had lower initial starch content compared to fresh sweetpotato preparations. As previously mentioned, flour sweetpotato preparations were dried at 70°C for 60 hours to prevent decomposition of the sweetpotato during storage. Drying the sweetpotato may have contributed to the loss of starch content among all flour preparations. A study performed on the effect of drying conditions on the quality of dried potato cubes showed that initial starch contents of potato dried at 70°C had an average of 67% starch content (% dry basis) compared to approximately 75% starch content found for raw, unblanched potato cubes (Bondaruk et al., 2007). These results are comparable to an average of approximately 66% initial starch content found for flour sweetpotato preparations during liquefaction and saccharification in this study. Bondaruk et al. (2007) also found that blanching the potato cubes in hot water for 4.5 minutes (95°C) before drying at a temperature of 50°C caused a

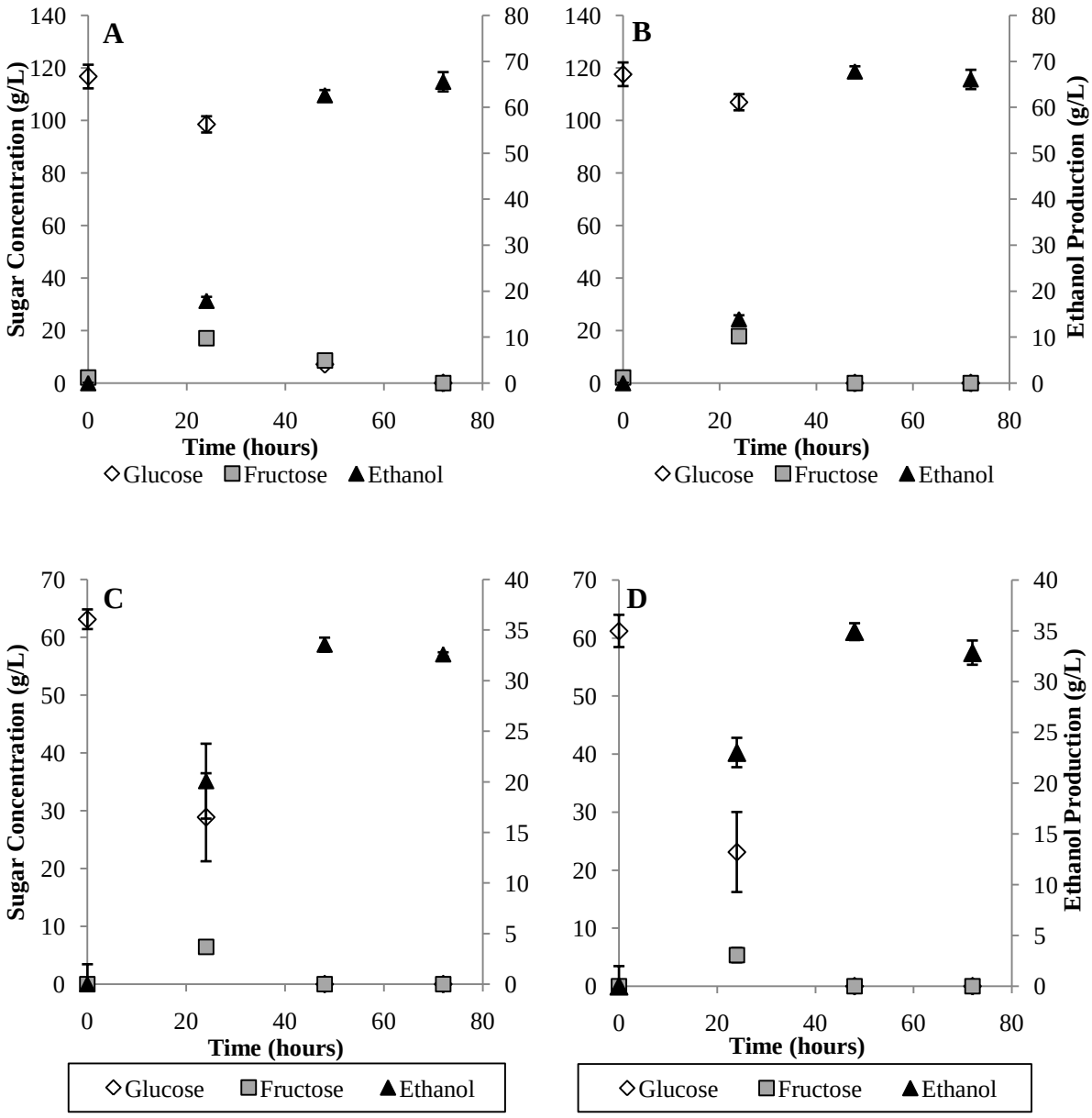

Figure 2.7 Ethanol, glucose, and fructose concentrations measured over time during fermentation of flour and fresh FTA-94 industrial sweetpotatoes: A) Flour, 0.1% yeast, no salt. B) Flour, 0.1% yeast, salt extract. C) Fresh, 0.1% yeast, no salt. D) Fresh, 0.1% yeast, salt extract.

smaller reduction in starch content (73% compared to 75% for raw potato). This suggests that in the future a lower drying temperature preceded by a blanching step may help improve the initial starch content of flour sweetpotato preparations. More research must be performed specifically on comparisons between different drying methods and storage conditions to determine the most effective preparation method for preserving available starch to be hydrolyzed into sugars.

The importance of a two step hydrolysis (liquefaction and saccharification) and the relevance of analyzing both starch and sugars as it relates to sweetpotato starch conversion is evident in the results of both liquefaction and saccharification experiments. During the liquefaction process, the incubation temperature (85°C) initiated gelatinization of the sweetpotato starch and allowed the added α-amylase greater accessibility to starch polymers. The Liquozyme SC was effective at converting available starch to soluble dextrin sugars, resulting in a 79.4 and 85.3% change in available starch after liquefaction. The change in starch content (% of dry matter lost) was not largely improved after saccharification with glucoamylase relative to liquefaction. The glucoamylase did, however, dramatically increase the amount of soluble sugars, specifically glucose, available for fermentation by at least 5.6, 3.9, and 6.1 times more glucose on average for Spirizyme Fuel, Spirizyme Plus Tech and Spirizyme Ultra, respectively. This suggests that the α-amylase during liquefaction affects the quantity of all of the available insoluble starch, while the glucoamylase during saccharification allows for the generation of smaller, more easily fermentable sugars. Quantification of individual sugars in addition to change in starch content gave a more complete representation of the extent of hydrolysis.

In terms of reducing sugars produced by liquefaction alone, fresh sweetpotato preparations produced statistically higher reducing sugar levels per dry gram ISP and per gram starch than flour preparations at all enzyme loadings and incubation times. This could have been a result of the change in composition of the starch after being dried for 60 hours at 70˚C, which would have inhibited a more complete starch conversion. Bondaruk et al. (2007) showed that the inner structure of potato cubes dried at 70˚C is composed of a compact starch-protein matrix containing diluted cell walls, residual conductive bundles and starch grains. Although the structure showed considerable porosity, it also exhibited higher mechanical resistance compared to samples dried at 50°C. This mechanical resistance could have occurred in flour sweetpotato preparations during liquefaction and reduced the available binding sites on the starch granules for α-amylase, resulting in a decreased recovery of reducing sugars.

Liquozyme SC loadings of 0 to 3.0% v/w were tested to determine whether increasing loadings by multiples of ten would result in corresponding increases in reducing sugar levels. The 0.3% v/w loading level proved to exhibit the most effective utilization of available enzyme to convert available starch into sugars. The addition of 3.0% v/w of α-amylase did not result in the expected increase in starch loss and reducing sugars. This may have been due to saturation of available binding sites on inner portions of amylose and amylopectin by native amylases and the addition of "excess" α-amylase, resulting in unused enzyme remaining dormant in the solution. Also, because sweetpotato starch contains high amounts of amylopectin containing bonds which are not digestible by α-amylase alone, the excess enzyme added during liquefaction did not help increase changes in starch content and

reducing sugars due to the enzyme's inability to digest certain portions of the sweetpotato starch (Zhang and Oates, 1999). Thermostability of the commercial amylase may also have been a factor, as some enzymes are known to lose all activity in as little as two hours.

The effects of increased loadings of glucoamylase during saccharification did not show indications of reduced enzyme activity due to saturation, as increases in glucoamylase up to 5 AGU/g dry ISP resulted in increased production of glucose. Enzyme loadings of glucoamylase used for saccharification were based on preliminary studies and previous work done on corn. Loadings up to 0.75 AGU/g dry sweetpotato in previous experiments did not significantly increase reducing sugars, so the experiments presented were designed to test higher loadings of glucoamylase. The best saccharification conditions for flour preparations was determined to be 5.0 AGU/g dry sweetpotato of Spirizyme Ultra incubated for 48 hours, which produced 513.8 mg/g dry sweetpotato of glucose and converted approximately 80% of the available starch to single glucose units (94% dextrose equivalent based on reducing power of glucose from maltotriose, maltose, and glucose concentrations). Azhar and Hamdy (1981) performed a study on the acid hydrolysis of sweetpotatoes and found a dextrose equivalent value of 83%, though only 1% w/v sweetpotato was used and extremely high levels of HMFs were detected. This shows that higher amounts of sugars can be recovered from starch using environmentally friendly commercial enzymes without the addition of acid. This treatment combination of 5.0 AGU/g dry sweetpotato of Spirizyme Ultra incubated for 48 hours also increased the number of reducing sugars by converting nearly all of the complex oligosaccharides to glucose and increased the total amount of composite sugars from 1.2 to 3.0 mmol/g dry sweetpotato over the liquefaction control (no glucoamylase

added). A study on the saccharification of sweetpotato mashes using native amylases for 32 hours of incubation found that at 70°C, 1.99% fructose, 3.45% glucose, and 18.37% maltose (% dry matter) were converted leaving 35.7% AIS (Mcardle and Bouwkamp, 1986). Comparing these values to the over 51% glucose (% dry matter) produced using commercial α-amylase and glucoamylase in this study shows that although endogenous enzymes can effectively produce sugars from sweetpotato starch using only heat treatments, significantly higher amounts of fermentable sugars can be obtained with the help of adding additional enzymes. Despite the successful conversion of starch to sugars during liquefaction and saccharification, at least 10% of available starch remained unhydrolyzed for fresh and flour ISP preparations, suggesting inhibition effects during the hydrolysis process.

The inability of glucoamylase to complete the starch digestion can be partially attributed to competitive product inhibition caused by the high concentration of sugars produced during hydrolysis (Weselake and Hill, 1983; Houng et al., 1992). A study performed on barley malt during cold starch hydrolysis suggested that glucose product inhibition can be related to the product molecules directly binding to the active or other sites on the enzyme (Hill et al., 1997; Robyt, 1984). In a study investigating the semi-continuous hydrolysis of raw sweetpotato starch by glucoamylase, results showed similar inhibitions of starch digestion to those found in this work with increasing glucose concentrations, where glucose was produced at a high rate during the first 12 hours of incubation (up to 4% w/v glucose). However, the rate decreased rapidly during the next 12 hours, indicating an inhibition effect on starch digestion (Noda et al., 1992). Results on hydrolysis of sweetpotatoes from this work showed that during saccharification, glucose levels reached 13.9 and 6.7% w/v of

glucose for flour and fresh preparations, respectively. These glucose concentrations were high enough to induce product inhibitions on glucoamylase activity. The use of simultaneous saccharification and fermentation (SSF) could help improve the extent of starch hydrolysis under circumstances of product inhibition. During SSF, microorganisms convert the inhibitory product (glucose) to a final product as available enzymes continue to break down starch into sugars.

Physical removal of glucose from a hydrolysis vessel would serve a similar purpose, yet would preserve the glucose feedstock for an intended use. In addition, glucoamylase is known to have trouble hydrolyzing α-1,6 bonds (Roy and Gupta, 2004). Incomplete conversion of these bonds by glucoamylase may have occurred during saccharification of this study and contributed to the incomplete starch digestion. The existence of pullulanase or other debranching enzymes may prove successful in future studies to act on the α-1,6 glycosidic bonds.

Results of fresh sweetpotato preparations during saccharification showed that for all three glucoamylases, samples taken after enzyme addition and before saccharification incubation (time 0) produced the highest glucose values of all incubation times. These values also significantly increased as glucoamylase increased to 5.0 AGU/g dry sweetpotato. This suggests that the enzyme instantly acted on the available starch and sugars to produce glucose. During experimentation, there was a lag time of approximately one hour before the samples were placed in the freezer at -80°C in order to centrifuge the samples and remove the supernatant. During this time, despite the low temperature of 4°C within the centrifuge, the enzymes may have remained fairly active reducing the complex sugars into glucose. Results

for flour preparation also showed significant increases in glucose levels at time 0 with increasing glucoamylase loadings, though as incubation time increased to 48 hours, glucose levels continued to increase. The higher rate of hydrolysis for fresh treatments could have been a result of the lower loading rate (12.5% w/v), which involves a greater volume of liquid and natural water content of the sweetpotato. The increased water content, presence of bound and absorbed water in the pore spaces of the sweetpotato and easily accessible starch granules (compared to more complex granules of flour treatments caused by heating during preparation) may have allowed for a faster conversion of starch to sugars (Bondaruk et al., 2007). Further examination of sugar accumulation during the first 24 hours of saccharification for fresh sweetpotato preparations will help clarify enzyme reaction rates and better understand enzyme function.

During saccharification of fresh treatments, higher amounts of maltose were observed over the entire course of saccharification when compared to flour treatments. In the presence of high levels of glucose and high dissolved solids, excess glucoamylase loading has been known to catalyze the reverse condensation reaction. This causes maltose, isomaltose, and other byproducts from glucose (Crabb and Shetty, 1999; Roy and Gupta, 2004). These byproducts are referred to as 'reversion products' and are known to decrease overall yield. This may explain the increase in maltose and decrease in glucose throughout saccharification which occurred in fresh treatments. As stated previously, the highest levels of glucose were recorded at time 0 of saccharification. If the rapid hydrolysis of susceptible starch was complete after the aforementioned lag time during sampling, the active enzymes still

remaining in the solution could have led to the reversion of these glucose products into maltose.

2.4.2 Fermentation to ethanol

Fermentation of hydrolyzed sweetpotato was successful and showed no inhibition by ethanol or sugars. The highest volume of ethanol produced in any of the 10 ml fermentation tubes was 8.6% v/v, which was recorded for flour preparations with salts after 48 hours of incubation. Fresh preparations produced a lower value of 4.4% v/v ethanol for samples with salts after 48 hours. This was due to the lower initial glucose loading for all fresh samples. Ethanol values for each treatment combination seemed to increase until glucose levels depleted, showing no inhibition of the yeast. Strains of *Saccharomyces,* which are more tolerant than most types of yeast, can generate up to 10-15% v/v ethanol (Boulton, 2001). Glucose values used for fermentation ranged from 61.2 to 117.5 g/L. The yeast used in this experiment (Ethanol Red Yeast) could have tolerated more sugar, however initial sugar concentrations were limited by the initial hydrolysis loading rates and sugar dilution from the addition of 1 ml of either salts or ddH_2O to the 9 ml of supernatant used for fermentation. One study using batch fermentation of 20% glucose to study ethanol formation resulted in the formation of more than 12%v/v ethanol, indicating that higher sugar concentrations (up to a certain level) can lead to more ethanol (Dombek and Ingram, 1987).

After 48 hours ethanol yield values were between 0.55 and 0.59 g/g glucose used for fresh and flour preparations, which are consistent with related studies (Dombek and Ingram, 1987). These values, however, are higher than the theoretical yields (1 g glucose yields ~0.51 g ethanol). The presence of salts seemed to help increase ethanol yields, however the

ethanol production rate, 1.4 g/L/h for fresh samples and 0.7 g/L/h for flour samples, and overall production of ethanol were not significantly affected, suggesting that the addition of salts during fermentation of ISP hydrolysates is not necessary.

The production of fructose and trace amounts of glycerol were both recorded during the course of fermentation. The different pathways for the dissimilation of glucose to ethanol in yeast via glycolysis and the hexose monophosphate shunt shows that before ethanol is produced from glucose, it is converted to fructose 1,6-biphosphate (Boulton, 2001, p82). The fructose can then follow a pathway to produce glycerol rather than ethanol. Yeast must maintain an appropriate redox balance. It is generally considered that glycerol production is a result of the yeast trying to maintain its redox balance. The formation of these higher alcohols could represent a further 'fine tuning' mechanism for regenerating NAD^+ (Quain and Duffield, 1985). Similar overall fermentation behavior in product yields and sugar use between flour and fresh preparations indicates that sugars from both preparations can be used effectively by Ethanol Red Yeast and yeast performance is independent of sweetpotato preparation provided that sugar is available for conversion.

It has been shown that the use of commercial enzymes during liquefaction and saccharification of FTA-94 ISPs has a substantial effect on the conversion of starch to fermentable sugars. The majority of the available starch was converted during liquefaction of flour and fresh sweetpotato preparations with the addition of 0.45 KNU-S/g dry ISP of Liquozyme SC after 2 hours of incubation, leaving at most 18.7% starch dry matter to be converted. Additionally, saccharification was able to increase the breakdown of starch, however its main function was converting the soluble dextrins resulting from liquefaction to

fermentable sugars. The addition of 5.0 AGU/g of Spirizyme Ultra after 48 hours of incubation was able to produce 862.2 and 743.9 mg of simple sugars/g of starch with flour and fresh preparations, respectively. Fermentation with Ethanol Red Yeast of these appropriate loadings tested ethanol generation over time was able to generate 62.6 and 33.6 g/L of ethanol for flour (25% w/v substrate loading) and fresh (12.5% w/v) ISP, respectively, after 48 hours of fermentation without salts, proving that sweetpotatoes can offer a viable alternative starch source for industrial application of ethanol production. More research must be done, however, on minimizing enzyme inhibition effects to increase the extent of hydrolysis and improve conversion efficiency.

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Chapter 3: Enzymatic Hydrolysis of Industrial Sweetpotatoes using α-Amylase, Glucoamylase, and Pullulanase and Fermentation of Sugars to Ethanol

3.1 Introduction

The United States consumed 19.7 million barrels of petroleum per day in 2002, totaling one-quarter of the world's entire oil production. More than half of this oil, 62%, was imported (EERE, 2006). The Energy Information Administration (EIA) projected that by the year 2025 total petroleum consumption is expected to reach 28.3 million barrels per day, requiring dependence on 70% from foreign imports (EIA, 2004). To compete with this growing trend, an economy based on carbohydrates has been introduced which focuses on the production of renewable biobased products, specifically ethanol, derived from biomass.

Starch is the most widespread carbon reserve stored in plants and is of significant importance in the industry for food, chemical, and enzymatic uses (Geigenberger, 2003). The conversion of starch to sugars is an efficient and widely used process to produce ethanol from glucose. Starch, unlike lignocellulosic biomass, is more easily convertible to ethanol. The starch can be converted to a useable fermentable sugar through a variety of different processes, including acid hydrolysis (Bej et al., 2008), high temperature and pressure extrusion (Kim and Hamdy, 1987), and enzymatic hydrolysis (Sawai et al., 2004). Of these three methods, hydrolysis of starch with enzymes offers the simplest and most environmentally friendly method to produce ethanol.

Enzymatic hydrolysis of starch can be described in two basic steps: liquefaction and saccharification. Initially, an aqueous slurry of starch is gelatinized through heating to swell starch granules and then liquefied using a liquefying agent/enzyme to produce shorter

oligosaccharides from amylose and amylopectin polymers. The liquefied starch is then saccharified in the presence of at least one saccharifying enzyme to create an aqueous solution containing 60-80% weight of the original starch in the form of fermentable sugars. (Muller and Miller, 1981). Once the starch is converted to simple sugars, the sugars can be fermented by yeast or bacteria to produce ethanol (EERE, 2006) or other microbial catalysts to produce high value chemicals. There are specific processing parameters, however, which must be defined based on composition differences between starch-based feedstock types and varieties.

Sweetpotatoes (*Ipomoea batatas,* Morning-glory family) are a major starch-based crop grown in the Southeastern region of the United States which offers an alternative feedstock to corn with up to a 30 % yield in starch that can be converted to sugars needed for ethanol and value-added chemical production (Zhang and Oates, 1999). In 2007, 82% of sweetpotatoes were grown in North Carolina, Mississippi, Louisiana, and Alabama alone (NASS, 2007**)**. Sweetpotatoes are a low impact crop which are resistant to drought, grow on marginal lands, and continue to increase in weight during the long growing season until harvested (Noda et al., 1992; Sachs, 1980; Wu and Bagby, 1987). This enables sweetpotatoes to be grown as an alternative non-competitive crop which can be grown on soils which corn could not survive. High starch industrial sweetpotatoes (ISPs) are not intended for use as a food crop and have been bred for higher dry matter content to generate up to 50% higher yields in starch than the common orange-fleshed sweetpotato (Nichols, 2007). Industrial sweetpotatoes have potential to serve as a dedicated energy crop that contributes to the regional diversification of US energy and chemical needs.

Starch is a polymer of glucose, linked by glycosidic bonds and is composed of two major molecules, amylose and amylopectin (van der Maarel et al., 2002). Amylose, the minor linear polymer in sweetpotatoes, consists mainly of α-1,4 linked D-glucopyranosol residues and contains up to 6000 glucose units (Hoover, 2001). Amylopectin, the major polymer in sweetpotatoes, is composed of short α-1,4 linked linear chains of 10-60 glucose units and α-1,6 linked side chains containing 15-45 glucose units. Amylopectin contributes to the side branching of starch and a single molecule usually contains around 2,000,000 glucose units, making it one of the largest molecules existing in nature (van der Maarel et al., 2002). The starch in sweetpotatoes is considered more complex than cereal starches (corn, rice), containing only 19.1% amylose (Collado et al., 1999). Composed of longer and more complex amylopectin chains, sweetpotato starches are more difficult to hydrolyze into fermentable sugars (Hoover, 2001 and Srichuwong et al., 2005).

Several enzymes can be used to convert starch into its simple sugars, including α-amylase, β-amylase, glucoamylase, α-glucosidase, and pullulanase. The enzyme α-amylase acts on the inner portions of the two main polymers of starch, amylose (α-1,4 bonds) and amylopectin (α-1,6 bonds), to form glucose chains of varying length. Conversely, β-amylase breaks the external glucose units of amylose and amylopectin to produce maltose and shorter glucose chains. Glucoamylase produces free glucose by cleaving both α-1,4 and α-1,6 glycosidic bonds on longer chains of amylose and amylopectin (van der Maarel, 2002). α-Glucosidase cleaves short maltose chains to produce glucose and pullulanase breaks the α-1,6 bonds in amylopectin. Due to the high, complex content of amylopectin in sweetpotatoes, use of enzymes which break the amylopectin bonds, including glucoamylase

and pullulanase, need to be examined more closely during saccharification. Pullulanase is generally used with glucoamylase to produce glucose from gelatinized starch. A practical problem that arises during saccharification using only glucoamylase is that glucoamylase is specialized in cleaving α-1,4 glycosidic bonds and slowly hydrolyzes α-1,6 glycosidic bonds present in maltodextrins, resulting in the accumulation of isomaltose. Use of glucoamylase in combination with a pullulanase that efficiently hydrolyzes α-1,6 glycosidic bonds is one way to address this limitation (van der Maarel et al., 2002).

In order for saccharification enzymes to function effectively, hydrolysis must take place at optimal temperatures that support high activity. When a hydrolysis step is performed using two or more enzymes with different optimal temperatures, it is necessary to use a processing temperature which ensures compatibility and synergy of the two enzymes (Mamo and Gessesse, 1999). Thus, it is important to identify incubation temperatures that promote the highest synergistic activities of select enzymes.

The main objective of this study was to develop a saccharification method to effectively convert starch from FTA-94 industrial sweetpotatoes into useful sugars and examine the ethanol yields from fermentation. Saccharification using glucoamylase with the addition of pullulanase at different loadings was investigated at different temperatures to determine the most useful conditions for glucose production with the enzyme combinations.

3.2 Materials and Methods

3.2.1 Enzymes

3.2.1.1 α-Amylase

The α-amylase used for liquefaction of the starch-containing mashes was Liquozyme SC (Novozymes, North America, stored at 4ºC, density 1.25 g/ml). It has an optimal pH of 5.5 with a broad pH tolerance, an optimal temperature of 85ºC, and an activity of 120 KNU-S/g enzyme. KNU-S/g (kilo novo units) of α-amylase is the amount of enzyme which breaks down 5.26 grams of starch per hour according to Novozymes standard method for α-amylase determination.

3.2.1.2 Glucoamylase

The glucoamylase enzyme used for saccharification of the industrial sweetpotatoes was Spirizyme Ultra. It has an activity of 900 AGU/g protein. The enzyme was produced from submerged fermentation, has an approximate density of 1.15 g/ml, and an activity based on amyloglucosidase units (AGU/g), which represents the amount of enzyme able to hydrolyze 1 µmol of maltose per minute at 37°C and a pH of 4.3. The optimal temperature of the enzyme is 65ºC.

3.2.1.3 Pullulanase

The pullulanase enzyme used in saccharification, termed Promozyme, was from a selected strain of *Bacillus acidopullulyticus.* It is a debranching enzyme with a density of 1.25 g/ml, an optimal pH of 5.0, and an optimal temperature of 40°C. Promozyme has an activity of 400 Units/ml, with one Unit being defined as the amount of enzyme which

hydrolyzes pullulan, liberating reducing carbohydrate with a reducing power equivalent to 1.0 µmole of glucose per minute at 40°C and a pH of 5.0.

3.2.2 Industrial Sweetpotato Preparation

Industrial sweetpotatoes (ISP), clone FTA-94, were grown on the Horticultural Crops Research Station in Clinton, NC (35.023°N; 78.278°W). They were planted on May 23, 2007, and harvested on October 11, 2007. Fresh and flour (dry) sweetpotato preparations were studied in this work. Sweetpotatoes which were prepared fresh were refrigerated at 58ºC until use. They were then washed, diced into chunks, and ground in a food processor to produce 3-5 mm pieces just prior to use in experiments. For flour preparations, sweetpotatoes were washed, cut into slices, and dried at 70ºC for 60 hours. The slices were then broken into smaller pieces and ground through a 3 mm screen using a Wiley mill. Flour was stored in an air-tight container until use in experiments.

3.2.3 Experimental Design and Statistical Analysis

The effects of incubation temperature (45, 55, and 65°C), substrate preparation (fresh and flour sweetpotato), and pullulanase enzyme loading rate (0.0, 0.1, 0.5, and 1.0% v/w) on the change in starch content and the change in sugars during saccharification of FTA-94 industrial sweetpotatoes were investigated over time. All treatment combinations were completed in triplicate. Controls without the addition of saccharification enzymes (glucoamylase, pullulanase combinations) were also completed in triplicate (liquefaction controls). Main and interaction effects of incubation temperature (temp), substrate preparation (prep), and pullulanase loading (load) were evaluated using analysis of variance (ANOVA) of the General Linear Model (GLM) in SAS (version 9.3.1, SAS Inc, Cary, NC).

Pairwise t-test comparisons were performed to determine if each treatment effect was significantly different. Assessments of statistical significance were made at $\alpha = 0.05$. The SAS code and output are presented in Appendix C.

3.2.4 Saccharification

Using data from previous studies on liquefaction and saccharification (chapter 2), enzymatic conversion experiments were performed on both fresh and flour sweetpotatoes using the most promising conditions for α-amylase and glucoamylase treatments. For flour preparations, 3 grams of dried sweetpotato and 12 ml of distilled deionized water (ddH_20), resulting in a 25% g dry ISP/total volume substrate loading, were placed into 50 ml Falcon tubes. For fresh preparations, 8.95 g of fresh sweetpotato (3 dry grams, initial moisture content 66.5% wet-basis) and 17 ml of ddH_20 were placed into the tubes, resulting in a 12.5% g dry ISP/total volume substrate loading. A 12.5% w/v ratio was used for fresh preparation to allow for sufficient supernatant collection and minimize handling challenges. Liquozyme SC was added at a level of 0.3% volume enzyme/g dry ISP (0.45 KNU-S/g dry ISP) to both flour and fresh samples, and incubated at 85ºC for 2 hours for liquefaction. After liquefaction, glucoamylase (Spirizyme Ultra) was added to treatments at a level of 5.0 AGU/g dry ISP. Promozyme was also added to appropriate treatments at loading rates of 0.1, 0.5, and 1.0 NPUN/g dry ISP. Sodium azide was added after the enzymes at a loading of 0.2% w/v to prevent contamination. Liquefaction controls for flour and fresh preparations did not receive additional enzymes during the saccharification incubation period. Treatment tubes were incubated at 45, 55, and 65ºC for 48 hours and sampled by centrifugation (4000 rpm, 4ºC, 15 min) with removal of supernatant (2 ml aliquots). Samples were stored at

-80°C prior to sugar analysis.

3.2.5 Starch Quantification

Quantification of initial starch and the remaining starch after both liquefaction and saccharification was determined using a modified Alcohol Insoluble Solids (AIS) method (Ridley et al., 2005). Initially, 8 ml of 80% ethanol (4 ml for every 1.5g of initial dry ISP) was poured into each sample and homogenized for 2 minutes using a PowerGen 700 homogenizer (Model # FGLH, Fisher Scientific, Chicago, IL). Samples were then transferred into 30 ml Kimax Gooch medium porosity filtering crucibles with 1.5 g of Celite No. 219 (diatomite functional filler, Celite Corp., Lompoc, CA), which was used as a filtering agent. The homogenizer and tubes were then rinsed twice with 8 ml of 80% ethanol. All liquids were pulled through the filter until contents no longer dripped through using a vacuum pump. The filter apparati were then dried for 24 hours at 70ºC and weighed. The difference in weight minus the ash content of the celite and sweetpotato was equivalent to the AIS content. Ash content of the sweetpotato was determined by drying the apparati for 24 hours at 105ºC and 600º C for 5 hours and removing ash content contributions from the Celite 219 (1.45 grams). Protein and fibrous fractions of the sweetpotato dry matter were not measured so final results report the change in starch content as a fraction of dry matter lost, assuming the enzymes were not degrading protein and fiber (difference between initial and final AIS values).

3.2.6 Fermentation

Fermentation of available sweetpotato sugars from flour and fresh ISP preparations was carried out in 250 ml volumetric flasks to measure ethanol production and conversion

efficiency over time. All flasks, stoppers with attached bacterial air-vent filters (0.45 μm; Pall-Gallman PN4210) and necessary deionized, distilled water (ddH_2O) were autoclaved for 15 minutes (121°C, 15 psig). Material transfers and sampling were performed aseptically under a biological safety cabinet (Kendro KS-18). For flour treatments, 15 grams of dried sweetpotato and 60 ml of sterile deionized, distilled water (25% w/v) were placed into flasks. For fresh treatments, 44.7 grams of fresh sweetpotato (15 dry grams; initial moisture content 66.5% wet-basis) and 78.26 ml of ddH_20 were placed into the flasks [12.5% w/v upon addition of supplemental salt solution (12 ml) for fermentation step]. Both flour and fresh sweetpotato treatment flasks were stoppered and incubated for 2 hours at 85ºC (shaking waterbath; 50 rpm) with Liquozyme SC (0.3% volume enzyme/g dry ISP; 0.45 KNU-S/g dry ISP), followed by saccharification with Spirizyme Ultra (5.0 AGU/g solid loading) and Promozyme (0.5 NPUN/g solid loading) for 48 hours at 55ºC (shaking waterbath; 50 rpm). Sodium azide was not added to minimize the possibility of growth inhibition of yeast during fermentation. Following saccharification, 12 ml of salt solution was added to each flask, and flasks containing flour sweetpotato received an additional 48 ml of sterile ddH_2O to bring all samples to a 12.5% w/v ratio. The salt solution contained (per ml): 13.2 mg NH_4Cl, 0.11 mg $MgSO_4$, 0.69 mg $CaCl_2$, and 85 mg yeast extract resulting in final salt concentrations in flasks of 1.32 g/L NH_4Cl, 0.11 g/L $MgSO_4$, 0.069 g/L $CaCl_2$, and 8.5 g/L yeast extract. Time zero samples (1 ml) were taken from the liquid fraction of each flask and stored at -80°C. Flasks were inoculated with dried Ethanol Red Yeast (*Saccharomyces cerevisiae,* Lesaffre) at a concentration of 0.1% g yeast/total volume of sample. Flasks were capped with rubber stoppers and bacterial air vent filters (Pall-Gallman 0.45 μm; Pall-Gallman PN4210) sealed

with Parafilm, and incubated at 35ºC in a shaking waterbath. Hydrolysis and fermentation treatment flasks were completed in triplicate. Controls without salts or yeast were completed in duplicate for each ISP preparation. Flasks were sampled every 12 hours for 72 hours, excluding hour 60. Samples (1 ml aliquots) were stored at -80ºC until HPLC analysis.

3.2.7 Saccharification Sugars and Ethanol Concentrations

Individual sugars maltotriose, maltose, glucose, and fructose and ethanol concentrations for each sample were quantified using a Shimadzu LC-20AT HPLC system. The HPLC was equipped with a Biorad Aminex HPX-87H ion exchange column (column temp. 65ºC) with a guard column (Micro-Guard Refill Cartridge, Biorad, Richmond, CA), an automated sampler (SIL-20A), a gradient pump (LC-20AT) with degaser (GDU-20A) and a differential refractometric detector (RID-10A) (Shimadzu Corp., Columbia, MD). The mobile phase used was 5mM H_2SO_4 at a flow rate of 0.6 ml/min. All samples were diluted (10x) and filtered through 0.2 µm nylon syringe filters before analysis.

3.3 Results

3.3.1 Saccharification

3.3.1.1 Starch Quantification

Alcohol insoluble solid (AIS) values for both fresh and flour sweetpotato preparations are presented as the change in starch content relative to initial starch dry matter (% of dry matter lost). The analysis of variance for AIS for flour preparations is presented in Table 3.1. The main and interaction effects of incubation temperature (temp) and pullulanase loading (load) were not statistically significant (p-values > 0.05). The change in starch dry matter ranged from 50 to 54.2% (Figure 3.1a), where the average initial starch contents of the treatments at

each temperature were 66.4, 66.6, and 66.2% for 45, 55, and 65°C, respectively, leaving at least 12% of starch still available for conversion. No significant trends existed among starch degradation for glucoamylase only treatments and those saccharified with glucoamylase and pullulanase. Increases in change in starch content of nearly 3% did occur, however, between liquefaction controls and all other samples. Within each incubation temperature, the highest change in starch for 45°C treatments occurred at a Promozyme loading of 0.5 NPUN/g dry ISP (53.5%), while the 0.1 NPUN/g dry ISP loading resulted in the greatest average change for treatments incubated at 55 and 65°C (Figure 3.1a). These values were, however, statistically the same as all other pullulanase loading levels within each incubation temperature, except the Promozyme loading of 0.1 NPUN/g dry ISP at 65°C (54.2%) which was significantly larger than the change at 0.5 NPUN/g dry ISP (p-value > 0.05).

Table 3.1 ANOVA table of flour and fresh FTA-94 industrial sweetpotato during saccharification for incubation temperature and enzyme loading on change in starch

		Flour			Fresh		
Source	**DF**	**Mean Square**	**F-value**	**Pr > F**	**Mean Square**	**F-value**	**Pr > F**
Temp	2	0.60	1.58	0.2270	966.08	8406.65	<.0001
Load	3	0.51	1.36	0.2799	0.81	7.09	0.0015
Temp*Load	6	0.67	1.77	0.1476	0.51	4.45	0.0039

The analysis of variance for saccharification of fresh sweetpotato preparations revealed significant p-values for both main and interaction effects of incubation temperature and enzyme loading (p-value < 0.05; Table 3.1). Results for change in starch dry matter content of fresh sweetpotato during saccharification with pullulanase ranged from 46.8 to 65.7% (Figure 3.1b). Average initial starch contents of samples at each temperature were 60.1,

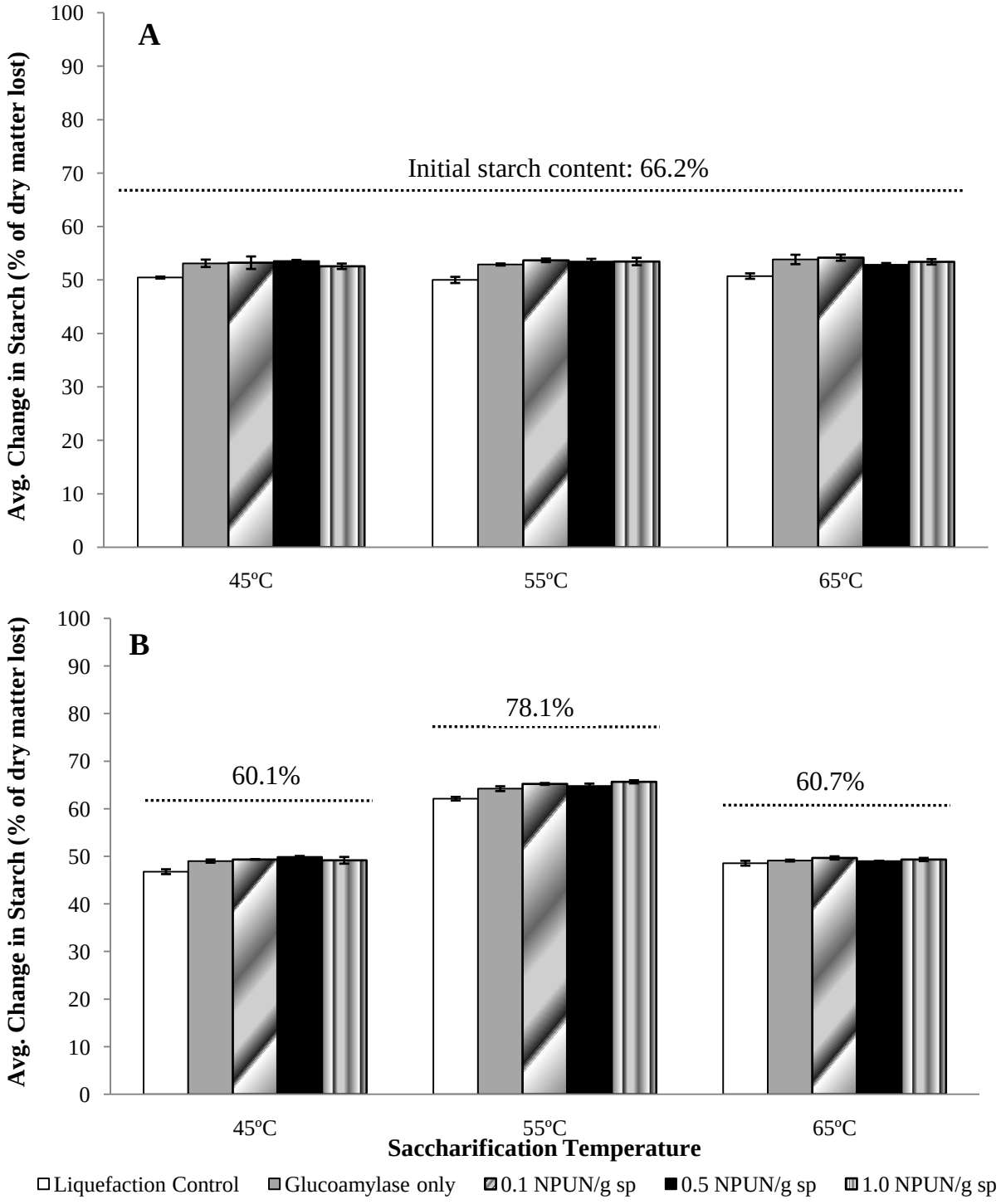

Figure 3.1 Average change in starch (% loss of dry matter) over time during saccharification of flour and fresh FTA-94 industrial sweetpotatoes using Promozyme: A) flour preparations. B) fresh preparations.

78.1, and 60.7% for 45, 55, and 65°C, respectively. This left an average of at least 11% starch not hydrolyzed during saccharification. The treatment combination of 45°C and 0.5 NPUN/g dry ISP produced a 49.9% change in starch, which was significantly higher than any other loading at that same temperature (p-value < 0.05). Results for samples saccharified at 55°C showed similar change in starch values of 65.2 and 65.7% for loadings of 0.1 and 1.0 NPUN/g dry ISP, respectively, which were statistically higher than treatments loaded with 0 and 0.5 NPUN/g dry ISP of Promozyme. Change in starch dry mater at enzyme loadings of 0.1 and 1.0 NPUN/g dry ISP were also statistically higher than loadings of 0 and 0.5 NPUN/g dry ISP for samples incubated at 65°C (p-value < 0.05). Comparison of results between temperatures showed that change in starch content seemed to correspond with initial starch values. Each enzyme loading incubated at 55°C (highest initial starch content), including liquefaction controls, had significantly higher change in starch values than any samples saccharified at both 45 and 65°C, regardless of loading rate.

Comparison of fresh and flour sweetpotato preparations further justified the significance of initial starch content in observed changes in starch dry matter content. The interaction of sweetpotato preparation, enzyme loading, and incubation temperature showed that all flour sweetpotato samples (66.2% avg. initial starch content) at each loading and temperature combination had significantly higher changes in starch dry matter than any treatment combination of fresh sweetpotato samples incubated at both 45 and 65°C (60.4% avg. initial starch content; all p-values < 0.05). Also, fresh sweetpotato samples incubated at 55°C, which had the highest average initial starch content of 78.1%, produced significantly higher

changes in dry matter than any other combination of preparation, loading, or temperature (p-values < 0.05).

3.3.1.2 Glucose Production

Results for glucose are reported in terms of milligrams of glucose recovered per gram of starch rather than per gram of dry sweetpoato due to the high variability of initial starch content data. This unit more accurately represents glucose yields and and simplifies comparisons between treatment combinations including flour and fresh sweetpotato preparations.

The analysis of variance for flour sweetpotato treatments on glucose revealed a statistically significant main effect of pullulanase loading (p-value < 0.05) and an insignificant main effect of temperature and interaction effect of temperature and pullulanase loading (Table 3.2). Saccharification of flour sweetpotato preparations with pullulanase yielded glucose values ranging from 768.4 to 879.3 mg/g of starch (Figure 3.2a). Hydrolyzed starch from all samples was completely converted to glucose, excluding those saccharified at 65°C with 0.5 and 1.0 NPUN/g dry ISP, which left trace amounts of maltose and maltotriose (data not shown), and liquefaction control samples, which contained substantial amounts of both maltose and maltotriose. Observing pullulanase loadings across all three incubation temperatures, a loading of 0.5 NPUN/g dry ISP produced significantly higher glucose values than all other loadings, including 1.0 NPUN/g dry ISP. The highest level of glucose was achieved at a Promozyme loading of 0.5 NPUN/g dry ISP and a temperature of 65°C (879.3 mg/g starch), however, the yield was not significantly different than glucose produced with the same enzyme loading at 45 and 55°C (816.5 and 828.7 mg

glucose/g starch; p-values > 0.05). Within each incubation temperature level, an enzyme loading of 1.0 NPUN/g dry ISP produced the lowest glucose values of all pullulanase loadings, including those treatments that only contained glucoamyalse.

The main and interaction effects of pllulanase loading and incubation temperature for fresh sweetpotato preparations on glucose were not statistically significant (Table 3.2), although the main effect of load had a p-value of 0.065. Glucose produced from saccharification of fresh sweetpotato with pullulanase ranged from 770.7 to 880.2 mg/g starch (Figure 3.2b) . Samples incubated at 45 and 55°C converted hydrolyzed starch completely to glucose. At 65°C, however, levels of maltose were recorded for all samples ranging up to 231.5 mg/g starch. Across all temperatures, enzyme loadings of 0.1 and 0.5 NPUN/g dry ISP produced statistically similar glucose yields which were significantly higher than those found at loadings of 0 and 1.0 NPUN/g dry ISP (p-values < 0.05). Aside from the two lowest values of glucose found at 0 and 1.0 NPUN/g dry ISP saccharified at 65°C, all levels of glucose across all temperatures were statistically similar to one another. The highest average glucose yield was produced at 65°C with a Promozyme loading of 0.1 NPUN/g dry ISP (880.2 mg/g starch).

Table 3.2 ANOVA table of flour and fresh FTA-94 industrial sweetpotato during saccharification for incubation temperature and enzyme loading on glucose

		Flour			Fresh		
Source	**DF**	**Mean Square**	**F-value**	**Pr > F**	**Mean Square**	**F-value**	**Pr > F**
Temp	2	353.03	0.21	0.8120	2626.21	1.79	0.1887
Load	3	5925.29	3.53	0.0301	4037.69	2.75	0.0648
Temp*Load	6	1372.06	0.82	0.5677	2857.81	1.95	0.1140

The main effects of preparation and pullulanase loading rate were statistically significant when comparing data from fresh and flour sweetpotato preparations (p-values < 0.05; Table 3.3). Across all enzyme loadings and incubation temperatures, fresh sweetpotato significantly outperformed flour in terms of glucose production by an average of 40 mg/g starch. The most productive enzyme loading was seen at 0.5 NPUN/g dry ISP, though not statistically different than 0.1 NPUN/g dry ISP. Examination of interaction effects indicated that at each temperature and loading, all fresh treatment preparations yielded higher average glucose values than their corresponding flour treatments, excluding 65°C at pullulanase loadings of 0 and 1 NPUN/g dry ISP. However, the highest glucose value found for fresh, 880.2 mg/g starch (0.1 NPUN/g dry ISP at 65°C), was not statistically different than the two highest values found for flour treatments with 828.7 mg/g starch and 879.3 mg/g starch for 0.5 NPUN/g dry ISP at 55 and 65°C, respectively.

Table 3.3 ANOVA table of flour and fresh FTA-94 industrial sweetpotato during saccharification with pullulanase for sweetpotato preparation, incubation temperature, and enzyme loading on levels of glucose

Product	Source	DF	Mean Square	F value	Pr > F
Glucose	Prep	1	28600.35	18.17	<.0001
	Temp	2	530.90	0.34	0.7154
	Load	3	8195.24	5.21	0.0034
	Prep*Temp	2	2448.34	1.56	0.2215
	Prep*Load	3	1767.75	1.12	0.3491
	Temp*Load	6	2425.79	1.54	0.1852
	Prep*Temp*Load	6	1804.08	1.15	0.3507

3.3.2 Fermentation

Results for glucose, ethanol and fructose concentrations over time during fermentation of flour and fresh sweetpotato preparations are shown in Figure 3.3. Sugars from both preparations were successfully converted to ethanol. Small amounts of glycerol were also

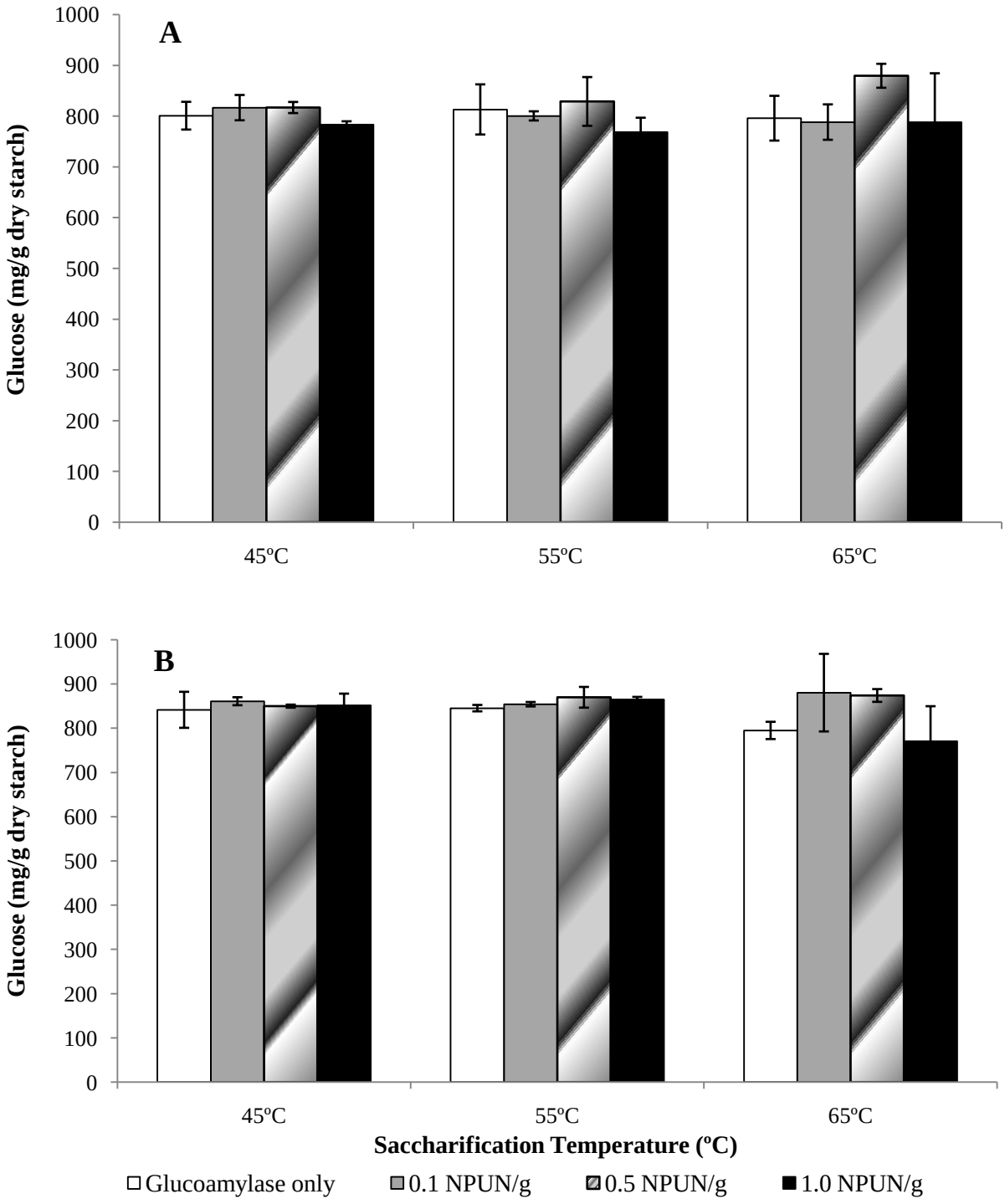

Figure 3.2 Concentration of glucose found during saccharification of flour and fresh FTA-94 industrial sweetpotatoes over time using Promozyme: A) flour preparation. B) fresh preparation.

detected on the HPLC chromatograms in all samples inoculated with the Ethanol Red Yeast, excluding time 0 (data not shown).

Flour-based sweetpotato sugars produced theoretical amounts of ethanol based on initial glucose during the 72 hour incubation. Samples reached an average of 17.3 mg of ethanol/g dry ISP after 12 hours and quickly rose to 292 mg ethanol/g dry ISP after 24 hours, only increasing by 6.4% after 36 hours of incubation (Figure 3.3a). Glucose levels at the beginning of the fermentation were on average 500.5 mg/g dry ISP. This value gradually increased to 508.5 mg/g dry ISP after 12 hours. This increase coupled with the fact that 17.3 mg/g dry ISP of ethanol was recorded indicates production of glucose took place during the first few hours of fermentation as well as the utilization of this glucose by the yeast to produce ethanol. After 24 hours, levels of glucose significantly decreased to 35.2 mg/g dry ISP. No glucose was recorded after 36 hours. Fructose values increased to 67.7 mg/g dry ISP after 12 hours of incubation. This value decreased over time and was completely converted by hour 36.

Fermentation results with fresh sweetpotato preparations are shown in Figure 3.3b. After 12 hours of fermentation, ethanol values were detected at an average level of 44.5 mg/g dry ISP. Within 24 hours, average values had significantly risen to 326.6 mg ethanol/g dry ISP, and gradually increased by only 2.4% after 36 hours. Glucose concentrations were initially at 584.3 mg/g dry ISP on average. At 24 hours glucose concentrations decreased to 5.3 mg/g dry ISP, and no glucose was detected thereafter. Fructose increased from 0 to 70.4 mg/g dry ISP within 12 hours, and was completely converted by hour 36.

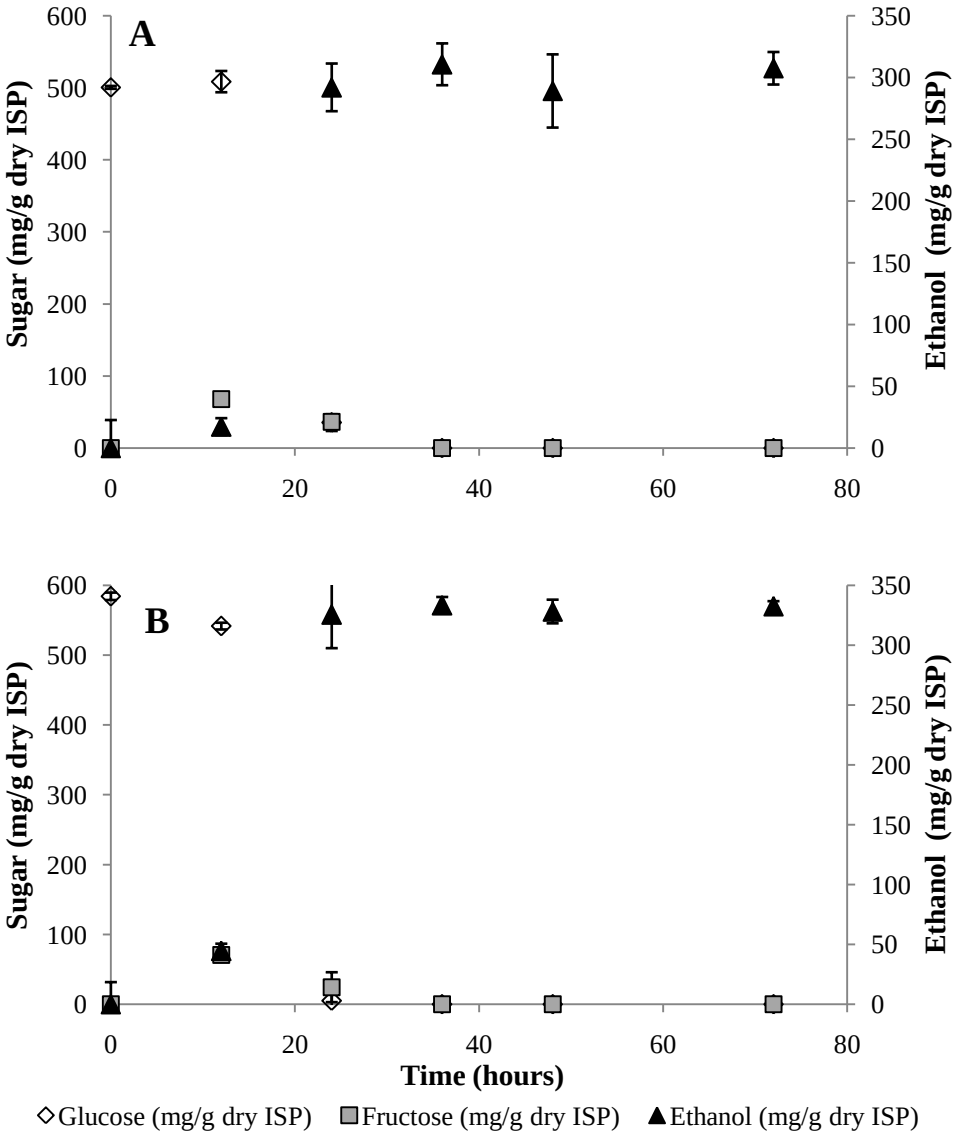

Figure 3.3 Ethanol, glucose, and fructose concentrations measured over time during fermentation of flour and fresh FTA-94 industrial sweetpotatoes: A) Flour, 0.1% yeast, salt extract. B) Fresh, 0.1% yeast, salt extract.

Yeast in both flour and fresh sweetpotato treatments were able to ferment available sugars to ethanol. On average, fresh preparations started with nearly 84 mg/g dry ISP (16.7%) more glucose than flour preparations, and as a result produced over 22 mg/g dry ISP more ethanol. Both preparations appeared to reach peak ethanol production by 36 hours of fermentation, indicating that 36 hours is a sufficient incubation period to produce maximum ethanol yields.

3.4 Discussion

3.4.1 Enzymatic hydrolysis

Initial starch contents were different based on the type of preparation used (flour or fresh). Experiments for flour and fresh sweetpotatoes were performed separately within a three-week time period. Initial starch dry matter for flour sweetpotato preparations at different temperatures were all consistent and had values close to 66%. Initial starch dry matter for fresh sweetpotato experiments, however, had initial values ranging from 60 to 78%. Flour sweetpotato substrate for each experiment was taken from the same source of dried and ground sweetpotato. Substrate for fresh sweetpotato experiments, however, were taken from different whole sweetpotatoes which were kept refrigerated at 58°F and processed for experimentation at different times within the three week experimental process. The variance in starch content for fresh preparations can be attributed to the decomposition of fresh sweetpotatoes during their long storage period (nearly 8 months). The different fresh sweetpotatoes used for experiments at each saccharification temperature may have decomposed at different rates throughout their storage period. It is known that improper

or extended storage causes decreases in total weight and starch content of sweetpotatoes (Zhang et al., 2002; Ray and Ravi, 2005). The process of drying the sweetpotato intended for use in flour preparation experiments may have permanently decreased the initial starch content of the substrate, but no significant decrease in starch was found after 8 months of storage in a flour state.

Previous studies performed on fresh sweetpotato gave initial starch contents up to 81.2%. This is significantly higher than the initial starch contents found for flour preparations. Flour sweetpotato preparations were dried at 70°C for 60 hours to prevent decomposition of the sweetpotato during storage. Drying the sweetpotato may have contributed to the loss of starch content among all flour preparations. Bondaruk et al. (2007) found that potatoes dried at 70°C resulted in 8% less starch on a dry basis than raw potatoes. This group also found that blanching the potato cubes in hot water for 4.5 minutes (95°C) prior to drying can help preserve starch content reducing starch dry matter by only 2%. These results are comparable to the average of approximately 66.2% initial starch content found for flour sweetpotato preparations during saccharification of this study. This suggests that in the future a lower drying temperature may help improve the initial starch content of flour sweetpotato preparation in an attempt to preserve the structural integrity of sweetpotato during storage. Because ISPs are an annual crop which would require storage if used consistently throughout the year as a feedstock to produce ethanol, more research must be performed specifically on these crops to evaluate different fresh storage conditions and drying methods that are effective in preserving available starch for subsequent hydrolysis (less available starch results in lower conversion of sugars).

Enzymatic hydrolysis of flour sweetpotato preparations showed that saccharification combining glucoamylase and pullulanase activities substantially increased the amount of reducing sugars and the conversion of these sugars to single glucose units. Within each temperature, Promozyme loadings of 0.5 NPUN/g dry ISP increased the amount of glucose produced, indicating that pullulanase helped cleave α-1,6 glycosidic bonds in addition to those hydrolyzed by glucoamylase. This increase, however, was not significant, and may have been due to the ratio of pullulanase loadings to the amount of glucoamylase present, which caused a decrease in the synergistic activity between the two enzymes resulting in insufficient binding of pullulanase to substrate.

The correct ratios of combined enzyme loading rates and incubation temperature are important in creating efficient hydrolysis of sweetpotato starch. Roy and Gupta (2004) found that increasing pullulanase loading from 1 to 4 units during saccharification (45°C) of potato starch increased the reducing sugars from approximately 140 to 550 µmol (measured as glucose). Their pullulanase was incubated with 15 U of glucoamylase, however because of the low temperature the glucoamylase was not fully activated. They concluded that a glucoamylase to pullulanase ratio of 3:2 was optimal, and as glucoamylase opened up the starch structure and exposed the α-1,6 linkages, pullulanase took over and a more efficient hydrolysis occurred. Based on our results, pullulanase was able to assist glucoamylase at 45 and 55°C; however the high ratio of glucoamylase to pullulanase may have limited the performance of pullulanase due to potential overcrowding and resulting decreased availability of enzyme binding sites as a result of the overcrowding of the glucoamylase enzyme.

Pullulanase was added to help increase the digestion of starch, which results showed was not significant because of the presence of residual starch. This could have been an additional effect of the decreased availability of the binding sites caused by excess loading of glucoamylase. If the glucoamylase was bound to the α-1,6 bonds without effectively hydrolyzing the starch, then pullulanase would have had less opportunity to bind to the resistant starch and convert it to sugars. The incomplete starch digestion could have also been caused by feedback inhibition. In a study investigating the semi-continuous hydrolysis of raw sweetpotato starch by glucoamylase, results showed inhibitions of starch digestion with increasing glucose concentrations (Noda et al., 1992). Glucose was produced at a high rate during the first 12 hours of incubation (up to 4% w/v glucose). However, the rate decreased rapidly during the next 12 hours, indicating an inhibition of starch digestion. Glucose levels during saccharification of this experiment using FTA-94 ISP increased to 8.5 and 13.0% w/v. This implies that due to the excess amounts of glucose present after saccharification of FTA-94 ISP, production inhibition may have been caused by glucose, resulting in the incomplete conversion of starch to sugar.

Generally, the three levels of pullulanase loading did generate more glucose in combination with glucoamylase than with just glucoamylase alone at the 45 and 55°C incubation temperatures. However, the pullulanse loading of 1.0 NPUN/g dry ISP at 65°C did not produce better glucose results. At a temperature of 65°C, the optimum for glucoamylase and 25°C higher than the recommended temperature for pullulanase, the glucoamylase was clearly more active, producing high levels of glucose in addition to maltose. The maltose formed can be attributed to the reversion process. In the presence of

high levels of glucose and high dissolved solids, glucoamylase has been known to catalyze the reverse condensation reaction. This causes maltose, isomaltose, and other byproducts to be created from glucose (Crabb and Shetty, 1999). At temperatures of 45 and 55°C, no additional sugars other than glucose were recorded for any loading, including the glucoamylase control. Because incubation time was not tested during saccharification, activity rates of each enzyme cannot be analyzed. However, the lack of maltose being produced at these temperatures even without any pullulanase added is an indication that glucoamylase may not have been fully active and was not producing glucose fast enough for the reversion process to occur.

During saccharification, increased amounts of glucoamylase when used alone are necessary to hydrolyze the α-1,6 glycosidic bonds, often leading to the creation of reversion products. But when this enzyme is used in conjunction with pullulanase at the appropriate ratio, the pullulanase can prevent this reversion by quickly hydrolyzing the α-1,6 bonds, provided that the pullulanase and glucoamylase remain active (Roy and Gupta, 2004). Results found at 65°C support the decreased thermostability of pullulanase as the existence of maltose indicated reversion. Because the temperature was 25°C above the optimal for pullulanase, the reversion of glucose can be attributed to the decreased activity of pullulanase at high temperatures. Roy and Gupta (2004) showed that even at 55°C, the residual activity of pullulanase completely disappeared after only 2 hours of incubation. They were able to achieve prolonged thermostability of the enzymes by immobilization inside calcium alginate beads, and as a result were able to show the synergistic effects of pullulanase in combination with glucoamylase. However, because the first hours of saccharification were not evaluated

in this study and glucoamylase loadings were fairly high with respect to pullulanase levels, it was difficult to assess the synergistic activity of pullulanase in combination with glucoamylase. Future studies on hydrolysis of sweetpotato starch should examine similar loadings of pullulanase in combination with decreased loadings of glucoamylase at different temperatures during the first few hours of saccharification to better evaluate synergistic effects and potentially increase glucose production.

3.4.2 Fermentation to ethanol

Saccharification with 5.0 AGU/g dry ISP of glucoamylase and 0.5 NPUN/g dry ISP of pullulanase at 55°C was considered the best hydrolysis condition for synergistic activity of the enzymes for glucose production from this study. These processing parameters were used to produce hydrolysate for ethanol fermentation studies within a single vessel without removal of sweetpotato solids. Fermentation of hydrolyzed sweetpotato sugars was successful and showed no inhibition by ethanol or initial sugar concentration. Ethanol values for each treatment combination seemed to increase until glucose levels depleted. The highest volume of ethanol produced in any of the fermentation vessels was achieved with fresh preparation after 36 hours and produced 5.5% v/v ethanol. This value was dependent on the initial substrate loading for all samples, which once fermentation was initiated was 12.5% g initial dry ISP/v for this study (6.3% w/v glucose for flour; 7.3% w/v glucose for fresh). One study using batch fermentation of 20% glucose to study ethanol formation resulted in the formation of more than 12% v/v ethanol (Dombek and Ingram, 1987). This implies that provided viscosity remains low enough and gelatinization does not inhibit starch

decomposition, the solid loading during enzymatic hydrolysis can be increased to at least twice its value (25% w/v) without inhibiting yeast performance.

Ethanol yields recorded after 12 hours of fermentation of flour and fresh sweetpotato preparations produced values greater than 1 g/g of initial glucose, respectively. Both values were unusually high in absolute value and could have been a result of glucose being produced during fermentation. Because hydrolysis and fermentation were conducted in the same 250 ml flasks and hydrolysates were not autoclaved, the enzymes may have remained active during fermentation continuing to produce glucose as glucose was consumed. This is most evident in the flour preparation treatments where glucose levels detected increased after 12 hours of incubation. After 36 hours, however, ethanol yields decreased to 0.67 and 0.59 g ethanol/g glucose used for flour and fresh preparations, respectively, which were more consistent with theoretical calculations (1 g glucose yields ~0.51 g ethanol). Similar ethanol yields and production rates were achieved for flour and fresh preparations indicating that sugars from both preparations can be used effectively by Ethanol Red Yeast and yeast performance is independent of sweetpotato preparation provided that sugar is available to be converted.

The 5.5%v/v ethanol value achieved with fresh preparation after 36 hours of fermentation is equivalent to 333.3 mg ethanol/g dry sweetpotato. This is comparable to 350 mg/g sweetpotato of ethanol found by a study on high alcohol production from starchy substrates using 4.5 mg of amylase per gram of starch (Loba chemie 1300 IU/g) in simultaneous saccharification and fermentation (SSF), which minimizes product inhibition by producing ethanol from glucose as it is converted from starch. Future studies on fermentation should

include SSF using α-amylase, glucoamylase, and pullulanase to determine the most efficient method for producing ethanol or other fermentation products from Industrial FTA-94 industrial sweetpotatoes. Accordingly, conducting fermentation in the presence on hydrolyzed solids may also prove more effective than separate hydrolysis and fermentation with solids removed.

Results of this study show successful conversion of FTA-94 ISPs into fermentable sugars during saccharification with the addition of glucoamylase and pullulanase. The addition of pullulanase during 48 hours of saccharification with 5.0 AGU/g Spirizyme Ultra at 45, 55, and 65ºC showed no consistent increase in the change in starch content. Adding 0.5 NPUN/g of Promozyme during saccharification at 55ºC slightly increased the amount of recovered glucose, producing 828.7 and 869.7 mg/g starch of glucose for flour and fresh ISP. It was shown that extended hydrolysis leads to higher starch conversion and increased sugar recovery, however no matter what the initial starch content, 10-12% of starch content remained after hydrolysis. The ability to degrade this residual recalcitrant starch must be further investigated. Fermentation of these treatment combinations yielded ethanol values of 310.7 and 333.3 mg/g dry ISP for flour and fresh preparations. Based on FTA-94 production yields in the past few years, this is equivalent to 703 gallons of ethanol/acre of ISP, which is considerably more than corn, which produces only 404 gallons/acre (EERE, 2006). Additional research investigating the synergistic activities of the saccharification enzymes may offer a better understanding of combined enzyme function and improve starch conversion. However this research demonstrates the potential of using sweetpotatoes as an alternative starch feedstock capable of competitive ethanol production.

3.5 References

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Chapter 4: Saccharification and Fermentation Process Assessment

In order to successfully scale up an efficient process for the enzymatic hydrolysis of industrial sweetpotatoes to provide a competitive alternative to current methods of ethanol production, there are several valuable factors which should be considered in the future: determination of more efficient means of sweetpotato storage, better understanding of enzyme kinetics, analysis of different ratios of multiple saccharification enzymes, and evaluation of scale up parameters.

These experiments have shown successful conversion of both fresh and oven-dried FTA-94 sweetpotatoes. There are advantages and disadvantages to using both preparations. Flour preparation treatments seemed to produce more glucose after hydrolysis, however, the drying reduced initial starch content. In addition, the drying also adds significant processing costs. The fresh preparation treatments generally retained higher initial starch contents, however less glucose was recovered and extended storage led to declining initial starch contents. Also, recurring viscosity issues occurring while using fresh preparations require lower solids loadings, and as a result, decreased sugar concentrations. To determine the more effective method, the economic processes of each preparation method must be fully examined.

During saccharification with glucoamylase alone and saccharification with glucoamylase and pullulanase, several inhibitions were attributed to the incomplete conversion of starch and reduced accumulation of glucose. Studies which evaluate kinetics and inhibitions in addition to trying to identify a model of the complete hydrolysis of ISPs could correctly determine all inhibitions in addition to establishing at what time each inhibition is occurring.

Future studies could then tailor experiments to decrease these constraints and improve the efficiency of hydrolysis, ultimately increasing conversion to fermentable sugars.

The examination of saccharification with glucoamylase and pullulanase during these experiments showed that both the incubation temperature relative to each enzyme's optimal temperature and the ratio of these enzymes are important factors contributing to the effectiveness of enzymatic hydrolysis of industrial sweetpotatoes. Decreased activities of both glucoamylase and pullulanase were assumed to occur at temperatures above and below their respective optimal temperatures. However, because this saccharification temperature was not examined over time, it was difficult to determine how incubation temperature affected their activities. In terms of the most effective loading ratio for these two enzymes, only one glucoamylase loading was examined (5.0 AGU/g dry ISP) with three small loadings of pullulanase. It was determined that this high ratio was not conducive to the low loadings of pullulanase, and that if lower loadings of glucoamylase were observed with various pullulanase loadings, the pullulanase may have shown increased productivity. Future studies on the enzymatic hydrolysis of sweetpotato starch should examine smaller ratios at different temperatures over time to better evaluate synergistic effects and potentially increase glucose production.

A reduction in the product inhibition which occurred as a result of glucose production can be accomplished by using a batch hydrolysis with continuous product removal. If the intended product is glucose, then the removal of glucose as it is produced by the enzyme is possible by using ultrafiltration (Noda et al. 1992) to allow the enzymes to continue hydrolysis. Also, using a batch membrane reactor (allowing hydrolysate liquid in and

removing glucose) may also reduce this inhibition by removing the glucose as it is formed. If the intended product is ethanol, then the implementation of simultaneous saccharification and fermentation (SSF) may prove beneficial. This process combines the enzymatic hydrolysis of starch to glucose and the conversion of this glucose to ethanol by fermentation into one unit operation (Sree et al. 1999). This would reduce incubation time and energy input of the process and allow the yeast to ferment glucose as it is produced by the enzymes, thereby reducing product inhibition and increasing the extent of starch hydrolysis. This process, however, would require additional research on the effects of temperature, enzyme loading, and yeast concentrations, as interactions between the enzymes and yeast will be different in a simultaneous process versus a separate stepwise process.

In order to successfully scale this project up for industrial use, there are certain factors which need to be analyzed. Scale up of a batch hydrolysis process may necessitate the addition of agitation (shaking) the vessel during hydrolysis in order to successfully mix the enzyme into the substrate. With large quantities of sweetpotato, simply shaking the enzyme into the aqueous slurry before hydrolysis, as performed in our experiments, may not sufficiently spread the enzyme among the substrate. In addition, efficient heating of the mixture will need to be examined in order for scale-up to be successful. Bench scale enzymatic hydrolysis was accomplished using heated waterbaths. Larger vessels may require the addition of a "jet-cooker" (steam injected heater) to adequately heat the sweetpotato during saccharification (Kwiatkowski et al. 2005). Finally, an industrial scale process for the hydrolysis of sweetpotatoes may require different enzyme loadings than those needed on a laboratory scale. Depending on the preparation and size of the sweetpotato, a larger scale

may require lower or higher loadings of hydrolysis enzymes to effectively convert a significant amount of starch. These factors must be considered to fully examine the feasibility of commercial scale ethanol production using industrial sweetpotatoes.

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APPENDICES

Appendix A: SAS® Analyses for Liquefaction of FTA-94 ISP

Appendix A.1 Flour ISP

```
title 'Liquefaction Exp on Dry FTA-94 SWP';
data DryFTALiquefaction080607;
input Hour Rep Enz DeltaRS DeltaAIS;
datalines;
1     1     0     15.518      23.22
1     2     0     21.833      22.56
1     3     0     18.224      24.22
2     1     0     24.193      26.56
2     2     0     19.821      25.89
2     3     0     24.679      23.22
3     1     0     32.798      25.56
3     2     0     37.865      27.89
3     3     0     31.480      27.22
1     1     3     81.161      50.33
1     2     3     47.710      48.33
1     3     3     73.943      50.67
2     1     3     85.325      50.67
2     2     3     91.710      50.33
2     3     3     169.021     52.67
3     1     3     74.082      53.67
3     2     3     81.300      52.00
3     3     3     111.697     52.33
1     1     .3    48.691      45.44
1     2     .3    124.337     49.44
1     3     .3    104.627     45.78
2     1     .3    77.145      48.11
2     2     .3    106.182     46.78
2     3     .3    102.157     48.11
3     1     .3    105.321     46.11
3     2     .3    129.334     48.78
3     3     .3    247.591     50.11
1     1     .03   9.952       41.22
1     2     .03   57.283      42.22
1     3     .03   50.343      44.56
2     1     .03   41.460      43.22
2     2     .03   58.948      47.22
2     3     .03   41.876      48.89
3     1     .03   68.942      42.89
3     2     .03   88.096      43.56
3     3     .03   74.772      43.89
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = DryFTALiquefaction080607;
      class Hour Enz;
      model DeltaRS DeltaAIS = Hour Enz Hour*Enz;
      lsmeans Hour Enz Hour*Enz/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Liquefaction Exp on Dry FTA-94 SWP

Obs	Hour	Rep	Enz	DeltaRS	Delta AIS
1	1	1	0.00	15.518	23.22
2	1	2	0.00	21.833	22.56
3	1	3	0.00	18.224	24.22
4	2	1	0.00	24.193	26.56
5	2	2	0.00	19.821	25.89
6	2	3	0.00	24.679	23.22
7	3	1	0.00	32.798	25.56
8	3	2	0.00	37.865	27.89
9	3	3	0.00	31.480	27.22
10	1	1	3.00	81.161	50.33
11	1	2	3.00	47.710	48.33
12	1	3	3.00	73.943	50.67
13	2	1	3.00	85.325	50.67
14	2	2	3.00	91.710	50.33
15	2	3	3.00	169.021	52.67
16	3	1	3.00	74.082	53.67
17	3	2	3.00	81.300	52.00
18	3	3	3.00	111.697	52.33
19	1	1	0.30	48.691	45.44
20	1	2	0.30	124.337	49.44
21	1	3	0.30	104.627	45.78
22	2	1	0.30	77.145	48.11
23	2	2	0.30	106.182	46.78
24	2	3	0.30	102.157	48.11
25	3	1	0.30	105.321	46.11
26	3	2	0.30	129.334	48.78
27	3	3	0.30	247.591	50.11
28	1	1	0.03	9.952	41.22
29	1	2	0.03	57.283	42.22
30	1	3	0.03	50.343	44.56
31	2	1	0.03	41.460	43.22
32	2	2	0.03	58.948	47.22
33	2	3	0.03	41.876	48.89
34	3	1	0.03	68.942	42.89
35	3	2	0.03	88.096	43.56
36	3	3	0.03	74.772	43.89

Liquefaction Exp on Dry FTA-94 SWP
Interaction and Main Effects of Treatments

The GLM Procedure
Class Level Information

Class	Levels	Values
Hour	3	1 2 3
Enz	4	0 0.03 0.3 3

Number of Observations Read	36
Number of Observations Used	36

The GLM Procedure

Dependent Variable: DeltaRS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	58323.48187	5302.13472	5.61	0.0002
Error	24	22688.89728	945.37072		
Corrected Total	35	81012.37915			

R-Square	Coeff Var	Root MSE	DeltaRS Mean
0.719933	42.91232	30.74688	71.65047

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	7729.20718	3864.60359	4.09	0.0297
Enz	3	43139.76115	14379.92038	15.21	<.0001
Hour*Enz	6	7454.51354	1242.41892	1.31	0.2890

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	7729.20718	3864.60359	4.09	0.0297
Enz	3	43139.76115	14379.92038	15.21	<.0001
Hour*Enz	6	7454.51354	1242.41892	1.31	0.2890

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	3707.681097	337.061918	132.25	<.0001
Error	24	61.169133	2.548714		
Corrected Total	35	3768.850231			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.983770	3.796923	1.596469	42.04639

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	34.534956	17.267478	6.77	0.0046
Enz	3	3649.155875	1216.385292	477.25	<.0001
Hour*Enz	6	23.990267	3.998378	1.57	0.1994

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	34.534956	17.267478	6.77	0.0046
Enz	3	3649.155875	1216.385292	477.25	<.0001
Hour*Enz	6	23.990267	3.998378	1.57	0.1994

The GLM Procedure
Least Squares Means

Hour	DeltaRS LSMEAN	LSMEAN Number
1	54.4685000	1
2	70.2097500	2
3	90.2731667	3

Least Squares Means for effect Hour
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3
1		0.2219	0.0088
2	0.2219		0.1230
3	0.0088	0.1230	

Hour	DeltaAIS LSMEAN	LSMEAN Number
1	40.6658333	1
2	42.6391667	2
3	42.8341667	3

Least Squares Means for effect Hour
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3
1		0.0058	0.0028
2	0.0058		0.7674
3	0.0028	0.7674	

Enz	DeltaRS LSMEAN	LSMEAN Number
0	25.156778	1
0.03	54.630222	2
0.3	116.153889	3
3	90.661000	4

Least Squares Means for effect Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3	4
1		0.0532	<.0001	0.0001
2	0.0532		0.0003	0.0203
3	<.0001	0.0003		0.0914
4	0.0001	0.0203	0.0914	

Enz	DeltaAIS LSMEAN	LSMEAN Number
0	25.1488889	1
0.03	44.1855556	2
0.3	47.6288889	3
3	51.2222222	4

Least Squares Means for effect Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		<.0001	<.0001	<.0001
2	<.0001		0.0001	<.0001
3	<.0001	0.0001		<.0001
4	<.0001	<.0001	<.0001	

Appendix A.2 Fresh ISP

```
title 'Liquefaction Exp on Fresh FTA-94 ISP';
data FreshFTALiquefaction0907;
input Hour Rep Enz DeltaRS DeltaAIS;
datalines;
1     1     0     128.316     44.33
1     2     0     185.655     51.33
1     3     0     168.265     51.00
2     1     0     130.431     47.00
2     2     0     109.986     52.00
2     3     0     119.504     50.33
3     1     0     129.608     47.33
3     2     0     147.821     52.00
3     3     0     154.401     53.33
1     1     3     205.294     65.44
1     2     3     255.756     65.44
1     3     3     238.307     65.44
2     1     3     181.477     65.44
2     2     3     233.119     65.44
2     3     3     287.119     65.11
3     1     3     239.957     68.11
3     2     3     224.394     67.78
3     3     3     266.132     68.11
1     1     .3    197.685     54.33
1     2     .3    201.222     55.33
1     3     .3    206.174     69.00
2     1     .3    338.462     65.67
2     2     .3    147.851     65.33
2     3     .3    162.235     65.33
3     1     .3    272.436     68.67
3     2     .3    280.925     68.67
3     3     .3    307.807     67.67
1     1     .03   166.620     55.33
1     2     .03   181.425     58.33
1     3     .03   195.995     58.00
2     1     .03   161.216     64.00
2     2     .03   211.035     63.67
2     3     .03   200.225     64.00
3     1     .03   177.665     68.33
3     2     .03   276.834     68.00
3     3     .03   226.545     68.33
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = FreshFTALiquefaction0907;
      class Hour Enz;
      model DeltaRS DeltaAIS = Hour Enz Hour*Enz;
      lsmeans Hour Enz Hour*Enz/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Liquefaction Exp on Fresh FTA-94 ISP

Obs	Hour	Rep	Enz	DeltaRS	Delta AIS
1	1	1	0.00	128.316	44.33
2	1	2	0.00	185.655	51.33
3	1	3	0.00	168.265	51.00
4	2	1	0.00	130.431	47.00
5	2	2	0.00	109.986	52.00
6	2	3	0.00	119.504	50.33
7	3	1	0.00	129.608	47.33
8	3	2	0.00	147.821	52.00
9	3	3	0.00	154.401	53.33
10	1	1	3.00	205.294	65.44
11	1	2	3.00	255.756	65.44
12	1	3	3.00	238.307	65.44
13	2	1	3.00	181.477	65.44
14	2	2	3.00	233.119	65.44
15	2	3	3.00	287.119	65.11
16	3	1	3.00	239.957	68.11
17	3	2	3.00	224.394	67.78
18	3	3	3.00	266.132	68.11
19	1	1	0.30	197.685	54.33
20	1	2	0.30	201.222	55.33
21	1	3	0.30	206.174	69.00
22	2	1	0.30	338.462	65.67
23	2	2	0.30	147.851	65.33
24	2	3	0.30	162.235	65.33
25	3	1	0.30	272.436	68.67
26	3	2	0.30	280.925	68.67
27	3	3	0.30	307.807	67.67
28	1	1	0.03	166.620	55.33
29	1	2	0.03	181.425	58.33
30	1	3	0.03	195.995	58.00
31	2	1	0.03	161.216	64.00
32	2	2	0.03	211.035	63.67
33	2	3	0.03	200.225	64.00
34	3	1	0.03	177.665	68.33
35	3	2	0.03	276.834	68.00
36	3	3	0.03	226.545	68.33

The GLM Procedure
Class Level Information

Class	Levels	Values
Hour	3	1 2 3
Enz	4	0 0.03 0.3 3

Number of Observations Read	36
Number of Observations Used	36

The GLM Procedure

Dependent Variable: DeltaRS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	72307.1087	6573.3735	3.94	0.0024
Error	24	40024.9845	1667.7077		
Corrected Total	35	112332.0932			

R-Square	Coeff Var	Root MSE	DeltaRS Mean
0.643691	20.08982	40.83758	203.2750

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	8889.27580	4444.63790	2.67	0.0901
Enz	3	53582.93949	17860.97983	10.71	0.0001
Hour*Enz	6	9834.89342	1639.14890	0.98	0.4584

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	8889.27580	4444.63790	2.67	0.0901
Enz	3	53582.93949	17860.97983	10.71	0.0001
Hour*Enz	6	9834.89342	1639.14890	0.98	0.4584

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	1838.350697	167.122791	19.58	<.0001
Error	24	204.823800	8.534325		
Corrected Total	35	2043.174497			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.899752	4.795770	2.921357	60.91528

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	222.906706	111.453353	13.06	0.0001
Enz	3	1514.183675	504.727892	59.14	<.0001
Hour*Enz	6	101.260317	16.876719	1.98	0.1089

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	222.906706	111.453353	13.06	0.0001
Enz	3	1514.183675	504.727892	59.14	<.0001
Hour*Enz	6	101.260317	16.876719	1.98	0.1089

The GLM Procedure
Least Squares Means

Hour	DeltaRS LSMEAN	LSMEAN Number
1	194.226167	1
2	190.221667	2
3	225.377083	3

Least Squares Means for effect Hour
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3
1		0.8122	0.0740
2	0.8122		0.0456
3	0.0740	0.0456	

Hour	DeltaAIS LSMEAN	LSMEAN Number
1	57.7750000	1
2	61.1100000	2
3	63.8608333	3

Least Squares Means for effect Hour
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3
1		0.0100	<.0001
2	0.0100		0.0300
3	<.0001	0.0300	

Enz	DeltaRS LSMEAN	LSMEAN Number
0	141.554111	1
0.03	199.728889	2
0.3	234.977444	3
3	236.839444	4

Least Squares Means for effect Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3	4
1		0.0059	<.0001	<.0001
2	0.0059		0.0795	0.0658
3	<.0001	0.0795		0.9238
4	<.0001	0.0658	0.9238	

The GLM Procedure
Least Squares Means

Enz	DeltaAIS LSMEAN	LSMEAN Number
0	49.8500000	1
0.03	63.1100000	2
0.3	64.4444444	3
3	66.2566667	4

Least Squares Means for effect Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		<.0001	<.0001	<.0001
2	<.0001		0.3422	0.0315
3	<.0001	0.3422		0.2006
4	<.0001	0.0315	0.2006	

Appendix A.3 Comparison of Flour and Fresh ISP

```
title 'Liquefaction Exp on Flour and Fresh FTA-94 ISP';
data Liquefaction080607;
input Prep$ Hour Rep Enz DeltaRS DeltaAIS;
datalines;
Dry   1     1     0     15.518      23.22
Dry   1     2     0     21.833      22.56
Dry   1     3     0     18.224      24.22
Dry   2     1     0     24.193      26.56
Dry   2     2     0     19.821      25.89
Dry   2     3     0     24.679      23.22
Dry   3     1     0     32.798      25.56
Dry   3     2     0     37.865      27.89
Dry   3     3     0     31.480      27.22
Dry   1     1     3     81.161      50.33
Dry   1     2     3     47.710      48.33
Dry   1     3     3     73.943      50.67
Dry   2     1     3     85.325      50.67
Dry   2     2     3     91.710      50.33
Dry   2     3     3     169.021     52.67
Dry   3     1     3     74.082      53.67
Dry   3     2     3     81.300      52.00
Dry   3     3     3     111.697     52.33
Dry   1     1     .3    48.691      45.44
Dry   1     2     .3    124.337     49.44
Dry   1     3     .3    104.627     45.78
Dry   2     1     .3    77.145      48.11
Dry   2     2     .3    106.182     46.78
Dry   2     3     .3    102.157     48.11
Dry   3     1     .3    105.321     46.11
Dry   3     2     .3    129.334     48.78
Dry   3     3     .3    247.591     50.11
Dry   1     1     .03   9.952       41.22
Dry   1     2     .03   57.283      42.22
Dry   1     3     .03   50.343      44.56
Dry   2     1     .03   41.460      43.22
Dry   2     2     .03   58.948      47.22
Dry   2     3     .03   41.876      48.89
Dry   3     1     .03   68.942      42.89
Dry   3     2     .03   88.096      43.56
Dry   3     3     .03   74.772      43.89
Fresh 1     1     0     128.316     44.33
Fresh 1     2     0     185.655     51.33
Fresh 1     3     0     168.265     51.00
Fresh 2     1     0     130.431     47.00
Fresh 2     2     0     109.986     52.00
Fresh 2     3     0     119.504     50.33
Fresh 3     1     0     129.608     47.33
Fresh 3     2     0     147.821     52.00
Fresh 3     3     0     154.401     53.33
Fresh 1     1     3     205.294     65.44
```

```
Fresh 1     2     3     255.756     65.44
Fresh 1     3     3     238.307     65.44
Fresh 2     1     3     181.477     65.44
Fresh 2     2     3     233.119     65.44
Fresh 2     3     3     287.119     65.11
Fresh 3     1     3     239.957     68.11
Fresh 3     2     3     224.394     67.78
Fresh 3     3     3     266.132     68.11
Fresh 1     1     .3    197.685     54.33
Fresh 1     2     .3    201.222     55.33
Fresh 1     3     .3    206.174     69.00
Fresh 2     1     .3    338.462     65.67
Fresh 2     2     .3    147.851     65.33
Fresh 2     3     .3    162.235     65.33
Fresh 3     1     .3    272.436     68.67
Fresh 3     2     .3    280.925     68.67
Fresh 3     3     .3    307.807     67.67
Fresh 1     1     .03   166.620     55.33
Fresh 1     2     .03   181.425     58.33
Fresh 1     3     .03   195.995     58.00
Fresh 2     1     .03   161.216     64.00
Fresh 2     2     .03   211.035     63.67
Fresh 2     3     .03   200.225     64.00
Fresh 3     1     .03   177.665     68.33
Fresh 3     2     .03   276.834     68.00
Fresh 3     3     .03   226.545     68.33
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Liquefaction080607;
      class Hour Enz Prep;
      model DeltaRS DeltaAIS = Hour Enz Prep Hour*Enz Hour*Prep Enz*Prep
Hour*Enz*Prep;
      lsmeans Hour Enz Hour*Enz Hour*Prep Enz*Prep Hour*Enz*Prep/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Liquefaction Exp on Flour and Fresh FTA-94 ISP

Obs	Prep	Hour	Rep	Enz	DeltaRS	Delta AIS
1	Dry	1	1	0.00	15.518	23.22
2	Dry	1	2	0.00	21.833	22.56
3	Dry	1	3	0.00	18.224	24.22
4	Dry	2	1	0.00	24.193	26.56
5	Dry	2	2	0.00	19.821	25.89
6	Dry	2	3	0.00	24.679	23.22
7	Dry	3	1	0.00	32.798	25.56
8	Dry	3	2	0.00	37.865	27.89
9	Dry	3	3	0.00	31.480	27.22
10	Dry	1	1	3.00	81.161	50.33
11	Dry	1	2	3.00	47.710	48.33
12	Dry	1	3	3.00	73.943	50.67
13	Dry	2	1	3.00	85.325	50.67
14	Dry	2	2	3.00	91.710	50.33
15	Dry	2	3	3.00	169.021	52.67
16	Dry	3	1	3.00	74.082	53.67
17	Dry	3	2	3.00	81.300	52.00
18	Dry	3	3	3.00	111.697	52.33
19	Dry	1	1	0.30	48.691	45.44
20	Dry	1	2	0.30	124.337	49.44
21	Dry	1	3	0.30	104.627	45.78
22	Dry	2	1	0.30	77.145	48.11
23	Dry	2	2	0.30	106.182	46.78
24	Dry	2	3	0.30	102.157	48.11
25	Dry	3	1	0.30	105.321	46.11
26	Dry	3	2	0.30	129.334	48.78
27	Dry	3	3	0.30	247.591	50.11
28	Dry	1	1	0.03	9.952	41.22
29	Dry	1	2	0.03	57.283	42.22
30	Dry	1	3	0.03	50.343	44.56
31	Dry	2	1	0.03	41.460	43.22
32	Dry	2	2	0.03	58.948	47.22
33	Dry	2	3	0.03	41.876	48.89
34	Dry	3	1	0.03	68.942	42.89
35	Dry	3	2	0.03	88.096	43.56
36	Dry	3	3	0.03	74.772	43.89
37	Fresh	1	1	0.00	128.316	44.33
38	Fresh	1	2	0.00	185.655	51.33
39	Fresh	1	3	0.00	168.265	51.00
40	Fresh	2	1	0.00	130.431	47.00
41	Fresh	2	2	0.00	109.986	52.00
42	Fresh	2	3	0.00	119.504	50.33
43	Fresh	3	1	0.00	129.608	47.33
44	Fresh	3	2	0.00	147.821	52.00
45	Fresh	3	3	0.00	154.401	53.33
46	Fresh	1	1	3.00	205.294	65.44
47	Fresh	1	2	3.00	255.756	65.44
48	Fresh	1	3	3.00	238.307	65.44

Obs	Prep	Hour	Rep	Enz	DeltaRS	Delta AIS
49	Fresh	2	1	3.00	181.477	65.44
50	Fresh	2	2	3.00	233.119	65.44
51	Fresh	2	3	3.00	287.119	65.11
52	Fresh	3	1	3.00	239.957	68.11
53	Fresh	3	2	3.00	224.394	67.78
54	Fresh	3	3	3.00	266.132	68.11
55	Fresh	1	1	0.30	197.685	54.33
56	Fresh	1	2	0.30	201.222	55.33
57	Fresh	1	3	0.30	206.174	69.00
58	Fresh	2	1	0.30	338.462	65.67
59	Fresh	2	2	0.30	147.851	65.33
60	Fresh	2	3	0.30	162.235	65.33
61	Fresh	3	1	0.30	272.436	68.67
62	Fresh	3	2	0.30	280.925	68.67
63	Fresh	3	3	0.30	307.807	67.67
64	Fresh	1	1	0.03	166.620	55.33
65	Fresh	1	2	0.03	181.425	58.33
66	Fresh	1	3	0.03	195.995	58.00
67	Fresh	2	1	0.03	161.216	64.00
68	Fresh	2	2	0.03	211.035	63.67
69	Fresh	2	3	0.03	200.225	64.00
70	Fresh	3	1	0.03	177.665	68.33
71	Fresh	3	2	0.03	276.834	68.00
72	Fresh	3	3	0.03	226.545	68.33

The GLM Procedure

Class Level Information

Class	Levels	Values
Hour	3	1 2 3
Enz	4	0 0.03 0.3 3
Prep	2	Dry Fresh

Number of Observations Read	72
Number of Observations Used	72

The GLM Procedure

Dependent Variable: DeltaRS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	442480.7526	19238.2936	14.72	<.0001
Error	48	62713.8818	1306.5392		
Corrected Total	71	505194.6344			

R-Square	Coeff Var	Root MSE	DeltaRS Mean
0.875862	26.29519	36.14608	137.4627

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	15339.8420	7669.9210	5.87	0.0052
Enz	3	93171.7450	31057.2483	23.77	<.0001
Prep	1	311850.1620	311850.1620	238.68	<.0001
Hour*Enz	6	14854.2099	2475.7017	1.89	0.1010
Hour*Prep	2	1278.6410	639.3205	0.49	0.6161
Enz*Prep	3	3550.9556	1183.6519	0.91	0.4452
Hour*Enz*Prep	6	2435.1970	405.8662	0.31	0.9284

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	15339.8420	7669.9210	5.87	0.0052
Enz	3	93171.7450	31057.2483	23.77	<.0001
Prep	1	311850.1620	311850.1620	238.68	<.0001
Hour*Enz	6	14854.2099	2475.7017	1.89	0.1010
Hour*Prep	2	1278.6410	639.3205	0.49	0.6161
Enz*Prep	3	3550.9556	1183.6519	0.91	0.4452
Hour*Enz*Prep	6	2435.1970	405.8662	0.31	0.9284

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	11954.66122	519.76788	93.80	<.0001
Error	48	265.99293	5.54152		
Corrected Total	71	12220.65415			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.978234	4.572659	2.354043	51.48083

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	2	209.975208	104.987604	18.95	<.0001
Enz	3	4925.122850	1641.707617	296.26	<.0001
Prep	1	6408.629422	6408.629422	1156.48	<.0001
Hour*Enz	6	43.133758	7.188960	1.30	0.2765
Hour*Prep	2	47.466453	23.733226	4.28	0.0194
Enz*Prep	3	238.216700	79.405567	14.33	<.0001
Hour*Enz*Prep	6	82.116825	13.686138	2.47	0.0367

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	2	209.975208	104.987604	18.95	<.0001
Enz	3	4925.122850	1641.707617	296.26	<.0001
Prep	1	6408.629422	6408.629422	1156.48	<.0001
Hour*Enz	6	43.133758	7.188960	1.30	0.2765
Hour*Prep	2	47.466453	23.733226	4.28	0.0194
Enz*Prep	3	238.216700	79.405567	14.33	<.0001
Hour*Enz*Prep	6	82.116825	13.686138	2.47	0.0367

The GLM Procedure
Least Squares Means

Hour	DeltaRS LSMEAN	LSMEAN Number
1	124.347333	1
2	130.215708	2
3	157.825125	3

Least Squares Means for effect Hour
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3
1		0.5765	0.0024
2	0.5765		0.0110
3	0.0024	0.0110	

Hour	DeltaAIS LSMEAN	LSMEAN Number
1	49.2204167	1
2	51.8745833	2
3	53.3475000	3

Dependent Variable: DeltaAIS

i/j	1	2	3
1		0.0003	<.0001
2	0.0003		0.0352
3	<.0001	0.0352	

Enz	DeltaRS LSMEAN	LSMEAN Number
0	83.355444	1
0.03	127.179556	2
0.3	175.565667	3
3	163.750222	4

Least Squares Means for effect Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaRS

i/j	1	2	3	4
1		0.0007	<.0001	<.0001
2	0.0007		0.0002	0.0039
3	<.0001	0.0002		0.3317
4	<.0001	0.0039	0.3317	

Enz	DeltaAIS LSMEAN	LSMEAN Number
0	37.4994444	1
0.03	53.6477778	2
0.3	56.0366667	3
3	58.7394444	4

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		<.0001	<.0001	<.0001
2	<.0001		0.0038	<.0001
3	<.0001	0.0038		0.0012
4	<.0001	<.0001	0.0012	

Hour	Prep	DeltaAIS LSMEAN	LSMEAN Number
1	Dry	40.6658333	1
1	Fresh	57.7750000	2
2	Dry	42.6391667	3
2	Fresh	61.1100000	4
3	Dry	42.8341667	5
3	Fresh	63.8608333	6

The GLM Procedure
Least Squares Means

Least Squares Means for effect Hour*Prep
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		<.0001	0.0455	<.0001	0.0286	<.0001
2	<.0001		<.0001	0.0011	<.0001	<.0001
3	0.0455	<.0001		<.0001	0.8401	<.0001
4	<.0001	0.0011	<.0001		<.0001	0.0062
5	0.0286	<.0001	0.8401	<.0001		<.0001
6	<.0001	<.0001	<.0001	0.0062	<.0001	

Enz	Prep	DeltaAIS LSMEAN	LSMEAN Number
0	Dry	25.1488889	1
0	Fresh	49.8500000	2
0.03	Dry	44.1855556	3
0.03	Fresh	63.1100000	4
0.3	Dry	47.6288889	5
0.3	Fresh	64.4444444	6
3	Dry	51.2222222	7
3	Fresh	66.2566667	8

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		<.0001	<.0001	<.0001
2	<.0001		<.0001	<.0001
3	<.0001	<.0001		<.0001
4	<.0001	<.0001	<.0001	
5	<.0001	0.0510	0.0032	<.0001
6	<.0001	<.0001	<.0001	0.2351
7	<.0001	0.2223	<.0001	<.0001
8	<.0001	<.0001	<.0001	0.0067

Dependent Variable: DeltaAIS

i/j	5	6	7	8
1	<.0001	<.0001	<.0001	<.0001
2	0.0510	<.0001	0.2223	<.0001
3	0.0032	<.0001	<.0001	<.0001
4	<.0001	0.2351	<.0001	0.0067
5		<.0001	0.0022	<.0001
6	<.0001		<.0001	0.1090
7	0.0022	<.0001		<.0001
8	<.0001	0.1090	<.0001	

The GLM Procedure
Least Squares Means

Hour	Enz	Prep	DeltaAIS LSMEAN	LSMEAN Number
1	0	Dry	23.3333333	1
1	0	Fresh	48.8866667	2
1	0.03	Dry	42.6666667	3
1	0.03	Fresh	57.2200000	4
1	0.3	Dry	46.8866667	5
1	0.3	Fresh	59.5533333	6
1	3	Dry	49.7766667	7
1	3	Fresh	65.4400000	8
2	0	Dry	25.2233333	9
2	0	Fresh	49.7766667	10
2	0.03	Dry	46.4433333	11
2	0.03	Fresh	63.8900000	12
2	0.3	Dry	47.6666667	13
2	0.3	Fresh	65.4433333	14
2	3	Dry	51.2233333	15
2	3	Fresh	65.3300000	16
3	0	Dry	26.8900000	17
3	0	Fresh	50.8866667	18
3	0.03	Dry	43.4466667	19
3	0.03	Fresh	68.2200000	20
3	0.3	Dry	48.3333333	21
3	0.3	Fresh	68.3366667	22
3	3	Dry	52.6666667	23
3	3	Fresh	68.0000000	24

Least Squares Means for effect Hour*Enz*Prep
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		<.0001	<.0001	<.0001	<.0001	<.0001
2	<.0001		0.0022	<.0001	0.3033	<.0001
3	<.0001	0.0022		<.0001	0.0330	<.0001
4	<.0001	<.0001	<.0001		<.0001	0.2307
5	<.0001	0.3033	0.0330	<.0001		<.0001
6	<.0001	<.0001	<.0001	0.2307	<.0001	
7	<.0001	0.6454	0.0006	0.0003	0.1392	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	0.0036
9	0.3304	<.0001	<.0001	<.0001	<.0001	<.0001
10	<.0001	0.6454	0.0006	0.0003	0.1392	<.0001
11	<.0001	0.2098	0.0552	<.0001	0.8186	<.0001
12	<.0001	<.0001	<.0001	0.0011	<.0001	0.0286
13	<.0001	0.5286	0.0123	<.0001	0.6867	<.0001
14	<.0001	<.0001	<.0001	<.0001	<.0001	0.0036
15	<.0001	0.2300	<.0001	0.0031	0.0286	<.0001
16	<.0001	<.0001	<.0001	0.0001	<.0001	0.0042
17	0.0704	<.0001	<.0001	<.0001	<.0001	<.0001
18	<.0001	0.3033	<.0001	0.0019	0.0428	<.0001
19	<.0001	0.0068	0.6867	<.0001	0.0798	<.0001
20	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
21	<.0001	0.7747	0.0049	<.0001	0.4553	<.0001
22	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
23	<.0001	0.0550	<.0001	0.0219	0.0042	0.0008
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

i/j	7	8	9	10	11	12
1	<.0001	<.0001	0.3304	<.0001	<.0001	<.0001
2	0.6454	<.0001	<.0001	0.6454	0.2098	<.0001
3	0.0006	<.0001	<.0001	0.0006	0.0552	<.0001
4	0.0003	<.0001	<.0001	0.0003	<.0001	0.0011
5	0.1392	<.0001	<.0001	0.1392	0.8186	<.0001
6	<.0001	0.0036	<.0001	<.0001	<.0001	0.0286
7		<.0001	<.0001	1.0000	0.0893	<.0001
8	<.0001		<.0001	<.0001	<.0001	0.4240
9	<.0001	<.0001		<.0001	<.0001	<.0001
10	1.0000	<.0001	<.0001		0.0893	<.0001
11	0.0893	<.0001	<.0001	0.0893		<.0001
12	<.0001	0.4240	<.0001	<.0001	<.0001	
13	0.2778	<.0001	<.0001	0.2778	0.5275	<.0001
14	<.0001	0.9986	<.0001	<.0001	<.0001	0.4230
15	0.4553	<.0001	<.0001	0.4553	0.0164	<.0001
16	<.0001	0.9546	<.0001	<.0001	<.0001	0.4574
17	<.0001	<.0001	0.3902	<.0001	<.0001	<.0001
18	0.5663	<.0001	<.0001	0.5663	0.0251	<.0001
19	0.0019	<.0001	<.0001	0.0019	0.1255	<.0001
20	<.0001	0.1546	<.0001	<.0001	<.0001	0.0289
21	0.4564	<.0001	<.0001	0.4564	0.3304	<.0001
22	<.0001	0.1383	<.0001	<.0001	<.0001	0.0250
23	0.1392	<.0001	<.0001	0.1392	0.0022	<.0001
24	<.0001	0.1892	<.0001	<.0001	<.0001	0.0376

Dependent Variable: DeltaAIS

i/j	13	14	15	16	17	18
1	<.0001	<.0001	<.0001	<.0001	0.0704	<.0001
2	0.5286	<.0001	0.2300	<.0001	<.0001	0.3033
3	0.0123	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	0.0031	0.0001	<.0001	0.0019
5	0.6867	<.0001	0.0286	<.0001	<.0001	0.0428
6	<.0001	0.0036	<.0001	0.0042	<.0001	<.0001
7	0.2778	<.0001	0.4553	<.0001	<.0001	0.5663
8	<.0001	0.9986	<.0001	0.9546	<.0001	<.0001
9	<.0001	<.0001	<.0001	<.0001	0.3902	<.0001
10	0.2778	<.0001	0.4553	<.0001	<.0001	0.5663
11	0.5275	<.0001	0.0164	<.0001	<.0001	0.0251
12	<.0001	0.4230	<.0001	0.4574	<.0001	<.0001
13		<.0001	0.0704	<.0001	<.0001	0.1004
14	<.0001		<.0001	0.9532	<.0001	<.0001
15	0.0704	<.0001		<.0001	<.0001	0.8617
16	<.0001	0.9532	<.0001		<.0001	<.0001
17	<.0001	<.0001	<.0001	<.0001		<.0001
18	0.1004	<.0001	0.8617	<.0001	<.0001	
19	0.0330	<.0001	0.0002	<.0001	<.0001	0.0003
20	<.0001	0.1551	<.0001	0.1392	<.0001	<.0001
21	0.7302	<.0001	0.1392	<.0001	<.0001	0.1903
22	<.0001	0.1388	<.0001	0.1243	<.0001	<.0001
23	0.0123	<.0001	0.4564	<.0001	<.0001	0.3590
24	<.0001	0.1897	<.0001	0.1712	<.0001	<.0001

i/j	19	20	21	22	23	24
1	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
2	0.0068	<.0001	0.7747	<.0001	0.0550	<.0001
3	0.6867	<.0001	0.0049	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	0.0219	<.0001
5	0.0798	<.0001	0.4553	<.0001	0.0042	<.0001
6	<.0001	<.0001	<.0001	<.0001	0.0008	<.0001
7	0.0019	<.0001	0.4564	<.0001	0.1392	<.0001
8	<.0001	0.1546	<.0001	0.1383	<.0001	0.1892
9	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	0.0019	<.0001	0.4564	<.0001	0.1392	<.0001
11	0.1255	<.0001	0.3304	<.0001	0.0022	<.0001
12	<.0001	0.0289	<.0001	0.0250	<.0001	0.0376
13	0.0330	<.0001	0.7302	<.0001	0.0123	<.0001
14	<.0001	0.1551	<.0001	0.1388	<.0001	0.1897
15	0.0002	<.0001	0.1392	<.0001	0.4564	<.0001
16	<.0001	0.1392	<.0001	0.1243	<.0001	0.1712
17	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
18	0.0003	<.0001	0.1903	<.0001	0.3590	<.0001
19		<.0001	0.0143	<.0001	<.0001	<.0001
20	<.0001		<.0001	0.9519	<.0001	0.9094
21	0.0143	<.0001		<.0001	0.0288	<.0001
22	<.0001	0.9519	<.0001		<.0001	0.8617
23	<.0001	<.0001	0.0288	<.0001		<.0001
24	<.0001	0.9094	<.0001	0.8617	<.0001	

Appendix B: SAS® Analyses for Saccharification of FTA-94 ISP with Spirizyme Fuel, Spirizyme Plus Tech, and Spirizyme Ultra

Appendix B.1 Flour ISP

```
title 'Saccharification Exp on FTA-94 SWP: HPLC Sugars and Change in Starch Content
(AIS)';
data Saccharification032008;
input Prep$ Enz$ Load Hour Rep DeltaAIS Maltotriose Maltose Glucose;
datalines;
Dry    Fuel   0      0      1      50.3   46.8   247.6  12.8
Dry    Fuel   0      0      2      50     42.8   233.6  12.4
Dry    Fuel   0      0      3      51     46.4   276.4  16
Dry    Fuel   0.5    0      1      51.3   26     274.8  74
Dry    Fuel   0.5    0      2      50.7   22     280.4  88.4
Dry    Fuel   0.5    0      3      50.3   22     272.4  77.6
Dry    Fuel   1      0      1      49.7   4      258.4  120.8
Dry    Fuel   1      0      2      50     8      270    112.8
Dry    Fuel   1      0      3      49.7   3.6    252.4  124
Dry    Fuel   5      0      1      51.3   0      74.4   343.6
Dry    Fuel   5      0      2      49     0      70.4   368.4
Dry    Fuel   5      0      3      49.7   0      44.8   380.4
Dry    Fuel   0      24     1      52     49.2   285.2  34.7
Dry    Fuel   0      24     2      53     51.7   278.6  28.5
Dry    Fuel   0      24     3      53.7   47.5   261.6  28.1
Dry    Fuel   0.5    24     1      52.7   11.6   255.4  144.3
Dry    Fuel   0.5    24     2      53     5.4    252.5  174
Dry    Fuel   0.5    24     3      52     0      219.1  188.1
Dry    Fuel   1      24     1      53     0      203.8  250.9
Dry    Fuel   1      24     2      52.7   0      199.2  231.5
Dry    Fuel   1      24     3      52.3   4.1    152.9  267
Dry    Fuel   5      24     1      49.3   0      22.7   468.7
Dry    Fuel   5      24     2      52     0      24.4   448.5
Dry    Fuel   5      24     3      54.3   0      18.6   474.1
Dry    Fuel   0      48     1      50     43     241.8  25.2
Dry    Fuel   0      48     2      50     58.7   298    30.6
Dry    Fuel   0      48     3      51.7   60.3   296.8  30.2
Dry    Fuel   0.5    48     1      52     7.9    233.1  198
Dry    Fuel   0.5    48     2      51.7   0      250.1  222
Dry    Fuel   0.5    48     3      51.7   3.3    245.9  195.5
Dry    Fuel   1      48     1      51.3   0      118.2  337.7
Dry    Fuel   1      48     2      50.3   0      164.5  312.5
Dry    Fuel   1      48     3      52.3   0      171.5  298
Dry    Fuel   5      48     1      52.3   0      19     491
Dry    Fuel   5      48     2      52     0      14.9   523.7
Dry    Fuel   5      48     3      51.7   0      14.1   527.4
Dry    Fuel   0      72     1      52.7   57.5   273.6  37.2
Dry    Fuel   0      72     2      53     54.6   279.8  31
Dry    Fuel   0      72     3      53     61.6   304.6  31.8
Dry    Fuel   0.5    72     1      53.7   0      222.4  240.6
Dry    Fuel   0.5    72     2      53.3   0      251.7  207.9
Dry    Fuel   0.5    72     3      53     8.3    247.6  180.2
Dry    Fuel   1      72     1      53     0      150.5  296.8
Dry    Fuel   1      72     2      53.3   0      183.9  279
Dry    Fuel   1      72     3      53     7      184.8  233.9
Dry    Fuel   5      72     1      53.3   0      14.5   503.9
Dry    Fuel   5      72     2      52.3   0      36.8   469.5
Dry    Fuel   5      72     3      53     0      18.2   506.3
```

Dry	Tech	0	0	1	48.4	39.2	260.4	12.8
Dry	Tech	0	0	2	47.8	43.2	278.4	13.2
Dry	Tech	0	0	3	50.1	31.6	209.6	10
Dry	Tech	0.5	0	1	49.4	0	212.8	221.2
Dry	Tech	0.5	0	2	49.4	0	212.4	222.8
Dry	Tech	0.5	0	3	49.4	0	168	267.6
Dry	Tech	1	0	1	48.4	0	37.6	417.2
Dry	Tech	1	0	2	48.4	0	41.2	394.8
Dry	Tech	1	0	3	49.1	0	19.2	429.6
Dry	Tech	5	0	1	49.8	0	0	484.8
Dry	Tech	5	0	2	50.4	0	0	492
Dry	Tech	5	0	3	50.1	0	0	478.8
Dry	Tech	0	24	1	51.4	30.2	300.1	78.9
Dry	Tech	0	24	2	51.4	47.1	280.7	35.5
Dry	Tech	0	24	3	51.1	45.9	279	31.4
Dry	Tech	0.5	24	1	50.8	0	168.2	258.3
Dry	Tech	0.5	24	2	51.4	4.5	194.3	220.3
Dry	Tech	0.5	24	3	51.8	0	166.2	257.5
Dry	Tech	1	24	1	52.1	0	78.1	365
Dry	Tech	1	24	2	52.1	0	100.4	376.1
Dry	Tech	1	24	3	52.1	0	102.5	369.9
Dry	Tech	5	24	1	51.4	0	16.1	516.7
Dry	Tech	5	24	2	52.1	0	9.9	482.8
Dry	Tech	5	24	3	51.8	0	18.2	500.1
Dry	Tech	0	48	1	51.4	49.6	281.5	37.2
Dry	Tech	0	48	2	51.4	48.4	269.9	25.6
Dry	Tech	0	48	3	51.4	54.1	291	25.2
Dry	Tech	0.5	48	1	51.8	0	202.9	259.2
Dry	Tech	0.5	48	2	51.4	0	205	261.2
Dry	Tech	0.5	48	3	51.8	0	188.1	267.4
Dry	Tech	1	48	1	52.1	0	100	368.3
Dry	Tech	1	48	2	52.1	0	110.8	363.7
Dry	Tech	1	48	3	51.8	0	78.9	360.4
Dry	Tech	5	48	1	52.1	0	12	451.8
Dry	Tech	5	48	2	51.8	0	12	524.1
Dry	Tech	5	48	3	51.4	0	10.7	540.2
Dry	Tech	0	72	1	49.8	48.4	279	38
Dry	Tech	0	72	2	50.1	54.1	300.5	31
Dry	Tech	0	72	3	50.1	56.2	298.4	30.2
Dry	Tech	0.5	72	1	50.4	0	202.9	243
Dry	Tech	0.5	72	2	49.4	0	203.4	272.4
Dry	Tech	0.5	72	3	50.1	0	188.9	248.8
Dry	Tech	1	72	1	48.1	0	99.2	369.9
Dry	Tech	1	72	2	50.4	0	104.6	370.3
Dry	Tech	1	72	3	50.1	0	64.1	450.1
Dry	Tech	5	72	1	49.8	0	12.8	575.8
Dry	Tech	5	72	2	50.1	0	11.6	546
Dry	Tech	5	72	3	50.4	0	10.7	527
Dry	Ultra	0	0	1	.	59.6	374.8	19.2
Dry	Ultra	0	0	2	48.2	18	186.8	44
Dry	Ultra	0	0	3	50.2	32	216	32.4
Dry	Ultra	0.5	0	1	49.2	8.8	274	110
Dry	Ultra	0.5	0	2	49.6	2.8	253.6	117.2
Dry	Ultra	0.5	0	3	50.9	0	254	120.8
Dry	Ultra	1	0	1	50.2	0	224.8	176.4
Dry	Ultra	1	0	2	51.2	0	228.8	185.2
Dry	Ultra	1	0	3	49.6	0	195.2	197.2
Dry	Ultra	5	0	1	49.6	5.2	0	424.4
Dry	Ultra	5	0	2	50.9	4.4	10.4	408.8

```
Dry    Ultra  5      0      3      50.6   6.4    0      475.2
Dry    Ultra  0      24     1      53.6   46.4   268.2  23.4
Dry    Ultra  0      24     2      52.2   49.4   292.5  24.3
Dry    Ultra  0      24     3      52.2   48.1   278.6  21.7
Dry    Ultra  0.5    24     1      52.2   13.9   264.8  194.6
Dry    Ultra  0.5    24     2      51.9   10     242.7  192.4
Dry    Ultra  0.5    24     3      51.9   13     238.3  211.9
Dry    Ultra  1      24     1      52.2   7.4    175.5  263.5
Dry    Ultra  1      24     2      52.2   6.5    196.3  266.1
Dry    Ultra  1      24     3      52.2   7.8    180.7  296
Dry    Ultra  5      24     1      52.6   8.2    45.9   495.7
Dry    Ultra  5      24     2      52.2   7.4    26.9   491.8
Dry    Ultra  5      24     3      51.9   7.4    34.7   499.6
Dry    Ultra  0      48     1      51.2   65     341.9  29
Dry    Ultra  0      48     2      51.9   56.3   295.1  22.1
Dry    Ultra  0      48     3      51.9   51.6   292.1  28.6
Dry    Ultra  0.5    48     1      52.2   15.6   250    196.7
Dry    Ultra  0.5    48     2      51.9   10.4   248.3  209.3
Dry    Ultra  0.5    48     3      51.9   14.7   240.9  218.8
Dry    Ultra  1      48     1      52.6   8.7    187.2  307.7
Dry    Ultra  1      48     2      51.2   6.5    170.3  354.5
Dry    Ultra  1      48     3      52.6   6.1    171.6  293.8
Dry    Ultra  5      48     1      52.2   6.9    27.3   515.7
Dry    Ultra  5      48     2      52.9   6.9    35.1   517.8
Dry    Ultra  5      48     3      52.2   6.9    46.4   507.9
Dry    Ultra  0      72     1      51.2   59.4   318.1  30.8
Dry    Ultra  0      72     2      52.9   53.7   292.1  29.9
Dry    Ultra  0      72     3      51.2   55.5   302.9  32.1
Dry    Ultra  0.5    72     1      52.6   18.2   250.9  172.5
Dry    Ultra  0.5    72     2      51.9   23.8   253.9  148.2
Dry    Ultra  0.5    72     3      52.2   13.4   234    219.3
Dry    Ultra  1      72     1      51.9   6.9    211.5  277.3
Dry    Ultra  1      72     2      51.9   7.8    195    273.4
Dry    Ultra  1      72     3      53.6   10.4   179    275.6
Dry    Ultra  5      72     1      52.6   6.5    36.4   474.9
Dry    Ultra  5      72     2      52.6   10     58.5   478.4
Dry    Ultra  5      72     3      51.9   5.6    49.8   437.2
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
       class Hour Enz Load;
       model DeltaAIS Maltotriose Maltose Glucose = Hour Enz Load Hour*Enz
Hour*Load Enz*Load  Hour*Enz*Load;
       lsmeans Hour Enz Load Hour*Enz Hour*Load Enz*Load Hour*Enz*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Saccharification Exp on Flour FTA-94 ISP: Sugars and Change in Starch

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
1	Dry	Fuel	0.0	0	1	50.3	46.8	247.6	12.8
2	Dry	Fuel	0.0	0	2	50.0	42.8	233.6	12.4
3	Dry	Fuel	0.0	0	3	51.0	46.4	276.4	16.0
4	Dry	Fuel	0.5	0	1	51.3	26.0	274.8	74.0
5	Dry	Fuel	0.5	0	2	50.7	22.0	280.4	88.4
6	Dry	Fuel	0.5	0	3	50.3	22.0	272.4	77.6
7	Dry	Fuel	1.0	0	1	49.7	4.0	258.4	120.8
8	Dry	Fuel	1.0	0	2	50.0	8.0	270.0	112.8
9	Dry	Fuel	1.0	0	3	49.7	3.6	252.4	124.0
10	Dry	Fuel	5.0	0	1	51.3	0.0	74.4	343.6
11	Dry	Fuel	5.0	0	2	49.0	0.0	70.4	368.4
12	Dry	Fuel	5.0	0	3	49.7	0.0	44.8	380.4
13	Dry	Fuel	0.0	24	1	52.0	49.2	285.2	34.7
14	Dry	Fuel	0.0	24	2	53.0	51.7	278.6	28.5
15	Dry	Fuel	0.0	24	3	53.7	47.5	261.6	28.1
16	Dry	Fuel	0.5	24	1	52.7	11.6	255.4	144.3
17	Dry	Fuel	0.5	24	2	53.0	5.4	252.5	174.0
18	Dry	Fuel	0.5	24	3	52.0	0.0	219.1	188.1
19	Dry	Fuel	1.0	24	1	53.0	0.0	203.8	250.9
20	Dry	Fuel	1.0	24	2	52.7	0.0	199.2	231.5
21	Dry	Fuel	1.0	24	3	52.3	4.1	152.9	267.0
22	Dry	Fuel	5.0	24	1	49.3	0.0	22.7	468.7
23	Dry	Fuel	5.0	24	2	52.0	0.0	24.4	448.5
24	Dry	Fuel	5.0	24	3	54.3	0.0	18.6	474.1
25	Dry	Fuel	0.0	48	1	50.0	43.0	241.8	25.2
26	Dry	Fuel	0.0	48	2	50.0	58.7	298.0	30.6
27	Dry	Fuel	0.0	48	3	51.7	60.3	296.8	30.2
28	Dry	Fuel	0.5	48	1	52.0	7.9	233.1	198.0
29	Dry	Fuel	0.5	48	2	51.7	0.0	250.1	222.0
30	Dry	Fuel	0.5	48	3	51.7	3.3	245.9	195.5
31	Dry	Fuel	1.0	48	1	51.3	0.0	118.2	337.7
32	Dry	Fuel	1.0	48	2	50.3	0.0	164.5	312.5
33	Dry	Fuel	1.0	48	3	52.3	0.0	171.5	298.0
34	Dry	Fuel	5.0	48	1	52.3	0.0	19.0	491.0
35	Dry	Fuel	5.0	48	2	52.0	0.0	14.9	523.7
36	Dry	Fuel	5.0	48	3	51.7	0.0	14.1	527.4
37	Dry	Fuel	0.0	72	1	52.7	57.5	273.6	37.2
38	Dry	Fuel	0.0	72	2	53.0	54.6	279.8	31.0
39	Dry	Fuel	0.0	72	3	53.0	61.6	304.6	31.8
40	Dry	Fuel	0.5	72	1	53.7	0.0	222.4	240.6
41	Dry	Fuel	0.5	72	2	53.3	0.0	251.7	207.9
42	Dry	Fuel	0.5	72	3	53.0	8.3	247.6	180.2
43	Dry	Fuel	1.0	72	1	53.0	0.0	150.5	296.8
44	Dry	Fuel	1.0	72	2	53.3	0.0	183.9	279.0
45	Dry	Fuel	1.0	72	3	53.0	7.0	184.8	233.9
46	Dry	Fuel	5.0	72	1	53.3	0.0	14.5	503.9
47	Dry	Fuel	5.0	72	2	52.3	0.0	36.8	469.5
48	Dry	Fuel	5.0	72	3	53.0	0.0	18.2	506.3

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
49	Dry	Tech	0.0	0	1	48.4	39.2	260.4	12.8
50	Dry	Tech	0.0	0	2	47.8	43.2	278.4	13.2
51	Dry	Tech	0.0	0	3	50.1	31.6	209.6	10.0
52	Dry	Tech	0.5	0	1	49.4	0.0	212.8	221.2
53	Dry	Tech	0.5	0	2	49.4	0.0	212.4	222.8
54	Dry	Tech	0.5	0	3	49.4	0.0	168.0	267.6
55	Dry	Tech	1.0	0	1	48.4	0.0	37.6	417.2
56	Dry	Tech	1.0	0	2	48.4	0.0	41.2	394.8
57	Dry	Tech	1.0	0	3	49.1	0.0	19.2	429.6
58	Dry	Tech	5.0	0	1	49.8	0.0	0.0	484.8
59	Dry	Tech	5.0	0	2	50.4	0.0	0.0	492.0
60	Dry	Tech	5.0	0	3	50.1	0.0	0.0	478.8
61	Dry	Tech	0.0	24	1	51.4	30.2	300.1	78.9
62	Dry	Tech	0.0	24	2	51.4	47.1	280.7	35.5
63	Dry	Tech	0.0	24	3	51.1	45.9	279.0	31.4
64	Dry	Tech	0.5	24	1	50.8	0.0	168.2	258.3
65	Dry	Tech	0.5	24	2	51.4	4.5	194.3	220.3
66	Dry	Tech	0.5	24	3	51.8	0.0	166.2	257.5
67	Dry	Tech	1.0	24	1	52.1	0.0	78.1	365.0
68	Dry	Tech	1.0	24	2	52.1	0.0	100.4	376.1
69	Dry	Tech	1.0	24	3	52.1	0.0	102.5	369.9
70	Dry	Tech	5.0	24	1	51.4	0.0	16.1	516.7
71	Dry	Tech	5.0	24	2	52.1	0.0	9.9	482.8
72	Dry	Tech	5.0	24	3	51.8	0.0	18.2	500.1
73	Dry	Tech	0.0	48	1	51.4	49.6	281.5	37.2
74	Dry	Tech	0.0	48	2	51.4	48.4	269.9	25.6
75	Dry	Tech	0.0	48	3	51.4	54.1	291.0	25.2
76	Dry	Tech	0.5	48	1	51.8	0.0	202.9	259.2
77	Dry	Tech	0.5	48	2	51.4	0.0	205.0	261.2
78	Dry	Tech	0.5	48	3	51.8	0.0	188.1	267.4
79	Dry	Tech	1.0	48	1	52.1	0.0	100.0	368.3
80	Dry	Tech	1.0	48	2	52.1	0.0	110.8	363.7
81	Dry	Tech	1.0	48	3	51.8	0.0	78.9	360.4
82	Dry	Tech	5.0	48	1	52.1	0.0	12.0	451.8
83	Dry	Tech	5.0	48	2	51.8	0.0	12.0	524.1
84	Dry	Tech	5.0	48	3	51.4	0.0	10.7	540.2
85	Dry	Tech	0.0	72	1	49.8	48.4	279.0	38.0
86	Dry	Tech	0.0	72	2	50.1	54.1	300.5	31.0
87	Dry	Tech	0.0	72	3	50.1	56.2	298.4	30.2
88	Dry	Tech	0.5	72	1	50.4	0.0	202.9	243.0
89	Dry	Tech	0.5	72	2	49.4	0.0	203.4	272.4
90	Dry	Tech	0.5	72	3	50.1	0.0	188.9	248.8
91	Dry	Tech	1.0	72	1	48.1	0.0	99.2	369.9
92	Dry	Tech	1.0	72	2	50.4	0.0	104.6	370.3
93	Dry	Tech	1.0	72	3	50.1	0.0	64.1	450.1
94	Dry	Tech	5.0	72	1	49.8	0.0	12.8	575.8
95	Dry	Tech	5.0	72	2	50.1	0.0	11.6	546.0
96	Dry	Tech	5.0	72	3	50.4	0.0	10.7	527.0
97	Dry	Ultra	0.0	0	1	.	59.6	374.8	19.2
98	Dry	Ultra	0.0	0	2	48.2	18.0	186.8	44.0

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
99	Dry	Ultra	0.0	0	3	50.2	32.0	216.0	32.4
100	Dry	Ultra	0.5	0	1	49.2	8.8	274.0	110.0
101	Dry	Ultra	0.5	0	2	49.6	2.8	253.6	117.2
102	Dry	Ultra	0.5	0	3	50.9	0.0	254.0	120.8
103	Dry	Ultra	1.0	0	1	50.2	0.0	224.8	176.4
104	Dry	Ultra	1.0	0	2	51.2	0.0	228.8	185.2
105	Dry	Ultra	1.0	0	3	49.6	0.0	195.2	197.2
106	Dry	Ultra	5.0	0	1	49.6	5.2	0.0	424.4
107	Dry	Ultra	5.0	0	2	50.9	4.4	10.4	408.8
108	Dry	Ultra	5.0	0	3	50.6	6.4	0.0	475.2
109	Dry	Ultra	0.0	24	1	53.6	46.4	268.2	23.4
110	Dry	Ultra	0.0	24	2	52.2	49.4	292.5	24.3
111	Dry	Ultra	0.0	24	3	52.2	48.1	278.6	21.7
112	Dry	Ultra	0.5	24	1	52.2	13.9	264.8	194.6
113	Dry	Ultra	0.5	24	2	51.9	10.0	242.7	192.4
114	Dry	Ultra	0.5	24	3	51.9	13.0	238.3	211.9
115	Dry	Ultra	1.0	24	1	52.2	7.4	175.5	263.5
116	Dry	Ultra	1.0	24	2	52.2	6.5	196.3	266.1
117	Dry	Ultra	1.0	24	3	52.2	7.8	180.7	296.0
118	Dry	Ultra	5.0	24	1	52.6	8.2	45.9	495.7
119	Dry	Ultra	5.0	24	2	52.2	7.4	26.9	491.8
120	Dry	Ultra	5.0	24	3	51.9	7.4	34.7	499.6
121	Dry	Ultra	0.0	48	1	51.2	65.0	341.9	29.0
122	Dry	Ultra	0.0	48	2	51.9	56.3	295.1	22.1
123	Dry	Ultra	0.0	48	3	51.9	51.6	292.1	28.6
124	Dry	Ultra	0.5	48	1	52.2	15.6	250.0	196.7
125	Dry	Ultra	0.5	48	2	51.9	10.4	248.3	209.3
126	Dry	Ultra	0.5	48	3	51.9	14.7	240.9	218.8
127	Dry	Ultra	1.0	48	1	52.6	8.7	187.2	307.7
128	Dry	Ultra	1.0	48	2	51.2	6.5	170.3	354.5
129	Dry	Ultra	1.0	48	3	52.6	6.1	171.6	293.8
130	Dry	Ultra	5.0	48	1	52.2	6.9	27.3	515.7
131	Dry	Ultra	5.0	48	2	52.9	6.9	35.1	517.8
132	Dry	Ultra	5.0	48	3	52.2	6.9	46.4	507.9
133	Dry	Ultra	0.0	72	1	51.2	59.4	318.1	30.8
134	Dry	Ultra	0.0	72	2	52.9	53.7	292.1	29.9
135	Dry	Ultra	0.0	72	3	51.2	55.5	302.9	32.1
136	Dry	Ultra	0.5	72	1	52.6	18.2	250.9	172.5
137	Dry	Ultra	0.5	72	2	51.9	23.8	253.9	148.2
138	Dry	Ultra	0.5	72	3	52.2	13.4	234.0	219.3
139	Dry	Ultra	1.0	72	1	51.9	6.9	211.5	277.3
140	Dry	Ultra	1.0	72	2	51.9	7.8	195.0	273.4
141	Dry	Ultra	1.0	72	3	53.6	10.4	179.0	275.6
142	Dry	Ultra	5.0	72	1	52.6	6.5	36.4	474.9
143	Dry	Ultra	5.0	72	2	52.6	10.0	58.5	478.4
144	Dry	Ultra	5.0	72	3	51.9	5.6	49.8	437.2

The GLM Procedure
Class Level Information

Class	Levels	Values
Hour	4	0 24 48 72
Enz	3	Fuel Tech Ultra
Load	4	0 0.5 1 5

Data for Analysis of DeltaAIS

Number of Observations Read	144
Number of Observations Used	143

Data for Analysis of Maltotriose
Maltose Glucose

Number of Observations Read	144
Number of Observations Used	144

Saccharification Exp on Flour FTA-94 ISP: Sugars and Change in Starch
Interaction and Main Effects of Treatments

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	210.1960839	4.4722571	9.23	<.0001
Error	95	46.0400000	0.4846316		
Corrected Total	142	256.2360839			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.820322	1.355383	0.696155	51.36224

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	113.4406157	37.8135386	78.03	<.0001
Enz	2	39.8699796	19.9349898	41.13	<.0001
Load	3	2.2345786	0.7448595	1.54	0.2100
Hour*Enz	6	38.3417627	6.3902938	13.19	<.0001
Hour*Load	9	5.3570084	0.5952232	1.23	0.2872
Enz*Load	6	3.0088037	0.5014673	1.03	0.4078
Hour*Enz*Load	18	7.9433352	0.4412964	0.91	0.5677

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	114.2581538	38.0860513	78.59	<.0001
Enz	2	39.3234545	19.6617273	40.57	<.0001
Load	3	2.5067172	0.8355724	1.72	0.1673
Hour*Enz	6	38.4739454	6.4123242	13.23	<.0001
Hour*Load	9	5.4530159	0.6058907	1.25	0.2745
Enz*Load	6	3.0644301	0.5107384	1.05	0.3959
Hour*Enz*Load	18	7.9433352	0.4412964	0.91	0.5677

The GLM Procedure
Least Squares Means

Hour	Enz	DeltaAIS LSMEAN	LSMEAN Number
0	Fuel	50.2500000	1
0	Tech	49.2250000	2
0	Ultra	49.9500000	3
24	Fuel	52.5000000	4
24	Tech	51.6250000	5
24	Ultra	52.2750000	6
48	Fuel	51.4166667	7
48	Tech	51.7083333	8
48	Ultra	52.0583333	9
72	Fuel	53.0500000	10
72	Tech	49.9000000	11
72	Ultra	52.2083333	12

Least Squares Means for effect Hour*Enz
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		0.0005	0.3084	<.0001	<.0001	<.0001
2	0.0005		0.0151	<.0001	<.0001	<.0001
3	0.3084	0.0151		<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001		0.0027	0.4305
5	<.0001	<.0001	<.0001	0.0027		0.0244
6	<.0001	<.0001	<.0001	0.4305	0.0244	
7	<.0001	<.0001	<.0001	0.0002	0.4653	0.0032
8	<.0001	<.0001	<.0001	0.0065	0.7700	0.0490
9	<.0001	<.0001	<.0001	0.1235	0.1306	0.4477
10	<.0001	<.0001	<.0001	0.0559	<.0001	0.0076
11	0.2212	0.0196	0.8648	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	0.3074	0.0429	0.8150

i/j	7	8	9	10	11	12
1	<.0001	<.0001	<.0001	<.0001	0.2212	<.0001
2	<.0001	<.0001	<.0001	<.0001	0.0196	<.0001
3	<.0001	<.0001	<.0001	<.0001	0.8648	<.0001
4	0.0002	0.0065	0.1235	0.0559	<.0001	0.3074
5	0.4653	0.7700	0.1306	<.0001	<.0001	0.0429
6	0.0032	0.0490	0.4477	0.0076	<.0001	0.8150
7		0.3074	0.0262	<.0001	<.0001	0.0065
8	0.3074		0.2212	<.0001	<.0001	0.0817
9	0.0262	0.2212		0.0007	<.0001	0.5989
10	<.0001	<.0001	0.0007		<.0001	0.0039
11	<.0001	<.0001	<.0001	<.0001		<.0001
12	0.0065	0.0817	0.5989	0.0039	<.0001	

The GLM Procedure

Dependent Variable: Maltotriose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	59752.14326	1271.32220	64.17	<.0001
Error	96	1901.89333	19.81139		
Corrected Total	143	61654.03660			

R-Square	Coeff Var	Root MSE	Maltotriose Mean
0.969152	29.19618	4.450999	15.24514

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	344.48965	114.82988	5.80	0.0011
Enz	2	1197.50056	598.75028	30.22	<.0001
Load	3	55130.43688	18376.81229	927.59	<.0001
Hour*Enz	6	801.55056	133.59176	6.74	<.0001
Hour*Load	9	1172.73451	130.30383	6.58	<.0001
Enz*Load	6	468.27667	78.04611	3.94	0.0015
Hour*Enz*Load	18	637.15444	35.39747	1.79	0.0379

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	344.48965	114.82988	5.80	0.0011
Enz	2	1197.50056	598.75028	30.22	<.0001
Load	3	55130.43688	18376.81229	927.59	<.0001
Hour*Enz	6	801.55056	133.59176	6.74	<.0001
Hour*Load	9	1172.73451	130.30383	6.58	<.0001
Enz*Load	6	468.27667	78.04611	3.94	0.0015
Hour*Enz*Load	18	637.15444	35.39747	1.79	0.0379

Dependent Variable: Maltose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	1534543.605	32649.864	71.36	<.0001
Error	96	43925.813	457.561		
Corrected Total	143	1578469.418			

R-Square	Coeff Var	Root MSE	Maltose Mean
0.972172	12.41543	21.39067	172.2910

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	685.707	228.569	0.50	0.6835
Enz	2	78152.102	39076.051	85.40	<.0001
Load	3	1344216.771	448072.257	979.26	<.0001
Hour*Enz	6	18430.287	3071.714	6.71	<.0001
Hour*Load	9	14549.085	1616.565	3.53	0.0008
Enz*Load	6	58886.413	9814.402	21.45	<.0001
Hour*Enz*Load	18	19623.241	1090.180	2.38	0.0036

Dependent Variable: Maltose

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	685.707	228.569	0.50	0.6835
Enz	2	78152.102	39076.051	85.40	<.0001
Load	3	1344216.771	448072.257	979.26	<.0001
Hour*Enz	6	18430.287	3071.714	6.71	<.0001
Hour*Load	9	14549.085	1616.565	3.53	0.0008
Enz*Load	6	58886.413	9814.402	21.45	<.0001
Hour*Enz*Load	18	19623.241	1090.180	2.38	0.0036

The GLM Procedure

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	4304443.845	91583.912	248.62	<.0001
Error	96	35363.507	368.370		
Corrected Total	143	4339807.352			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.991851	7.645986	19.19296	251.0201

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	95147.027	31715.676	86.10	<.0001
Enz	2	139157.974	69578.987	188.88	<.0001
Load	3	3881911.075	1293970.358	3512.69	<.0001
Hour*Enz	6	50761.831	8460.305	22.97	<.0001
Hour*Load	9	22449.293	2494.366	6.77	<.0001
Enz*Load	6	77196.663	12866.111	34.93	<.0001
Hour*Enz*Load	18	37819.981	2101.110	5.70	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	95147.027	31715.676	86.10	<.0001
Enz	2	139157.974	69578.987	188.88	<.0001
Load	3	3881911.075	1293970.358	3512.69	<.0001
Hour*Enz	6	50761.831	8460.305	22.97	<.0001
Hour*Load	9	22449.293	2494.366	6.77	<.0001
Enz*Load	6	77196.663	12866.111	34.93	<.0001
Hour*Enz*Load	18	37819.981	2101.110	5.70	<.0001

Least Squares Means

Hour	Enz	Load	Maltotriose LSMEAN	LSMEAN Number
0	Fuel	0	45.3333333	1
0	Fuel	0.5	23.3333333	2
0	Fuel	1	5.2000000	3
0	Fuel	5	-0.0000000	4
0	Tech	0	38.0000000	5
0	Tech	0.5	0.0000000	6
0	Tech	1	0.0000000	7
0	Tech	5	-0.0000000	8
0	Ultra	0	36.5333333	9
0	Ultra	0.5	3.8666667	10
0	Ultra	1	-0.0000000	11
0	Ultra	5	5.3333333	12
24	Fuel	0	49.4666667	13
24	Fuel	0.5	5.6666667	14
24	Fuel	1	1.3666667	15
24	Fuel	5	-0.0000000	16
24	Tech	0	41.0666667	17
24	Tech	0.5	1.5000000	18
24	Tech	1	0.0000000	19
24	Tech	5	-0.0000000	20
24	Ultra	0	47.9666667	21
24	Ultra	0.5	12.3000000	22
24	Ultra	1	7.2333333	23
24	Ultra	5	7.6666667	24
48	Fuel	0	54.0000000	25
48	Fuel	0.5	3.7333333	26
48	Fuel	1	0.0000000	27
48	Fuel	5	-0.0000000	28
48	Tech	0	50.7000000	29
48	Tech	0.5	0.0000000	30
48	Tech	1	0.0000000	31
48	Tech	5	-0.0000000	32
48	Ultra	0	57.6333333	33
48	Ultra	0.5	13.5666667	34
48	Ultra	1	7.1000000	35
48	Ultra	5	6.9000000	36
72	Fuel	0	57.9000000	37
72	Fuel	0.5	2.7666667	38
72	Fuel	1	2.3333333	39
72	Fuel	5	0.0000000	40
72	Tech	0	52.9000000	41
72	Tech	0.5	-0.0000000	42
72	Tech	1	-0.0000000	43
72	Tech	5	0.0000000	44
72	Ultra	0	56.2000000	45
72	Ultra	0.5	18.4666667	46
72	Ultra	1	8.3666667	47
72	Ultra	5	7.3666667	48

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Maltotriose

i/j	1	2	3	4	5	6	7
1		<.0001	<.0001	<.0001	0.0464	<.0001	<.0001
2	<.0001		<.0001	<.0001	0.0001	<.0001	<.0001
3	<.0001	<.0001		0.1557	<.0001	0.1557	0.1557
4	<.0001	<.0001	0.1557		<.0001	1.0000	1.0000
5	0.0464	0.0001	<.0001	<.0001		<.0001	<.0001
6	<.0001	<.0001	0.1557	1.0000	<.0001		1.0000
7	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	
8	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
9	0.0173	0.0005	<.0001	<.0001	0.6874	<.0001	<.0001
10	<.0001	<.0001	0.7145	0.2900	<.0001	0.2900	0.2900
11	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
12	<.0001	<.0001	0.9708	0.1455	<.0001	0.1455	0.1455
13	0.2582	<.0001	<.0001	<.0001	0.0021	<.0001	<.0001
14	<.0001	<.0001	0.8981	0.1222	<.0001	0.1222	0.1222
15	<.0001	<.0001	0.2942	0.7077	<.0001	0.7077	0.7077
16	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
17	0.2433	<.0001	<.0001	<.0001	0.4009	<.0001	<.0001
18	<.0001	<.0001	0.3112	0.6807	<.0001	0.6807	0.6807
19	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
20	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
21	0.4705	<.0001	<.0001	<.0001	0.0073	<.0001	<.0001
22	<.0001	0.0031	0.0537	0.0010	<.0001	0.0010	0.0010
23	<.0001	<.0001	0.5771	0.0494	<.0001	0.0494	0.0494
24	<.0001	<.0001	0.4989	0.0375	<.0001	0.0375	0.0375
25	0.0191	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
26	<.0001	<.0001	0.6874	0.3069	<.0001	0.3069	0.3069
27	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
28	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
29	0.1430	<.0001	<.0001	<.0001	0.0007	<.0001	<.0001
30	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
31	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
32	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
33	0.0010	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
34	<.0001	0.0085	0.0235	0.0003	<.0001	0.0003	0.0003
35	<.0001	<.0001	0.6023	0.0537	<.0001	0.0537	0.0537
36	<.0001	<.0001	0.6410	0.0606	<.0001	0.0606	0.0606
37	0.0008	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
38	<.0001	<.0001	0.5047	0.4484	<.0001	0.4484	0.4484
39	<.0001	<.0001	0.4322	0.5224	<.0001	0.5224	0.5224
40	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
41	0.0400	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
42	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
43	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
44	<.0001	<.0001	0.1557	1.0000	<.0001	1.0000	1.0000
45	0.0035	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
46	<.0001	0.1837	0.0004	<.0001	<.0001	<.0001	<.0001
47	<.0001	<.0001	0.3857	0.0235	<.0001	0.0235	0.0235
48	<.0001	<.0001	0.5525	0.0454	<.0001	0.0454	0.0454

Dependent Variable: Maltotriose

i/j	8	9	10	11	12	13	14
1	<.0001	0.0173	<.0001	<.0001	<.0001	0.2582	<.0001
2	<.0001	0.0005	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.1557	<.0001	0.7145	0.1557	0.9708	<.0001	0.8981
4	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
5	<.0001	0.6874	<.0001	<.0001	<.0001	0.0021	<.0001
6	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
7	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
8		<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
9	<.0001		<.0001	<.0001	<.0001	0.0006	<.0001
10	0.2900	<.0001		0.2900	0.6874	<.0001	0.6215
11	1.0000	<.0001	0.2900		0.1455	<.0001	0.1222
12	0.1455	<.0001	0.6874	0.1455		<.0001	0.9271
13	<.0001	0.0006	<.0001	<.0001	<.0001		<.0001
14	0.1222	<.0001	0.6215	0.1222	0.9271	<.0001	
15	0.7077	<.0001	0.4932	0.7077	0.2778	<.0001	0.2397
16	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
17	<.0001	0.2153	<.0001	<.0001	<.0001	0.0230	<.0001
18	0.6807	<.0001	0.5165	0.6807	0.2942	<.0001	0.2544
19	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
20	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
21	<.0001	0.0022	<.0001	<.0001	<.0001	0.6807	<.0001
22	0.0010	<.0001	0.0224	0.0010	0.0582	<.0001	0.0711
23	0.0494	<.0001	0.3566	0.0494	0.6023	<.0001	0.6674
24	0.0375	<.0001	0.2984	0.0375	0.5224	<.0001	0.5834
25	<.0001	<.0001	<.0001	<.0001	<.0001	0.2153	<.0001
26	0.3069	<.0001	0.9708	0.3069	0.6607	<.0001	0.5960
27	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
28	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
29	<.0001	0.0002	<.0001	<.0001	<.0001	0.7351	<.0001
30	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
31	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
32	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
33	<.0001	<.0001	<.0001	<.0001	<.0001	0.0269	<.0001
34	0.0003	<.0001	0.0089	0.0003	0.0257	<.0001	0.0322
35	0.0537	<.0001	0.3759	0.0537	0.6280	<.0001	0.6942
36	0.0606	<.0001	0.4060	0.0606	0.6674	<.0001	0.7351
37	<.0001	<.0001	<.0001	<.0001	<.0001	0.0224	<.0001
38	0.4484	<.0001	0.7628	0.4484	0.4817	<.0001	0.4269
39	0.5224	<.0001	0.6740	0.5224	0.4111	<.0001	0.3613
40	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
41	<.0001	<.0001	<.0001	<.0001	<.0001	0.3472	<.0001
42	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
43	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
44	1.0000	<.0001	0.2900	1.0000	0.1455	<.0001	0.1222
45	<.0001	<.0001	<.0001	<.0001	<.0001	0.0670	<.0001
46	<.0001	<.0001	0.0001	<.0001	0.0005	<.0001	0.0007
47	0.0235	<.0001	0.2187	0.0235	0.4060	<.0001	0.4593
48	0.0454	<.0001	0.3379	0.0454	0.5771	<.0001	0.6410

Dependent Variable: Maltotriose

i/j	15	16	17	18	19	20	21
1	<.0001	<.0001	0.2433	<.0001	<.0001	<.0001	0.4705
2	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.2942	0.1557	<.0001	0.3112	0.1557	0.1557	<.0001
4	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
5	<.0001	<.0001	0.4009	<.0001	<.0001	<.0001	0.0073
6	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
7	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
8	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
9	<.0001	<.0001	0.2153	<.0001	<.0001	<.0001	0.0022
10	0.4932	0.2900	<.0001	0.5165	0.2900	0.2900	<.0001
11	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
12	0.2778	0.1455	<.0001	0.2942	0.1455	0.1455	<.0001
13	<.0001	<.0001	0.0230	<.0001	<.0001	<.0001	0.6807
14	0.2397	0.1222	<.0001	0.2544	0.1222	0.1222	<.0001
15		0.7077	<.0001	0.9708	0.7077	0.7077	<.0001
16	0.7077		<.0001	0.6807	1.0000	1.0000	<.0001
17	<.0001	<.0001		<.0001	<.0001	<.0001	0.0606
18	0.9708	0.6807	<.0001		0.6807	0.6807	<.0001
19	0.7077	1.0000	<.0001	0.6807		1.0000	<.0001
20	0.7077	1.0000	<.0001	0.6807	1.0000		<.0001
21	<.0001	<.0001	0.0606	<.0001	<.0001	<.0001	
22	0.0034	0.0010	<.0001	0.0037	0.0010	0.0010	<.0001
23	0.1097	0.0494	<.0001	0.1179	0.0494	0.0494	<.0001
24	0.0862	0.0375	<.0001	0.0930	0.0375	0.0375	<.0001
25	<.0001	<.0001	0.0006	<.0001	<.0001	<.0001	0.1001
26	0.5165	0.3069	<.0001	0.5403	0.3069	0.3069	<.0001
27	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
28	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
29	<.0001	<.0001	0.0094	<.0001	<.0001	<.0001	0.4538
30	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
31	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
32	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
33	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0092
34	0.0011	0.0003	<.0001	0.0013	0.0003	0.0003	<.0001
35	0.1179	0.0537	<.0001	0.1266	0.0537	0.0537	<.0001
36	0.1312	0.0606	<.0001	0.1406	0.0606	0.0606	<.0001
37	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0075
38	0.7009	0.4484	<.0001	0.7282	0.4484	0.4484	<.0001
39	0.7908	0.5224	<.0001	0.8191	0.5224	0.5224	<.0001
40	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
41	<.0001	<.0001	0.0016	<.0001	<.0001	<.0001	0.1778
42	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
43	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
44	0.7077	1.0000	<.0001	0.6807	1.0000	1.0000	<.0001
45	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0257
46	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
47	0.0570	0.0235	<.0001	0.0619	0.0235	0.0235	<.0001
48	0.1020	0.0454	<.0001	0.1097	0.0454	0.0454	<.0001

Dependent Variable: Maltotriose

i/j	22	23	24	25	26	27	28
1	<.0001	<.0001	<.0001	0.0191	<.0001	<.0001	<.0001
2	0.0031	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.0537	0.5771	0.4989	<.0001	0.6874	0.1557	0.1557
4	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
5	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
6	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
7	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
8	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
9	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	0.0224	0.3566	0.2984	<.0001	0.9708	0.2900	0.2900
11	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
12	0.0582	0.6023	0.5224	<.0001	0.6607	0.1455	0.1455
13	<.0001	<.0001	<.0001	0.2153	<.0001	<.0001	<.0001
14	0.0711	0.6674	0.5834	<.0001	0.5960	0.1222	0.1222
15	0.0034	0.1097	0.0862	<.0001	0.5165	0.7077	0.7077
16	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
17	<.0001	<.0001	<.0001	0.0006	<.0001	<.0001	<.0001
18	0.0037	0.1179	0.0930	<.0001	0.5403	0.6807	0.6807
19	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
20	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
21	<.0001	<.0001	<.0001	0.1001	<.0001	<.0001	<.0001
22		0.1665	0.2054	<.0001	0.0204	0.0010	0.0010
23	0.1665		0.9053	<.0001	0.3379	0.0494	0.0494
24	0.2054	0.9053		<.0001	0.2818	0.0375	0.0375
25	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
26	0.0204	0.3379	0.2818	<.0001		0.3069	0.3069
27	0.0010	0.0494	0.0375	<.0001	0.3069		1.0000
28	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	
29	<.0001	<.0001	<.0001	0.3661	<.0001	<.0001	<.0001
30	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
31	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
32	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
33	<.0001	<.0001	<.0001	0.3199	<.0001	<.0001	<.0001
34	0.7282	0.0846	0.1078	<.0001	0.0081	0.0003	0.0003
35	0.1557	0.9708	0.8764	<.0001	0.3566	0.0537	0.0537
36	0.1406	0.9271	0.8334	<.0001	0.3857	0.0606	0.0606
37	<.0001	<.0001	<.0001	0.2859	<.0001	<.0001	<.0001
38	0.0101	0.2221	0.1807	<.0001	0.7908	0.4484	0.4484
39	0.0073	0.1807	0.1455	<.0001	0.7009	0.5224	0.5224
40	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
41	<.0001	<.0001	<.0001	0.7628	<.0001	<.0001	<.0001
42	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
43	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
44	0.0010	0.0494	0.0375	<.0001	0.3069	1.0000	1.0000
45	<.0001	<.0001	<.0001	0.5464	<.0001	<.0001	<.0001
46	0.0930	0.0026	0.0037	<.0001	0.0001	<.0001	<.0001
47	0.2818	0.7558	0.8477	<.0001	0.2054	0.0235	0.0235
48	0.1778	0.9708	0.9344	<.0001	0.3199	0.0454	0.0454

Dependent Variable: Maltotriose

i/j	29	30	31	32	33	34	35
1	0.1430	<.0001	<.0001	<.0001	0.0010	<.0001	<.0001
2	<.0001	<.0001	<.0001	<.0001	<.0001	0.0085	<.0001
3	<.0001	0.1557	0.1557	0.1557	<.0001	0.0235	0.6023
4	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
5	0.0007	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
6	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
7	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
8	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
9	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	<.0001	0.2900	0.2900	0.2900	<.0001	0.0089	0.3759
11	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
12	<.0001	0.1455	0.1455	0.1455	<.0001	0.0257	0.6280
13	0.7351	<.0001	<.0001	<.0001	0.0269	<.0001	<.0001
14	<.0001	0.1222	0.1222	0.1222	<.0001	0.0322	0.6942
15	<.0001	0.7077	0.7077	0.7077	<.0001	0.0011	0.1179
16	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
17	0.0094	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
18	<.0001	0.6807	0.6807	0.6807	<.0001	0.0013	0.1266
19	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
20	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
21	0.4538	<.0001	<.0001	<.0001	0.0092	<.0001	<.0001
22	<.0001	0.0010	0.0010	0.0010	<.0001	0.7282	0.1557
23	<.0001	0.0494	0.0494	0.0494	<.0001	0.0846	0.9708
24	<.0001	0.0375	0.0375	0.0375	<.0001	0.1078	0.8764
25	0.3661	<.0001	<.0001	<.0001	0.3199	<.0001	<.0001
26	<.0001	0.3069	0.3069	0.3069	<.0001	0.0081	0.3566
27	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
28	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
29		<.0001	<.0001	<.0001	0.0594	<.0001	<.0001
30	<.0001		1.0000	1.0000	<.0001	0.0003	0.0537
31	<.0001	1.0000		1.0000	<.0001	0.0003	0.0537
32	<.0001	1.0000	1.0000		<.0001	0.0003	0.0537
33	0.0594	<.0001	<.0001	<.0001		<.0001	<.0001
34	<.0001	0.0003	0.0003	0.0003	<.0001		0.0783
35	<.0001	0.0537	0.0537	0.0537	<.0001	0.0783	
36	<.0001	0.0606	0.0606	0.0606	<.0001	0.0697	0.9562
37	0.0504	<.0001	<.0001	<.0001	0.9417	<.0001	<.0001
38	<.0001	0.4484	0.4484	0.4484	<.0001	0.0037	0.2361
39	<.0001	0.5224	0.5224	0.5224	<.0001	0.0026	0.1928
40	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
41	0.5464	<.0001	<.0001	<.0001	0.1959	<.0001	<.0001
42	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
43	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
44	<.0001	1.0000	1.0000	1.0000	<.0001	0.0003	0.0537
45	0.1335	<.0001	<.0001	<.0001	0.6942	<.0001	<.0001
46	<.0001	<.0001	<.0001	<.0001	<.0001	0.1807	0.0023
47	<.0001	0.0235	0.0235	0.0235	<.0001	0.1557	0.7282
48	<.0001	0.0454	0.0454	0.0454	<.0001	0.0912	0.9417

Dependent Variable: Maltotriose

i/j	36	37	38	39	40	41	42
1	<.0001	0.0008	<.0001	<.0001	<.0001	0.0400	<.0001
2	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.6410	<.0001	0.5047	0.4322	0.1557	<.0001	0.1557
4	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
5	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
6	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
7	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
8	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
9	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	0.4060	<.0001	0.7628	0.6740	0.2900	<.0001	0.2900
11	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
12	0.6674	<.0001	0.4817	0.4111	0.1455	<.0001	0.1455
13	<.0001	0.0224	<.0001	<.0001	<.0001	0.3472	<.0001
14	0.7351	<.0001	0.4269	0.3613	0.1222	<.0001	0.1222
15	0.1312	<.0001	0.7009	0.7908	0.7077	<.0001	0.7077
16	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
17	<.0001	<.0001	<.0001	<.0001	<.0001	0.0016	<.0001
18	0.1406	<.0001	0.7282	0.8191	0.6807	<.0001	0.6807
19	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
20	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
21	<.0001	0.0075	<.0001	<.0001	<.0001	0.1778	<.0001
22	0.1406	<.0001	0.0101	0.0073	0.0010	<.0001	0.0010
23	0.9271	<.0001	0.2221	0.1807	0.0494	<.0001	0.0494
24	0.8334	<.0001	0.1807	0.1455	0.0375	<.0001	0.0375
25	<.0001	0.2859	<.0001	<.0001	<.0001	0.7628	<.0001
26	0.3857	<.0001	0.7908	0.7009	0.3069	<.0001	0.3069
27	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
28	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
29	<.0001	0.0504	<.0001	<.0001	<.0001	0.5464	<.0001
30	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
31	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
32	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
33	<.0001	0.9417	<.0001	<.0001	<.0001	0.1959	<.0001
34	0.0697	<.0001	0.0037	0.0026	0.0003	<.0001	0.0003
35	0.9562	<.0001	0.2361	0.1928	0.0537	<.0001	0.0537
36		<.0001	0.2582	0.2120	0.0606	<.0001	0.0606
37	<.0001		<.0001	<.0001	<.0001	0.1721	<.0001
38	0.2582	<.0001		0.9053	0.4484	<.0001	0.4484
39	0.2120	<.0001	0.9053		0.5224	<.0001	0.5224
40	0.0606	<.0001	0.4484	0.5224		<.0001	1.0000
41	<.0001	0.1721	<.0001	<.0001	<.0001		<.0001
42	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	
43	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
44	0.0606	<.0001	0.4484	0.5224	1.0000	<.0001	1.0000
45	<.0001	0.6410	<.0001	<.0001	<.0001	0.3661	<.0001
46	0.0020	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
47	0.6874	<.0001	0.1266	0.1001	0.0235	<.0001	0.0235
48	0.8981	<.0001	0.2087	0.1693	0.0454	<.0001	0.0454

Dependent Variable: Maltotriose

i/j	43	44	45	46	47	48
1	<.0001	<.0001	0.0035	<.0001	<.0001	<.0001
2	<.0001	<.0001	<.0001	0.1837	<.0001	<.0001
3	0.1557	0.1557	<.0001	0.0004	0.3857	0.5525
4	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
5	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
6	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
7	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
8	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
9	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	0.2900	0.2900	<.0001	0.0001	0.2187	0.3379
11	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
12	0.1455	0.1455	<.0001	0.0005	0.4060	0.5771
13	<.0001	<.0001	0.0670	<.0001	<.0001	<.0001
14	0.1222	0.1222	<.0001	0.0007	0.4593	0.6410
15	0.7077	0.7077	<.0001	<.0001	0.0570	0.1020
16	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
17	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
18	0.6807	0.6807	<.0001	<.0001	0.0619	0.1097
19	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
20	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
21	<.0001	<.0001	0.0257	<.0001	<.0001	<.0001
22	0.0010	0.0010	<.0001	0.0930	0.2818	0.1778
23	0.0494	0.0494	<.0001	0.0026	0.7558	0.9708
24	0.0375	0.0375	<.0001	0.0037	0.8477	0.9344
25	<.0001	<.0001	0.5464	<.0001	<.0001	<.0001
26	0.3069	0.3069	<.0001	0.0001	0.2054	0.3199
27	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
28	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
29	<.0001	<.0001	0.1335	<.0001	<.0001	<.0001
30	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
31	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
32	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
33	<.0001	<.0001	0.6942	<.0001	<.0001	<.0001
34	0.0003	0.0003	<.0001	0.1807	0.1557	0.0912
35	0.0537	0.0537	<.0001	0.0023	0.7282	0.9417
36	0.0606	0.0606	<.0001	0.0020	0.6874	0.8981
37	<.0001	<.0001	0.6410	<.0001	<.0001	<.0001
38	0.4484	0.4484	<.0001	<.0001	0.1266	0.2087
39	0.5224	0.5224	<.0001	<.0001	0.1001	0.1693
40	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
41	<.0001	<.0001	0.3661	<.0001	<.0001	<.0001
42	1.0000	1.0000	<.0001	<.0001	0.0235	0.0454
43		1.0000	<.0001	<.0001	0.0235	0.0454
44	1.0000		<.0001	<.0001	0.0235	0.0454
45	<.0001	<.0001		<.0001	<.0001	<.0001
46	<.0001	<.0001	<.0001		0.0066	0.0029
47	0.0235	0.0235	<.0001	0.0066		0.7838
48	0.0454	0.0454	<.0001	0.0029	0.7838	

Least Squares Means

Hour	Enz	Load	Maltose LSMEAN	LSMEAN Number
0	Fuel	0	252.533333	1
0	Fuel	0.5	275.866667	2
0	Fuel	1	260.266667	3
0	Fuel	5	63.200000	4
0	Tech	0	249.466667	5
0	Tech	0.5	197.733333	6
0	Tech	1	32.666667	7
0	Tech	5	0.000000	8
0	Ultra	0	259.200000	9
0	Ultra	0.5	260.533333	10
0	Ultra	1	216.266667	11
0	Ultra	5	3.466667	12
24	Fuel	0	275.133333	13
24	Fuel	0.5	242.333333	14
24	Fuel	1	185.300000	15
24	Fuel	5	21.900000	16
24	Tech	0	286.600000	17
24	Tech	0.5	176.233333	18
24	Tech	1	93.666667	19
24	Tech	5	14.733333	20
24	Ultra	0	279.766667	21
24	Ultra	0.5	248.600000	22
24	Ultra	1	184.166667	23
24	Ultra	5	35.833333	24
48	Fuel	0	278.866667	25
48	Fuel	0.5	243.033333	26
48	Fuel	1	151.400000	27
48	Fuel	5	16.000000	28
48	Tech	0	280.800000	29
48	Tech	0.5	198.666667	30
48	Tech	1	96.566667	31
48	Tech	5	11.566667	32
48	Ultra	0	309.700000	33
48	Ultra	0.5	246.400000	34
48	Ultra	1	176.366667	35
48	Ultra	5	36.266667	36
72	Fuel	0	286.000000	37
72	Fuel	0.5	240.566667	38
72	Fuel	1	173.066667	39
72	Fuel	5	23.166667	40
72	Tech	0	292.633333	41
72	Tech	0.5	198.400000	42
72	Tech	1	89.300000	43
72	Tech	5	11.700000	44
72	Ultra	0	304.366667	45
72	Ultra	0.5	246.266667	46
72	Ultra	1	195.166667	47
72	Ultra	5	48.233333	48

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Maltose

i/j	1	2	3	4	5	6	7
1		0.1847	0.6589	<.0001	0.8610	0.0023	<.0001
2	0.1847		0.3740	<.0001	0.1339	<.0001	<.0001
3	0.6589	0.3740		<.0001	0.5378	0.0005	<.0001
4	<.0001	<.0001	<.0001		<.0001	<.0001	0.0836
5	0.8610	0.1339	0.5378	<.0001		0.0039	<.0001
6	0.0023	<.0001	0.0005	<.0001	0.0039		<.0001
7	<.0001	<.0001	<.0001	0.0836	<.0001	<.0001	
8	<.0001	<.0001	<.0001	0.0005	<.0001	<.0001	0.0645
9	0.7035	0.3423	0.9514	<.0001	0.5786	0.0007	<.0001
10	0.6480	0.3822	0.9878	<.0001	0.5278	0.0005	<.0001
11	0.0405	0.0009	0.0134	<.0001	0.0603	0.2913	<.0001
12	<.0001	<.0001	<.0001	0.0009	<.0001	<.0001	0.0978
13	0.1988	0.9666	0.3968	<.0001	0.1449	<.0001	<.0001
14	0.5606	0.0578	0.3071	<.0001	0.6839	0.0122	<.0001
15	0.0002	<.0001	<.0001	<.0001	0.0004	0.4783	<.0001
16	<.0001	<.0001	<.0001	0.0201	<.0001	<.0001	0.5391
17	0.0540	0.5403	0.1349	<.0001	0.0361	<.0001	<.0001
18	<.0001	<.0001	<.0001	<.0001	<.0001	0.2213	<.0001
19	<.0001	<.0001	<.0001	0.0843	<.0001	<.0001	0.0007
20	<.0001	<.0001	<.0001	0.0066	<.0001	<.0001	0.3071
21	0.1222	0.8238	0.2670	<.0001	0.0860	<.0001	<.0001
22	0.8223	0.1218	0.5057	<.0001	0.9605	0.0045	<.0001
23	0.0002	<.0001	<.0001	<.0001	0.0003	0.4392	<.0001
24	<.0001	<.0001	<.0001	0.1204	<.0001	<.0001	0.8565
25	0.1349	0.8640	0.2896	<.0001	0.0956	<.0001	<.0001
26	0.5877	0.0632	0.3263	<.0001	0.7134	0.0110	<.0001
27	<.0001	<.0001	<.0001	<.0001	<.0001	0.0093	<.0001
28	<.0001	<.0001	<.0001	0.0081	<.0001	<.0001	0.3423
29	0.1088	0.7782	0.2426	<.0001	0.0760	<.0001	<.0001
30	0.0027	<.0001	0.0006	<.0001	0.0045	0.9575	<.0001
31	<.0001	<.0001	<.0001	0.0591	<.0001	<.0001	0.0004
32	<.0001	<.0001	<.0001	0.0039	<.0001	<.0001	0.2300
33	0.0015	0.0557	0.0057	<.0001	0.0008	<.0001	<.0001
34	0.7262	0.0948	0.4292	<.0001	0.8610	0.0064	<.0001
35	<.0001	<.0001	<.0001	<.0001	<.0001	0.2242	<.0001
36	<.0001	<.0001	<.0001	0.1263	<.0001	<.0001	0.8371
37	0.0583	0.5631	0.1439	<.0001	0.0391	<.0001	<.0001
38	0.4949	0.0460	0.2622	<.0001	0.6115	0.0160	<.0001
39	<.0001	<.0001	<.0001	<.0001	<.0001	0.1611	<.0001
40	<.0001	<.0001	<.0001	0.0241	<.0001	<.0001	0.5877
41	0.0239	0.3395	0.0669	<.0001	0.0152	<.0001	<.0001
42	0.0025	<.0001	0.0006	<.0001	0.0043	0.9696	<.0001
43	<.0001	<.0001	<.0001	0.1384	<.0001	<.0001	0.0016
44	<.0001	<.0001	<.0001	0.0040	<.0001	<.0001	0.2329
45	0.0038	0.1060	0.0132	<.0001	0.0022	<.0001	<.0001
46	0.7205	0.0934	0.4248	<.0001	0.8550	0.0066	<.0001
47	0.0014	<.0001	0.0003	<.0001	0.0025	0.8835	<.0001
48	<.0001	<.0001	<.0001	0.3936	<.0001	<.0001	0.3750

Dependent Variable: Maltose

i/j	8	9	10	11	12	13	14
1	<.0001	0.7035	0.6480	0.0405	<.0001	0.1988	0.5606
2	<.0001	0.3423	0.3822	0.0009	<.0001	0.9666	0.0578
3	<.0001	0.9514	0.9878	0.0134	<.0001	0.3968	0.3071
4	0.0005	<.0001	<.0001	<.0001	0.0009	<.0001	<.0001
5	<.0001	0.5786	0.5278	0.0603	<.0001	0.1449	0.6839
6	<.0001	0.0007	0.0005	0.2913	<.0001	<.0001	0.0122
7	0.0645	<.0001	<.0001	<.0001	0.0978	<.0001	<.0001
8		<.0001	<.0001	<.0001	0.8431	<.0001	<.0001
9	<.0001		0.9393	0.0158	<.0001	0.3639	0.3366
10	<.0001	0.9393		0.0129	<.0001	0.4053	0.3000
11	<.0001	0.0158	0.0129		<.0001	0.0011	0.1389
12	0.8431	<.0001	<.0001	<.0001		<.0001	<.0001
13	<.0001	0.3639	0.4053	0.0011	<.0001		0.0634
14	<.0001	0.3366	0.3000	0.1389	<.0001	0.0634	
15	<.0001	<.0001	<.0001	0.0794	<.0001	<.0001	0.0015
16	0.2129	<.0001	<.0001	<.0001	0.2939	<.0001	<.0001
17	<.0001	0.1200	0.1389	0.0001	<.0001	0.5131	0.0129
18	<.0001	<.0001	<.0001	0.0241	<.0001	<.0001	0.0003
19	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
20	0.4010	<.0001	<.0001	<.0001	0.5204	<.0001	<.0001
21	<.0001	0.2419	0.2736	0.0004	<.0001	0.7914	0.0346
22	<.0001	0.5453	0.4961	0.0672	<.0001	0.1320	0.7205
23	<.0001	<.0001	<.0001	0.0692	<.0001	<.0001	0.0012
24	0.0429	<.0001	<.0001	<.0001	0.0669	<.0001	<.0001
25	<.0001	0.2630	0.2965	0.0005	<.0001	0.8312	0.0391
26	<.0001	0.3570	0.3189	0.1287	<.0001	0.0692	0.9681
27	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001
28	0.3619	<.0001	<.0001	<.0001	0.4747	<.0001	<.0001
29	<.0001	0.2192	0.2488	0.0004	<.0001	0.7463	0.0300
30	<.0001	0.0008	0.0006	0.3161	<.0001	<.0001	0.0141
31	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
32	0.5094	<.0001	<.0001	<.0001	0.6439	<.0001	<.0001
33	<.0001	0.0047	0.0059	<.0001	<.0001	0.0507	0.0002
34	<.0001	0.4654	0.4204	0.0877	<.0001	0.1032	0.8164
35	<.0001	<.0001	<.0001	0.0245	<.0001	<.0001	0.0003
36	0.0405	<.0001	<.0001	<.0001	0.0634	<.0001	<.0001
37	<.0001	0.1282	0.1481	0.0001	<.0001	0.5353	0.0141
38	<.0001	0.2887	0.2558	0.1673	<.0001	0.0507	0.9196
39	<.0001	<.0001	<.0001	0.0151	<.0001	<.0001	0.0001
40	0.1878	<.0001	<.0001	<.0001	0.2622	<.0001	<.0001
41	<.0001	0.0586	0.0692	<.0001	<.0001	0.3189	0.0049
42	<.0001	0.0008	0.0006	0.3089	<.0001	<.0001	0.0135
43	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
44	0.5045	<.0001	<.0001	<.0001	0.6384	<.0001	<.0001
45	<.0001	0.0112	0.0138	<.0001	<.0001	0.0974	0.0006
46	<.0001	0.4608	0.4160	0.0891	<.0001	0.1016	0.8223
47	<.0001	0.0004	0.0003	0.2300	<.0001	<.0001	0.0082
48	0.0069	<.0001	<.0001	<.0001	0.0119	<.0001	<.0001

Dependent Variable: Maltose

i/j	15	16	17	18	19	20	21
1	0.0002	<.0001	0.0540	<.0001	<.0001	<.0001	0.1222
2	<.0001	<.0001	0.5403	<.0001	<.0001	<.0001	0.8238
3	<.0001	<.0001	0.1349	<.0001	<.0001	<.0001	0.2670
4	<.0001	0.0201	<.0001	<.0001	0.0843	0.0066	<.0001
5	0.0004	<.0001	0.0361	<.0001	<.0001	<.0001	0.0860
6	0.4783	<.0001	<.0001	0.2213	<.0001	<.0001	<.0001
7	<.0001	0.5391	<.0001	<.0001	0.0007	0.3071	<.0001
8	<.0001	0.2129	<.0001	<.0001	<.0001	0.4010	<.0001
9	<.0001	<.0001	0.1200	<.0001	<.0001	<.0001	0.2419
10	<.0001	<.0001	0.1389	<.0001	<.0001	<.0001	0.2736
11	0.0794	<.0001	0.0001	0.0241	<.0001	<.0001	0.0004
12	<.0001	0.2939	<.0001	<.0001	<.0001	0.5204	<.0001
13	<.0001	<.0001	0.5131	<.0001	<.0001	<.0001	0.7914
14	0.0015	<.0001	0.0129	0.0003	<.0001	<.0001	0.0346
15		<.0001	<.0001	0.6049	<.0001	<.0001	<.0001
16	<.0001		<.0001	<.0001	<.0001	0.6825	<.0001
17	<.0001	<.0001		<.0001	<.0001	<.0001	0.6965
18	0.6049	<.0001	<.0001		<.0001	<.0001	<.0001
19	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
20	<.0001	0.6825	<.0001	<.0001	<.0001		<.0001
21	<.0001	<.0001	0.6965	<.0001	<.0001	<.0001	
22	0.0005	<.0001	0.0320	<.0001	<.0001	<.0001	0.0775
23	0.9484	<.0001	<.0001	0.6507	<.0001	<.0001	<.0001
24	<.0001	0.4270	<.0001	<.0001	0.0013	0.2300	<.0001
25	<.0001	<.0001	0.6589	<.0001	<.0001	<.0001	0.9590
26	0.0013	<.0001	0.0143	0.0002	<.0001	<.0001	0.0381
27	0.0552	<.0001	<.0001	0.1583	0.0013	<.0001	<.0001
28	<.0001	0.7362	<.0001	<.0001	<.0001	0.9423	<.0001
29	<.0001	<.0001	0.7405	<.0001	<.0001	<.0001	0.9529
30	0.4460	<.0001	<.0001	0.2021	<.0001	<.0001	<.0001
31	<.0001	<.0001	<.0001	<.0001	0.8685	<.0001	<.0001
32	<.0001	0.5555	<.0001	<.0001	<.0001	0.8565	<.0001
33	<.0001	<.0001	0.1891	<.0001	<.0001	<.0001	0.0898
34	0.0007	<.0001	0.0235	0.0001	<.0001	<.0001	0.0591
35	0.6102	<.0001	<.0001	0.9939	<.0001	<.0001	<.0001
36	<.0001	0.4128	<.0001	<.0001	0.0014	0.2206	<.0001
37	<.0001	<.0001	0.9727	<.0001	<.0001	<.0001	0.7220
38	0.0021	<.0001	0.0098	0.0004	<.0001	<.0001	0.0271
39	0.4854	<.0001	<.0001	0.8565	<.0001	<.0001	<.0001
40	<.0001	0.9423	<.0001	<.0001	0.0001	0.6303	<.0001
41	<.0001	<.0001	0.7305	<.0001	<.0001	<.0001	0.4631
42	0.4551	<.0001	<.0001	0.2074	<.0001	<.0001	<.0001
43	<.0001	0.0002	<.0001	<.0001	0.8031	<.0001	<.0001
44	<.0001	0.5606	<.0001	<.0001	<.0001	0.8625	<.0001
45	<.0001	<.0001	0.3116	<.0001	<.0001	<.0001	0.1622
46	0.0007	<.0001	0.0231	0.0001	<.0001	<.0001	0.0581
47	0.5734	<.0001	<.0001	0.2811	<.0001	<.0001	<.0001
48	<.0001	0.1349	<.0001	<.0001	0.0108	0.0581	<.0001

Dependent Variable: Maltose

i/j	22	23	24	25	26	27	28
1	0.8223	0.0002	<.0001	0.1349	0.5877	<.0001	<.0001
2	0.1218	<.0001	<.0001	0.8640	0.0632	<.0001	<.0001
3	0.5057	<.0001	<.0001	0.2896	0.3263	<.0001	<.0001
4	<.0001	<.0001	0.1204	<.0001	<.0001	<.0001	0.0081
5	0.9605	0.0003	<.0001	0.0956	0.7134	<.0001	<.0001
6	0.0045	0.4392	<.0001	<.0001	0.0110	0.0093	<.0001
7	<.0001	<.0001	0.8565	<.0001	<.0001	<.0001	0.3423
8	<.0001	<.0001	0.0429	<.0001	<.0001	<.0001	0.3619
9	0.5453	<.0001	<.0001	0.2630	0.3570	<.0001	<.0001
10	0.4961	<.0001	<.0001	0.2965	0.3189	<.0001	<.0001
11	0.0672	0.0692	<.0001	0.0005	0.1287	0.0003	<.0001
12	<.0001	<.0001	0.0669	<.0001	<.0001	<.0001	0.4747
13	0.1320	<.0001	<.0001	0.8312	0.0692	<.0001	<.0001
14	0.7205	0.0012	<.0001	0.0391	0.9681	<.0001	<.0001
15	0.0005	0.9484	<.0001	<.0001	0.0013	0.0552	<.0001
16	<.0001	<.0001	0.4270	<.0001	<.0001	<.0001	0.7362
17	0.0320	<.0001	<.0001	0.6589	0.0143	<.0001	<.0001
18	<.0001	0.6507	<.0001	<.0001	0.0002	0.1583	<.0001
19	<.0001	<.0001	0.0013	<.0001	<.0001	0.0013	<.0001
20	<.0001	<.0001	0.2300	<.0001	<.0001	<.0001	0.9423
21	0.0775	<.0001	<.0001	0.9590	0.0381	<.0001	<.0001
22		0.0004	<.0001	0.0863	0.7506	<.0001	<.0001
23	0.0004		<.0001	<.0001	0.0011	0.0637	<.0001
24	<.0001	<.0001		<.0001	<.0001	<.0001	0.2590
25	0.0863	<.0001	<.0001		0.0429	<.0001	<.0001
26	0.7506	0.0011	<.0001	0.0429		<.0001	<.0001
27	<.0001	0.0637	<.0001	<.0001	<.0001		<.0001
28	<.0001	<.0001	0.2590	<.0001	<.0001	<.0001	
29	0.0683	<.0001	<.0001	0.9121	0.0331	<.0001	<.0001
30	0.0052	0.4085	<.0001	<.0001	0.0127	0.0081	<.0001
31	<.0001	<.0001	0.0008	<.0001	<.0001	0.0022	<.0001
32	<.0001	<.0001	0.1679	<.0001	<.0001	<.0001	0.8002
33	0.0007	<.0001	<.0001	0.0807	0.0002	<.0001	<.0001
34	0.9000	0.0006	<.0001	0.0661	0.8476	<.0001	<.0001
35	<.0001	0.6562	<.0001	<.0001	0.0002	0.1561	<.0001
36	<.0001	<.0001	0.9803	<.0001	<.0001	<.0001	0.2488
37	0.0348	<.0001	<.0001	0.6839	0.0157	<.0001	<.0001
38	0.6466	0.0017	<.0001	0.0307	0.8880	<.0001	<.0001
39	<.0001	0.5266	<.0001	<.0001	0.0001	0.2178	<.0001
40	<.0001	<.0001	0.4701	<.0001	<.0001	<.0001	0.6825
41	0.0133	<.0001	<.0001	0.4325	0.0055	<.0001	<.0001
42	0.0050	0.4171	<.0001	<.0001	0.0122	0.0084	<.0001
43	<.0001	<.0001	0.0029	<.0001	<.0001	0.0006	<.0001
44	<.0001	<.0001	0.1702	<.0001	<.0001	<.0001	0.8061
45	0.0019	<.0001	<.0001	0.1475	0.0007	<.0001	<.0001
46	0.8940	0.0006	<.0001	0.0650	0.8535	<.0001	<.0001
47	0.0029	0.5303	<.0001	<.0001	0.0073	0.0139	<.0001
48	<.0001	<.0001	0.4794	<.0001	<.0001	<.0001	0.0680

Dependent Variable: Maltose

i/j	29	30	31	32	33	34	35
1	0.1088	0.0027	<.0001	<.0001	0.0015	0.7262	<.0001
2	0.7782	<.0001	<.0001	<.0001	0.0557	0.0948	<.0001
3	0.2426	0.0006	<.0001	<.0001	0.0057	0.4292	<.0001
4	<.0001	<.0001	0.0591	0.0039	<.0001	<.0001	<.0001
5	0.0760	0.0045	<.0001	<.0001	0.0008	0.8610	<.0001
6	<.0001	0.9575	<.0001	<.0001	<.0001	0.0064	0.2242
7	<.0001	<.0001	0.0004	0.2300	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	0.5094	<.0001	<.0001	<.0001
9	0.2192	0.0008	<.0001	<.0001	0.0047	0.4654	<.0001
10	0.2488	0.0006	<.0001	<.0001	0.0059	0.4204	<.0001
11	0.0004	0.3161	<.0001	<.0001	<.0001	0.0877	0.0245
12	<.0001	<.0001	<.0001	0.6439	<.0001	<.0001	<.0001
13	0.7463	<.0001	<.0001	<.0001	0.0507	0.1032	<.0001
14	0.0300	0.0141	<.0001	<.0001	0.0002	0.8164	0.0003
15	<.0001	0.4460	<.0001	<.0001	<.0001	0.0007	0.6102
16	<.0001	<.0001	<.0001	0.5555	<.0001	<.0001	<.0001
17	0.7405	<.0001	<.0001	<.0001	0.1891	0.0235	<.0001
18	<.0001	0.2021	<.0001	<.0001	<.0001	0.0001	0.9939
19	<.0001	<.0001	0.8685	<.0001	<.0001	<.0001	<.0001
20	<.0001	<.0001	<.0001	0.8565	<.0001	<.0001	<.0001
21	0.9529	<.0001	<.0001	<.0001	0.0898	0.0591	<.0001
22	0.0683	0.0052	<.0001	<.0001	0.0007	0.9000	<.0001
23	<.0001	0.4085	<.0001	<.0001	<.0001	0.0006	0.6562
24	<.0001	<.0001	0.0008	0.1679	<.0001	<.0001	<.0001
25	0.9121	<.0001	<.0001	<.0001	0.0807	0.0661	<.0001
26	0.0331	0.0127	<.0001	<.0001	0.0002	0.8476	0.0002
27	<.0001	0.0081	0.0022	<.0001	<.0001	<.0001	0.1561
28	<.0001	<.0001	<.0001	0.8002	<.0001	<.0001	<.0001
29		<.0001	<.0001	<.0001	0.1013	0.0518	<.0001
30	<.0001		<.0001	<.0001	<.0001	0.0075	0.2047
31	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
32	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
33	0.1013	<.0001	<.0001	<.0001		0.0005	<.0001
34	0.0518	0.0075	<.0001	<.0001	0.0005		0.0001
35	<.0001	0.2047	<.0001	<.0001	<.0001	0.0001	
36	<.0001	<.0001	0.0008	0.1605	<.0001	<.0001	<.0001
37	0.7666	<.0001	<.0001	<.0001	0.1780	0.0256	<.0001
38	0.0234	0.0184	<.0001	<.0001	0.0001	0.7391	0.0004
39	<.0001	0.1460	<.0001	<.0001	<.0001	<.0001	0.8505
40	<.0001	<.0001	<.0001	0.5082	<.0001	<.0001	<.0001
41	0.4997	<.0001	<.0001	<.0001	0.3309	0.0095	<.0001
42	<.0001	0.9878	<.0001	<.0001	<.0001	0.0072	0.2102
43	<.0001	<.0001	0.6783	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	0.9939	<.0001	<.0001	<.0001
45	0.1804	<.0001	<.0001	<.0001	0.7607	0.0013	<.0001
46	0.0509	0.0076	<.0001	<.0001	0.0005	0.9939	0.0001
47	<.0001	0.8416	<.0001	<.0001	<.0001	0.0042	0.2844
48	<.0001	<.0001	0.0068	0.0384	<.0001	<.0001	<.0001

Dependent Variable: Maltose

i/j	36	37	38	39	40	41	42
1	<.0001	0.0583	0.4949	<.0001	<.0001	0.0239	0.0025
2	<.0001	0.5631	0.0460	<.0001	<.0001	0.3395	<.0001
3	<.0001	0.1439	0.2622	<.0001	<.0001	0.0669	0.0006
4	0.1263	<.0001	<.0001	<.0001	0.0241	<.0001	<.0001
5	<.0001	0.0391	0.6115	<.0001	<.0001	0.0152	0.0043
6	<.0001	<.0001	0.0160	0.1611	<.0001	<.0001	0.9696
7	0.8371	<.0001	<.0001	<.0001	0.5877	<.0001	<.0001
8	0.0405	<.0001	<.0001	<.0001	0.1878	<.0001	<.0001
9	<.0001	0.1282	0.2887	<.0001	<.0001	0.0586	0.0008
10	<.0001	0.1481	0.2558	<.0001	<.0001	0.0692	0.0006
11	<.0001	0.0001	0.1673	0.0151	<.0001	<.0001	0.3089
12	0.0634	<.0001	<.0001	<.0001	0.2622	<.0001	<.0001
13	<.0001	0.5353	0.0507	<.0001	<.0001	0.3189	<.0001
14	<.0001	0.0141	0.9196	0.0001	<.0001	0.0049	0.0135
15	<.0001	<.0001	0.0021	0.4854	<.0001	<.0001	0.4551
16	0.4128	<.0001	<.0001	<.0001	0.9423	<.0001	<.0001
17	<.0001	0.9727	0.0098	<.0001	<.0001	0.7305	<.0001
18	<.0001	<.0001	0.0004	0.8565	<.0001	<.0001	0.2074
19	0.0014	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001
20	0.2206	<.0001	<.0001	<.0001	0.6303	<.0001	<.0001
21	<.0001	0.7220	0.0271	<.0001	<.0001	0.4631	<.0001
22	<.0001	0.0348	0.6466	<.0001	<.0001	0.0133	0.0050
23	<.0001	<.0001	0.0017	0.5266	<.0001	<.0001	0.4171
24	0.9803	<.0001	<.0001	<.0001	0.4701	<.0001	<.0001
25	<.0001	0.6839	0.0307	<.0001	<.0001	0.4325	<.0001
26	<.0001	0.0157	0.8880	0.0001	<.0001	0.0055	0.0122
27	<.0001	<.0001	<.0001	0.2178	<.0001	<.0001	0.0084
28	0.2488	<.0001	<.0001	<.0001	0.6825	<.0001	<.0001
29	<.0001	0.7666	0.0234	<.0001	<.0001	0.4997	<.0001
30	<.0001	<.0001	0.0184	0.1460	<.0001	<.0001	0.9878
31	0.0008	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
32	0.1605	<.0001	<.0001	<.0001	0.5082	<.0001	<.0001
33	<.0001	0.1780	0.0001	<.0001	<.0001	0.3309	<.0001
34	<.0001	0.0256	0.7391	<.0001	<.0001	0.0095	0.0072
35	<.0001	<.0001	0.0004	0.8505	<.0001	<.0001	0.2102
36		<.0001	<.0001	<.0001	0.4551	<.0001	<.0001
37	<.0001		0.0108	<.0001	<.0001	0.7049	<.0001
38	<.0001	0.0108		0.0002	<.0001	0.0036	0.0177
39	<.0001	<.0001	0.0002		<.0001	<.0001	0.1502
40	0.4551	<.0001	<.0001	<.0001		<.0001	<.0001
41	<.0001	0.7049	0.0036	<.0001	<.0001		<.0001
42	<.0001	<.0001	0.0177	0.1502	<.0001	<.0001	
43	0.0031	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001
44	0.1628	<.0001	<.0001	<.0001	0.5131	<.0001	<.0001
45	<.0001	0.2956	0.0004	<.0001	<.0001	0.5033	<.0001
46	<.0001	0.0251	0.7449	<.0001	<.0001	0.0093	0.0073
47	<.0001	<.0001	0.0108	0.2088	<.0001	<.0001	0.8535
48	0.4949	<.0001	<.0001	<.0001	0.1545	<.0001	<.0001

Dependent Variable: Maltose

i/j	43	44	45	46	47	48
1	<.0001	<.0001	0.0038	0.7205	0.0014	<.0001
2	<.0001	<.0001	0.1060	0.0934	<.0001	<.0001
3	<.0001	<.0001	0.0132	0.4248	0.0003	<.0001
4	0.1384	0.0040	<.0001	<.0001	<.0001	0.3936
5	<.0001	<.0001	0.0022	0.8550	0.0025	<.0001
6	<.0001	<.0001	<.0001	0.0066	0.8835	<.0001
7	0.0016	0.2329	<.0001	<.0001	<.0001	0.3750
8	<.0001	0.5045	<.0001	<.0001	<.0001	0.0069
9	<.0001	<.0001	0.0112	0.4608	0.0004	<.0001
10	<.0001	<.0001	0.0138	0.4160	0.0003	<.0001
11	<.0001	<.0001	<.0001	0.0891	0.2300	<.0001
12	<.0001	0.6384	<.0001	<.0001	<.0001	0.0119
13	<.0001	<.0001	0.0974	0.1016	<.0001	<.0001
14	<.0001	<.0001	0.0006	0.8223	0.0082	<.0001
15	<.0001	<.0001	<.0001	0.0007	0.5734	<.0001
16	0.0002	0.5606	<.0001	<.0001	<.0001	0.1349
17	<.0001	<.0001	0.3116	0.0231	<.0001	<.0001
18	<.0001	<.0001	<.0001	0.0001	0.2811	<.0001
19	0.8031	<.0001	<.0001	<.0001	<.0001	0.0108
20	<.0001	0.8625	<.0001	<.0001	<.0001	0.0581
21	<.0001	<.0001	0.1622	0.0581	<.0001	<.0001
22	<.0001	<.0001	0.0019	0.8940	0.0029	<.0001
23	<.0001	<.0001	<.0001	0.0006	0.5303	<.0001
24	0.0029	0.1702	<.0001	<.0001	<.0001	0.4794
25	<.0001	<.0001	0.1475	0.0650	<.0001	<.0001
26	<.0001	<.0001	0.0007	0.8535	0.0073	<.0001
27	0.0006	<.0001	<.0001	<.0001	0.0139	<.0001
28	<.0001	0.8061	<.0001	<.0001	<.0001	0.0680
29	<.0001	<.0001	0.1804	0.0509	<.0001	<.0001
30	<.0001	<.0001	<.0001	0.0076	0.8416	<.0001
31	0.6783	<.0001	<.0001	<.0001	<.0001	0.0068
32	<.0001	0.9939	<.0001	<.0001	<.0001	0.0384
33	<.0001	<.0001	0.7607	0.0005	<.0001	<.0001
34	<.0001	<.0001	0.0013	0.9939	0.0042	<.0001
35	<.0001	<.0001	<.0001	0.0001	0.2844	<.0001
36	0.0031	0.1628	<.0001	<.0001	<.0001	0.4949
37	<.0001	<.0001	0.2956	0.0251	<.0001	<.0001
38	<.0001	<.0001	0.0004	0.7449	0.0108	<.0001
39	<.0001	<.0001	<.0001	<.0001	0.2088	<.0001
40	0.0003	0.5131	<.0001	<.0001	<.0001	0.1545
41	<.0001	<.0001	0.5033	0.0093	<.0001	<.0001
42	<.0001	<.0001	<.0001	0.0073	0.8535	<.0001
43		<.0001	<.0001	<.0001	<.0001	0.0208
44	<.0001		<.0001	<.0001	<.0001	0.0391
45	<.0001	<.0001		0.0012	<.0001	<.0001
46	<.0001	<.0001	0.0012		0.0043	<.0001
47	<.0001	<.0001	<.0001	0.0043		<.0001
48	0.0208	0.0391	<.0001	<.0001	<.0001	

Least Squares Means

Hour	Enz	Load	Glucose LSMEAN	LSMEAN Number
0	Fuel	0	13.733333	1
0	Fuel	0.5	80.000000	2
0	Fuel	1	119.200000	3
0	Fuel	5	364.133333	4
0	Tech	0	12.000000	5
0	Tech	0.5	237.200000	6
0	Tech	1	413.866667	7
0	Tech	5	485.200000	8
0	Ultra	0	31.866667	9
0	Ultra	0.5	116.000000	10
0	Ultra	1	186.266667	11
0	Ultra	5	436.133333	12
24	Fuel	0	30.433333	13
24	Fuel	0.5	168.800000	14
24	Fuel	1	249.800000	15
24	Fuel	5	463.766667	16
24	Tech	0	48.600000	17
24	Tech	0.5	245.366667	18
24	Tech	1	370.333333	19
24	Tech	5	499.866667	20
24	Ultra	0	23.133333	21
24	Ultra	0.5	199.633333	22
24	Ultra	1	275.200000	23
24	Ultra	5	495.700000	24
48	Fuel	0	28.666667	25
48	Fuel	0.5	205.166667	26
48	Fuel	1	316.066667	27
48	Fuel	5	514.033333	28
48	Tech	0	29.333333	29
48	Tech	0.5	262.600000	30
48	Tech	1	364.133333	31
48	Tech	5	505.366667	32
48	Ultra	0	26.566667	33
48	Ultra	0.5	208.266667	34
48	Ultra	1	318.666667	35
48	Ultra	5	513.800000	36
72	Fuel	0	33.333333	37
72	Fuel	0.5	209.566667	38
72	Fuel	1	269.900000	39
72	Fuel	5	493.233333	40
72	Tech	0	33.066667	41
72	Tech	0.5	254.733333	42
72	Tech	1	396.766667	43
72	Tech	5	549.600000	44
72	Ultra	0	30.933333	45
72	Ultra	0.5	180.000000	46
72	Ultra	1	275.433333	47
72	Ultra	5	463.500000	48

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	1	2	3	4	5	6	7
1		<.0001	<.0001	<.0001	0.9122	<.0001	<.0001
2	<.0001		0.0141	<.0001	<.0001	<.0001	<.0001
3	<.0001	0.0141		<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001		<.0001	<.0001	0.0020
5	0.9122	<.0001	<.0001	<.0001		<.0001	<.0001
6	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
7	<.0001	<.0001	<.0001	0.0020	<.0001	<.0001	
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.2501	0.0028	<.0001	<.0001	0.2080	<.0001	<.0001
10	<.0001	0.0238	0.8386	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	0.0016	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1586
13	0.2892	0.0021	<.0001	<.0001	0.2424	<.0001	<.0001
14	<.0001	<.0001	0.0021	<.0001	<.0001	<.0001	<.0001
15	<.0001	<.0001	<.0001	<.0001	<.0001	0.4234	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0020
17	0.0284	0.0479	<.0001	<.0001	0.0216	<.0001	<.0001
18	<.0001	<.0001	<.0001	<.0001	<.0001	0.6035	<.0001
19	<.0001	<.0001	<.0001	0.6933	<.0001	<.0001	0.0066
20	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
21	0.5500	0.0005	<.0001	<.0001	0.4792	<.0001	<.0001
22	<.0001	<.0001	<.0001	<.0001	<.0001	0.0185	<.0001
23	<.0001	<.0001	<.0001	<.0001	<.0001	0.0172	<.0001
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
25	0.3430	0.0015	<.0001	<.0001	0.2902	<.0001	<.0001
26	<.0001	<.0001	<.0001	<.0001	<.0001	0.0437	<.0001
27	<.0001	<.0001	<.0001	0.0028	<.0001	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29	0.3220	0.0017	<.0001	<.0001	0.2715	<.0001	<.0001
30	<.0001	<.0001	<.0001	<.0001	<.0001	0.1083	<.0001
31	<.0001	<.0001	<.0001	1.0000	<.0001	<.0001	0.0020
32	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
33	0.4149	0.0010	<.0001	<.0001	0.3549	<.0001	<.0001
34	<.0001	<.0001	<.0001	<.0001	<.0001	0.0679	<.0001
35	<.0001	<.0001	<.0001	0.0046	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	0.2141	0.0037	<.0001	<.0001	0.1766	<.0001	<.0001
38	<.0001	<.0001	<.0001	<.0001	<.0001	0.0810	<.0001
39	<.0001	<.0001	<.0001	<.0001	<.0001	0.0396	<.0001
40	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
41	0.2203	0.0035	<.0001	<.0001	0.1820	<.0001	<.0001
42	<.0001	<.0001	<.0001	<.0001	<.0001	0.2660	<.0001
43	<.0001	<.0001	<.0001	0.0400	<.0001	<.0001	0.2779
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	0.2751	0.0023	<.0001	<.0001	0.2299	<.0001	<.0001
46	<.0001	<.0001	0.0002	<.0001	<.0001	0.0004	<.0001
47	<.0001	<.0001	<.0001	<.0001	<.0001	0.0165	<.0001
48	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0021

Dependent Variable: Glucose

i/j	8	9	10	11	12	13	14
1	<.0001	0.2501	<.0001	<.0001	<.0001	0.2892	<.0001
2	<.0001	0.0028	0.0238	<.0001	<.0001	0.0021	<.0001
3	<.0001	<.0001	0.8386	<.0001	<.0001	<.0001	0.0021
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	0.2080	<.0001	<.0001	<.0001	0.2424	<.0001
6	<.0001	<.0001	<.0001	0.0016	<.0001	<.0001	<.0001
7	<.0001	<.0001	<.0001	<.0001	0.1586	<.0001	<.0001
8		<.0001	<.0001	<.0001	0.0023	<.0001	<.0001
9	<.0001		<.0001	<.0001	<.0001	0.9273	<.0001
10	<.0001	<.0001		<.0001	<.0001	<.0001	0.0011
11	<.0001	<.0001	<.0001		<.0001	<.0001	0.2678
12	0.0023	<.0001	<.0001	<.0001		<.0001	<.0001
13	<.0001	0.9273	<.0001	<.0001	<.0001		<.0001
14	<.0001	<.0001	0.0011	0.2678	<.0001	<.0001	
15	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001	<.0001
16	0.1746	<.0001	<.0001	<.0001	0.0810	<.0001	<.0001
17	<.0001	0.2883	<.0001	<.0001	<.0001	0.2492	<.0001
18	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001
19	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
20	0.3517	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
21	<.0001	0.5786	<.0001	<.0001	<.0001	0.6424	<.0001
22	<.0001	<.0001	<.0001	0.3958	<.0001	<.0001	0.0520
23	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
24	0.5044	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001
25	<.0001	0.8386	<.0001	<.0001	<.0001	0.9105	<.0001
26	<.0001	<.0001	<.0001	0.2308	<.0001	<.0001	0.0224
27	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
28	0.0689	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29	<.0001	0.8719	<.0001	<.0001	<.0001	0.9442	<.0001
30	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
31	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
32	0.2012	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
33	<.0001	0.7359	<.0001	<.0001	<.0001	0.8056	<.0001
34	<.0001	<.0001	<.0001	0.1636	<.0001	<.0001	0.0134
35	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
36	0.0711	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	<.0001	0.9256	<.0001	<.0001	<.0001	0.8536	<.0001
38	<.0001	<.0001	<.0001	0.1403	<.0001	<.0001	0.0108
39	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
40	0.6094	<.0001	<.0001	<.0001	0.0004	<.0001	<.0001
41	<.0001	0.9391	<.0001	<.0001	<.0001	0.8669	<.0001
42	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
43	<.0001	<.0001	<.0001	<.0001	0.0137	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	<.0001	0.9526	<.0001	<.0001	<.0001	0.9746	<.0001
46	<.0001	<.0001	<.0001	0.6901	<.0001	<.0001	0.4765
47	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
48	0.1693	<.0001	<.0001	<.0001	0.0840	<.0001	<.0001

Dependent Variable: Glucose

i/j	15	16	17	18	19	20	21
1	<.0001	<.0001	0.0284	<.0001	<.0001	<.0001	0.5500
2	<.0001	<.0001	0.0479	<.0001	<.0001	<.0001	0.0005
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	0.6933	<.0001	<.0001
5	<.0001	<.0001	0.0216	<.0001	<.0001	<.0001	0.4792
6	0.4234	<.0001	<.0001	0.6035	<.0001	<.0001	<.0001
7	<.0001	0.0020	<.0001	<.0001	0.0066	<.0001	<.0001
8	<.0001	0.1746	<.0001	<.0001	<.0001	0.3517	<.0001
9	<.0001	<.0001	0.2883	<.0001	<.0001	<.0001	0.5786
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	0.0001	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001
12	<.0001	0.0810	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	0.2492	<.0001	<.0001	<.0001	0.6424
14	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
15		<.0001	<.0001	0.7779	<.0001	<.0001	<.0001
16	<.0001		<.0001	<.0001	<.0001	0.0234	<.0001
17	<.0001	<.0001		<.0001	<.0001	<.0001	0.1074
18	0.7779	<.0001	<.0001		<.0001	<.0001	<.0001
19	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
20	<.0001	0.0234	<.0001	<.0001	<.0001		<.0001
21	<.0001	<.0001	0.1074	<.0001	<.0001	<.0001	
22	0.0019	<.0001	<.0001	0.0044	<.0001	<.0001	<.0001
23	0.1083	<.0001	<.0001	0.0599	<.0001	<.0001	<.0001
24	<.0001	0.0443	<.0001	<.0001	<.0001	0.7909	<.0001
25	<.0001	<.0001	0.2064	<.0001	<.0001	<.0001	0.7248
26	0.0054	<.0001	<.0001	0.0119	<.0001	<.0001	<.0001
27	<.0001	<.0001	<.0001	<.0001	0.0008	<.0001	<.0001
28	<.0001	0.0018	<.0001	<.0001	<.0001	0.3683	<.0001
29	<.0001	<.0001	0.2219	<.0001	<.0001	<.0001	0.6933
30	0.4161	<.0001	<.0001	0.2742	<.0001	<.0001	<.0001
31	<.0001	<.0001	<.0001	<.0001	0.6933	<.0001	<.0001
32	<.0001	0.0093	<.0001	<.0001	<.0001	0.7264	<.0001
33	<.0001	<.0001	0.1630	<.0001	<.0001	<.0001	0.8270
34	0.0094	<.0001	<.0001	0.0199	<.0001	<.0001	<.0001
35	<.0001	<.0001	<.0001	<.0001	0.0014	<.0001	<.0001
36	<.0001	0.0019	<.0001	<.0001	<.0001	0.3762	<.0001
37	<.0001	<.0001	0.3324	<.0001	<.0001	<.0001	0.5167
38	0.0118	<.0001	<.0001	0.0245	<.0001	<.0001	<.0001
39	0.2027	<.0001	<.0001	0.1208	<.0001	<.0001	<.0001
40	<.0001	0.0631	<.0001	<.0001	<.0001	0.6730	<.0001
41	<.0001	<.0001	0.3241	<.0001	<.0001	<.0001	0.5277
42	0.7536	<.0001	<.0001	0.5514	<.0001	<.0001	<.0001
43	<.0001	<.0001	<.0001	<.0001	0.0949	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	0.0020	<.0001
45	<.0001	<.0001	0.2624	<.0001	<.0001	<.0001	0.6198
46	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
47	0.1052	<.0001	<.0001	0.0580	<.0001	<.0001	<.0001
48	<.0001	0.9865	<.0001	<.0001	<.0001	0.0224	<.0001

Dependent Variable: Glucose

i/j	22	23	24	25	26	27	28
1	<.0001	<.0001	<.0001	0.3430	<.0001	<.0001	<.0001
2	<.0001	<.0001	<.0001	0.0015	<.0001	<.0001	<.0001
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001	0.0028	<.0001
5	<.0001	<.0001	<.0001	0.2902	<.0001	<.0001	<.0001
6	0.0185	0.0172	<.0001	<.0001	0.0437	<.0001	<.0001
7	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
8	<.0001	<.0001	0.5044	<.0001	<.0001	<.0001	0.0689
9	<.0001	<.0001	<.0001	0.8386	<.0001	<.0001	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	0.3958	<.0001	<.0001	<.0001	0.2308	<.0001	<.0001
12	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	<.0001	0.9105	<.0001	<.0001	<.0001
14	0.0520	<.0001	<.0001	<.0001	0.0224	<.0001	<.0001
15	0.0019	0.1083	<.0001	<.0001	0.0054	<.0001	<.0001
16	<.0001	<.0001	0.0443	<.0001	<.0001	<.0001	0.0018
17	<.0001	<.0001	<.0001	0.2064	<.0001	<.0001	<.0001
18	0.0044	0.0599	<.0001	<.0001	0.0119	<.0001	<.0001
19	<.0001	<.0001	<.0001	<.0001	<.0001	0.0008	<.0001
20	<.0001	<.0001	0.7909	<.0001	<.0001	<.0001	0.3683
21	<.0001	<.0001	<.0001	0.7248	<.0001	<.0001	<.0001
22		<.0001	<.0001	<.0001	0.7248	<.0001	<.0001
23	<.0001		<.0001	<.0001	<.0001	0.0106	<.0001
24	<.0001	<.0001		<.0001	<.0001	<.0001	0.2449
25	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
26	0.7248	<.0001	<.0001	<.0001		<.0001	<.0001
27	<.0001	0.0106	<.0001	<.0001	<.0001		<.0001
28	<.0001	<.0001	0.2449	<.0001	<.0001	<.0001	
29	<.0001	<.0001	<.0001	0.9662	<.0001	<.0001	<.0001
30	0.0001	0.4234	<.0001	<.0001	0.0004	0.0009	<.0001
31	<.0001	<.0001	<.0001	<.0001	<.0001	0.0028	<.0001
32	<.0001	<.0001	0.5388	<.0001	<.0001	<.0001	0.5815
33	<.0001	<.0001	<.0001	0.8937	<.0001	<.0001	<.0001
34	0.5830	<.0001	<.0001	<.0001	0.8436	<.0001	<.0001
35	<.0001	0.0067	<.0001	<.0001	<.0001	0.8686	<.0001
36	<.0001	<.0001	0.2510	<.0001	<.0001	<.0001	0.9882
37	<.0001	<.0001	<.0001	0.7665	<.0001	<.0001	<.0001
38	0.5277	<.0001	<.0001	<.0001	0.7795	<.0001	<.0001
39	<.0001	0.7359	<.0001	<.0001	<.0001	0.0040	<.0001
40	<.0001	<.0001	0.8753	<.0001	<.0001	<.0001	0.1876
41	<.0001	<.0001	<.0001	0.7795	<.0001	<.0001	<.0001
42	0.0007	0.1947	<.0001	<.0001	0.0021	0.0002	<.0001
43	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	0.0009	<.0001	<.0001	<.0001	0.0255
45	<.0001	<.0001	<.0001	0.8853	<.0001	<.0001	<.0001
46	0.2133	<.0001	<.0001	<.0001	0.1116	<.0001	<.0001
47	<.0001	0.9882	<.0001	<.0001	<.0001	0.0110	<.0001
48	<.0001	<.0001	0.0426	<.0001	<.0001	<.0001	0.0017

Dependent Variable: Glucose

i/j	29	30	31	32	33	34	35
1	0.3220	<.0001	<.0001	<.0001	0.4149	<.0001	<.0001
2	0.0017	<.0001	<.0001	<.0001	0.0010	<.0001	<.0001
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001	0.0046
5	0.2715	<.0001	<.0001	<.0001	0.3549	<.0001	<.0001
6	<.0001	0.1083	<.0001	<.0001	<.0001	0.0679	<.0001
7	<.0001	<.0001	0.0020	<.0001	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	0.2012	<.0001	<.0001	<.0001
9	0.8719	<.0001	<.0001	<.0001	0.7359	<.0001	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	0.1636	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.9442	<.0001	<.0001	<.0001	0.8056	<.0001	<.0001
14	<.0001	<.0001	<.0001	<.0001	<.0001	0.0134	<.0001
15	<.0001	0.4161	<.0001	<.0001	<.0001	0.0094	<.0001
16	<.0001	<.0001	<.0001	0.0093	<.0001	<.0001	<.0001
17	0.2219	<.0001	<.0001	<.0001	0.1630	<.0001	<.0001
18	<.0001	0.2742	<.0001	<.0001	<.0001	0.0199	<.0001
19	<.0001	<.0001	0.6933	<.0001	<.0001	<.0001	0.0014
20	<.0001	<.0001	<.0001	0.7264	<.0001	<.0001	<.0001
21	0.6933	<.0001	<.0001	<.0001	0.8270	<.0001	<.0001
22	<.0001	0.0001	<.0001	<.0001	<.0001	0.5830	<.0001
23	<.0001	0.4234	<.0001	<.0001	<.0001	<.0001	0.0067
24	<.0001	<.0001	<.0001	0.5388	<.0001	<.0001	<.0001
25	0.9662	<.0001	<.0001	<.0001	0.8937	<.0001	<.0001
26	<.0001	0.0004	<.0001	<.0001	<.0001	0.8436	<.0001
27	<.0001	0.0009	0.0028	<.0001	<.0001	<.0001	0.8686
28	<.0001	<.0001	<.0001	0.5815	<.0001	<.0001	<.0001
29		<.0001	<.0001	<.0001	0.8602	<.0001	<.0001
30	<.0001		<.0001	<.0001	<.0001	0.0008	0.0005
31	<.0001	<.0001		<.0001	<.0001	<.0001	0.0046
32	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
33	0.8602	<.0001	<.0001	<.0001		<.0001	<.0001
34	<.0001	0.0008	<.0001	<.0001	<.0001		<.0001
35	<.0001	0.0005	0.0046	<.0001	<.0001	<.0001	
36	<.0001	<.0001	<.0001	0.5917	<.0001	<.0001	<.0001
37	0.7991	<.0001	<.0001	<.0001	0.6669	<.0001	<.0001
38	<.0001	0.0010	<.0001	<.0001	<.0001	0.9341	<.0001
39	<.0001	0.6424	<.0001	<.0001	<.0001	0.0002	0.0024
40	<.0001	<.0001	<.0001	0.4407	<.0001	<.0001	<.0001
41	0.8122	<.0001	<.0001	<.0001	0.6792	<.0001	<.0001
42	<.0001	0.6168	<.0001	<.0001	<.0001	0.0038	<.0001
43	<.0001	<.0001	0.0400	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	0.0058	<.0001	<.0001	<.0001
45	0.9189	<.0001	<.0001	<.0001	0.7811	<.0001	<.0001
46	<.0001	<.0001	<.0001	<.0001	<.0001	0.0744	<.0001
47	<.0001	0.4149	<.0001	<.0001	<.0001	<.0001	0.0069
48	<.0001	<.0001	<.0001	0.0089	<.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	36	37	38	39	40	41	42
1	<.0001	0.2141	<.0001	<.0001	<.0001	0.2203	<.0001
2	<.0001	0.0037	<.0001	<.0001	<.0001	0.0035	<.0001
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	0.1766	<.0001	<.0001	<.0001	0.1820	<.0001
6	<.0001	<.0001	0.0810	0.0396	<.0001	<.0001	0.2660
7	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
8	0.0711	<.0001	<.0001	<.0001	0.6094	<.0001	<.0001
9	<.0001	0.9256	<.0001	<.0001	<.0001	0.9391	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	0.1403	<.0001	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	0.0004	<.0001	<.0001
13	<.0001	0.8536	<.0001	<.0001	<.0001	0.8669	<.0001
14	<.0001	<.0001	0.0108	<.0001	<.0001	<.0001	<.0001
15	<.0001	<.0001	0.0118	0.2027	<.0001	<.0001	0.7536
16	0.0019	<.0001	<.0001	<.0001	0.0631	<.0001	<.0001
17	<.0001	0.3324	<.0001	<.0001	<.0001	0.3241	<.0001
18	<.0001	<.0001	0.0245	0.1208	<.0001	<.0001	0.5514
19	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
20	0.3762	<.0001	<.0001	<.0001	0.6730	<.0001	<.0001
21	<.0001	0.5167	<.0001	<.0001	<.0001	0.5277	<.0001
22	<.0001	<.0001	0.5277	<.0001	<.0001	<.0001	0.0007
23	<.0001	<.0001	<.0001	0.7359	<.0001	<.0001	0.1947
24	0.2510	<.0001	<.0001	<.0001	0.8753	<.0001	<.0001
25	<.0001	0.7665	<.0001	<.0001	<.0001	0.7795	<.0001
26	<.0001	<.0001	0.7795	<.0001	<.0001	<.0001	0.0021
27	<.0001	<.0001	<.0001	0.0040	<.0001	<.0001	0.0002
28	0.9882	<.0001	<.0001	<.0001	0.1876	<.0001	<.0001
29	<.0001	0.7991	<.0001	<.0001	<.0001	0.8122	<.0001
30	<.0001	<.0001	0.0010	0.6424	<.0001	<.0001	0.6168
31	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
32	0.5917	<.0001	<.0001	<.0001	0.4407	<.0001	<.0001
33	<.0001	0.6669	<.0001	<.0001	<.0001	0.6792	<.0001
34	<.0001	<.0001	0.9341	0.0002	<.0001	<.0001	0.0038
35	<.0001	<.0001	<.0001	0.0024	<.0001	<.0001	<.0001
36		<.0001	<.0001	<.0001	0.1925	<.0001	<.0001
37	<.0001		<.0001	<.0001	<.0001	0.9865	<.0001
38	<.0001	<.0001		0.0002	<.0001	<.0001	0.0049
39	<.0001	<.0001	0.0002		<.0001	<.0001	0.3356
40	0.1925	<.0001	<.0001	<.0001		<.0001	<.0001
41	<.0001	0.9865	<.0001	<.0001	<.0001		<.0001
42	<.0001	<.0001	0.0049	0.3356	<.0001	<.0001	
43	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
44	0.0245	<.0001	<.0001	<.0001	0.0005	<.0001	<.0001
45	<.0001	0.8786	<.0001	<.0001	<.0001	0.8920	<.0001
46	<.0001	<.0001	0.0622	<.0001	<.0001	<.0001	<.0001
47	<.0001	<.0001	<.0001	0.7248	<.0001	<.0001	0.1897
48	0.0018	<.0001	<.0001	<.0001	0.0608	<.0001	<.0001

Dependent Variable: Glucose

i/j	43	44	45	46	47	48
1	<.0001	<.0001	0.2751	<.0001	<.0001	<.0001
2	<.0001	<.0001	0.0023	<.0001	<.0001	<.0001
3	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001
4	0.0400	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	<.0001	0.2299	<.0001	<.0001	<.0001
6	<.0001	<.0001	<.0001	0.0004	0.0165	<.0001
7	0.2779	<.0001	<.0001	<.0001	<.0001	0.0021
8	<.0001	<.0001	<.0001	<.0001	<.0001	0.1693
9	<.0001	<.0001	0.9526	<.0001	<.0001	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	0.6901	<.0001	<.0001
12	0.0137	<.0001	<.0001	<.0001	<.0001	0.0840
13	<.0001	<.0001	0.9746	<.0001	<.0001	<.0001
14	<.0001	<.0001	<.0001	0.4765	<.0001	<.0001
15	<.0001	<.0001	<.0001	<.0001	0.1052	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	0.9865
17	<.0001	<.0001	0.2624	<.0001	<.0001	<.0001
18	<.0001	<.0001	<.0001	<.0001	0.0580	<.0001
19	0.0949	<.0001	<.0001	<.0001	<.0001	<.0001
20	<.0001	0.0020	<.0001	<.0001	<.0001	0.0224
21	<.0001	<.0001	0.6198	<.0001	<.0001	<.0001
22	<.0001	<.0001	<.0001	0.2133	<.0001	<.0001
23	<.0001	<.0001	<.0001	<.0001	0.9882	<.0001
24	<.0001	0.0009	<.0001	<.0001	<.0001	0.0426
25	<.0001	<.0001	0.8853	<.0001	<.0001	<.0001
26	<.0001	<.0001	<.0001	0.1116	<.0001	<.0001
27	<.0001	<.0001	<.0001	<.0001	0.0110	<.0001
28	<.0001	0.0255	<.0001	<.0001	<.0001	0.0017
29	<.0001	<.0001	0.9189	<.0001	<.0001	<.0001
30	<.0001	<.0001	<.0001	<.0001	0.4149	<.0001
31	0.0400	<.0001	<.0001	<.0001	<.0001	<.0001
32	<.0001	0.0058	<.0001	<.0001	<.0001	0.0089
33	<.0001	<.0001	0.7811	<.0001	<.0001	<.0001
34	<.0001	<.0001	<.0001	0.0744	<.0001	<.0001
35	<.0001	<.0001	<.0001	<.0001	0.0069	<.0001
36	<.0001	0.0245	<.0001	<.0001	<.0001	0.0018
37	<.0001	<.0001	0.8786	<.0001	<.0001	<.0001
38	<.0001	<.0001	<.0001	0.0622	<.0001	<.0001
39	<.0001	<.0001	<.0001	<.0001	0.7248	<.0001
40	<.0001	0.0005	<.0001	<.0001	<.0001	0.0608
41	<.0001	<.0001	0.8920	<.0001	<.0001	<.0001
42	<.0001	<.0001	<.0001	<.0001	0.1897	<.0001
43		<.0001	<.0001	<.0001	<.0001	<.0001
44	<.0001		<.0001	<.0001	<.0001	<.0001
45	<.0001	<.0001		<.0001	<.0001	<.0001
46	<.0001	<.0001	<.0001		<.0001	<.0001
47	<.0001	<.0001	<.0001	<.0001		<.0001
48	<.0001	<.0001	<.0001	<.0001	<.0001	

Appendix B.2 Fresh ISP

```
title 'Saccharification on Fresh FTA-94 ISP: Sugars and Change in Starch';
data Saccharification032008;
input Prep$ Enz$ Load Hour Rep DeltaAIS Maltotriose Maltose Glucose;
datalines;

Fresh  Fuel   0      0      1      51.9   33.8   287.7  0
Fresh  Fuel   0      0      2      53.6   29.1   297.1  0
Fresh  Fuel   0      0      3      54.6   33     303.4  0
Fresh  Fuel   0.5    0      1      53.9   0      286.9  81.7
Fresh  Fuel   0.5    0      2      53.6   15.7   296.3  65.2
Fresh  Fuel   0.5    0      3      53.2   13.4   277.5  64.5
Fresh  Fuel   1      0      1      53.2   0      246    139.1
Fresh  Fuel   1      0      2      53.2   0      256.2  130.5
Fresh  Fuel   1      0      3      54.6   21.2   274.3  40.1
Fresh  Fuel   5      0      1      54.9   0      37.7   403.2
Fresh  Fuel   5      0      2      54.9   0      54.2   379.6
Fresh  Fuel   5      0      3      53.6   0      48.7   371
Fresh  Fuel   0      24     1      55.9   37.6   313.3  16
Fresh  Fuel   0      24     2      56.6   36     299.8  15.2
Fresh  Fuel   0      24     3      56.9   37.6   317.3  18.4
Fresh  Fuel   0.5    24     1      56.6   10.4   295.8  135.9
Fresh  Fuel   0.5    24     2      56.6   16     268.6  78.3
Fresh  Fuel   0.5    24     3      56.6   15.2   302.1  111.1
Fresh  Fuel   1      24     1      56.2   0      224.6  165.5
Fresh  Fuel   1      24     2      55.9   10.4   257.4  157.5
Fresh  Fuel   1      24     3      56.2   24     279    140.7
Fresh  Fuel   5      24     1      56.9   0      114.3  384.5
Fresh  Fuel   5      24     2      55.9   9.6    150.3  285.4
Fresh  Fuel   5      24     3      55.9   0      87.9   386.9
Fresh  Fuel   0      48     1      54.6   39.2   378.1  23.2
Fresh  Fuel   0      48     2      56.2   39.2   370.9  24
Fresh  Fuel   0      48     3      55.9   38.4   366.9  22.4
Fresh  Fuel   0.5    48     1      55.2   12.8   327.7  118.3
Fresh  Fuel   0.5    48     2      55.6   12.8   322.9  121.5
Fresh  Fuel   0.5    48     3      56.2   8      287.8  118.3
Fresh  Fuel   1      48     1      56.2   25.6   368.5  81.5
Fresh  Fuel   1      48     2      56.6   18.4   374.1  127.1
Fresh  Fuel   1      48     3      56.6   12     323.7  139.1
Fresh  Fuel   5      48     1      56.2   13.6   211.8  310.1
Fresh  Fuel   5      48     2      56.2   8      165.5  402.1
Fresh  Fuel   5      48     3      55.9   0      129.5  416.5
Fresh  Fuel   0      72     1      56.6   41.6   362.1  24
Fresh  Fuel   0      72     2      56.2   42.4   378.1  25.6
Fresh  Fuel   0      72     3      55.9   40.8   366.9  24
Fresh  Fuel   0.5    72     1      56.2   19.2   329.3  97.5
Fresh  Fuel   0.5    72     2      56.2   12     311.7  109.5
Fresh  Fuel   0.5    72     3      56.6   16.8   352.5  127.1
Fresh  Fuel   1      72     1      56.2   15.2   275.8  151.9
Fresh  Fuel   1      72     2      56.6   12.8   294.2  168.7
Fresh  Fuel   1      72     3      56.6   12.8   272.6  134.3
Fresh  Fuel   5      72     1      56.6   17.6   177.5  259.8
Fresh  Fuel   5      72     2      56.9   13.6   172.7  312.5
Fresh  Fuel   5      72     3      56.9   8.8    148.7  334.9
Fresh  Tech   0      0      1      54.1   33.8   274.3  0
Fresh  Tech   0      0      2      53.8   25.9   250.7  0
Fresh  Tech   0      0      3      56.1   29.1   264.1  8.6
```

Fresh	Tech	0.5	0	1	56.4	0	193.4	191
Fresh	Tech	0.5	0	2	56.8	0	229.5	150.9
Fresh	Tech	0.5	0	3	54.1	0	228.7	90.4
Fresh	Tech	1	0	1	56.4	0	40.9	362.3
Fresh	Tech	1	0	2	54.4	0	168.2	169.8
Fresh	Tech	1	0	3	54.8	0	178.4	168.2
Fresh	Tech	5	0	1	54.4	0	0	391.4
Fresh	Tech	5	0	2	56.1	0	0	385.9
Fresh	Tech	5	0	3	56.8	0	0	418.2
Fresh	Tech	0	24	1	60.4	35.2	299	63.1
Fresh	Tech	0	24	2	61.1	34.4	293.4	31.2
Fresh	Tech	0	24	3	60.8	33.6	283	48
Fresh	Tech	0.5	24	1	60.4	7.2	223.8	220.6
Fresh	Tech	0.5	24	2	59.8	11.2	218.2	165.5
Fresh	Tech	0.5	24	3	60.4	12	223	165.5
Fresh	Tech	1	24	1	60.1	0	111.9	230.2
Fresh	Tech	1	24	2	60.8	12.8	208.6	208.6
Fresh	Tech	1	24	3	60.4	8	180.6	256.6
Fresh	Tech	5	24	1	61.1	0	95.9	314.9
Fresh	Tech	5	24	2	61.1	0	129.5	307.7
Fresh	Tech	5	24	3	61.1	0	131.1	302.9
Fresh	Tech	0	48	1	61.1	34.4	335.7	47.2
Fresh	Tech	0	48	2	60.8	30.4	302.1	41.6
Fresh	Tech	0	48	3	60.4	28.8	326.9	38.4
Fresh	Tech	0.5	48	1	60.8	20	282.2	160.7
Fresh	Tech	0.5	48	2	61.1	12	232.6	189.4
Fresh	Tech	0.5	48	3	61.8	12	215.8	191
Fresh	Tech	1	48	1	60.8	11.2	200.6	236.6
Fresh	Tech	1	48	2	60.4	8	191	316.5
Fresh	Tech	1	48	3	60.8	10.4	173.5	304.5
Fresh	Tech	5	48	1	62.1	8	151.1	249.4
Fresh	Tech	5	48	2	61.4	0	136.7	334.9
Fresh	Tech	5	48	3	61.4	0	119.1	324.5
Fresh	Tech	0	72	1	61.1	40.8	332.5	44.8
Fresh	Tech	0	72	2	61.4	40	324.5	35.2
Fresh	Tech	0	72	3	61.1	41.6	337.3	34.4
Fresh	Tech	0.5	72	1	61.8	31.2	311.7	98.3
Fresh	Tech	0.5	72	2	60.8	24	301.3	103.1
Fresh	Tech	0.5	72	3	61.8	19.2	278.2	113.5
Fresh	Tech	1	72	1	61.8	18.4	237.4	193.4
Fresh	Tech	1	72	2	60.8	12.8	222.2	173.5
Fresh	Tech	1	72	3	61.1	12.8	178.3	224.6
Fresh	Tech	5	72	1	61.4	7.2	131.9	296.6
Fresh	Tech	5	72	2	62.1	10.4	162.3	342.9
Fresh	Tech	5	72	3	61.8	7.2	120.7	344.5
Fresh	Ultra	0	0	1	54.8	25.9	309.7	0
Fresh	Ultra	0	0	2	.	23.6	296.3	0
Fresh	Ultra	0	0	3	54.4	27.5	332.5	0
Fresh	Ultra	0.5	0	1	55.1	0	264.1	177.6
Fresh	Ultra	0.5	0	2	54.1	0	216.2	206.7
Fresh	Ultra	0.5	0	3	55.1	0	188.6	201.2
Fresh	Ultra	1	0	1	56.4	0	181.6	284.5
Fresh	Ultra	1	0	2	55.1	0	33	360
Fresh	Ultra	1	0	3	55.4	0	117.1	318.3
Fresh	Ultra	5	0	1	55.1	0	0	524.3
Fresh	Ultra	5	0	2	54.4	0	0	512.5
Fresh	Ultra	5	0	3	55.4	0	0	488.9
Fresh	Ultra	0	24	1	58.1	32	355.6	16.4
Fresh	Ultra	0	24	2	58.1	32	345.8	17.2

```
Fresh  Ultra  0      24     3      58.4   29.5   331    14.7
Fresh  Ultra  0.5    24     1      58.4   18.8   331    104.9
Fresh  Ultra  0.5    24     2      58.8   18     324.5  100.8
Fresh  Ultra  0.5    24     3      59.1   23.8   347.4  87.7
Fresh  Ultra  1      24     1      58.1   14.7   310.5  156.5
Fresh  Ultra  1      24     2      58.1   16.4   312.2  145.8
Fresh  Ultra  1      24     3      58.1   18     326.1  129.5
Fresh  Ultra  5      24     1      57.8   10.7   172.9  313
Fresh  Ultra  5      24     2      59.1   9.8    167.1  326.9
Fresh  Ultra  5      24     3      57.4   13.1   189.3  311.3
Fresh  Ultra  0      48     1      59.4   39.3   390    23.8
Fresh  Ultra  0      48     2      59.4   36.9   376.9  23.8
Fresh  Ultra  0      48     3      59.8   36.9   379.4  22.1
Fresh  Ultra  0.5    48     1      59.4   27.9   370.3  68.8
Fresh  Ultra  0.5    48     2      60.1   30.3   382.6  72.1
Fresh  Ultra  0.5    48     3      60.1   23.8   355.6  103.2
Fresh  Ultra  1      48     1      60.1   28.7   385.9  109.8
Fresh  Ultra  1      48     2      60.4   27     399    132.7
Fresh  Ultra  1      48     3      59.8   21.3   317.9  136
Fresh  Ultra  5      48     1      59.8   14.7   231.1  281.9
Fresh  Ultra  5      48     2      59.1   16.4   266.3  327.7
Fresh  Ultra  5      48     3      59.8   16.4   244.2  257.3
Fresh  Ultra  0      72     1      58.8   37.7   376.1  25.4
Fresh  Ultra  0      72     2      59.4   36.9   369.5  22.9
Fresh  Ultra  0      72     3      59.8   38.5   391.6  24.6
Fresh  Ultra  0.5    72     1      58.1   28.7   386.7  77.8
Fresh  Ultra  0.5    72     2      59.4   29.5   369.5  72.9
Fresh  Ultra  0.5    72     3      60.1   27.9   375.3  90.1
Fresh  Ultra  1      72     1      59.4   23.8   347.4  124.5
Fresh  Ultra  1      72     2      59.8   25.4   365.4  125.4
Fresh  Ultra  1      72     3      59.8   19.7   326.1  145.0
Fresh  Ultra  5      72     1      60.1   26.2   340.0  231.9
Fresh  Ultra  5      72     2      59.4   20.5   280.2  291.7
Fresh  Ultra  5      72     3      59.8   15.6   239.2  273.7
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
       class Hour Enz Load;
       model DeltaAIS Maltotriose Maltose Glucose = Hour Enz Load Hour*Enz
Hour*Load Enz*Load Hour*Enz*Load ;
       lsmeans Hour Enz Load Hour*Enz Hour*Load Enz*Load Hour*Enz*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Saccharification on Fresh FTA-94 ISP: Sugars and Change in Starch

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
1	Fresh	Fuel	0.0	0	1	51.9	33.8	287.7	0.0
2	Fresh	Fuel	0.0	0	2	53.6	29.1	297.1	0.0
3	Fresh	Fuel	0.0	0	3	54.6	33.0	303.4	0.0
4	Fresh	Fuel	0.5	0	1	53.9	0.0	286.9	81.7
5	Fresh	Fuel	0.5	0	2	53.6	15.7	296.3	65.2
6	Fresh	Fuel	0.5	0	3	53.2	13.4	277.5	64.5
7	Fresh	Fuel	1.0	0	1	53.2	0.0	246.0	139.1
8	Fresh	Fuel	1.0	0	2	53.2	0.0	256.2	130.5
9	Fresh	Fuel	1.0	0	3	54.6	21.2	274.3	40.1
10	Fresh	Fuel	5.0	0	1	54.9	0.0	37.7	403.2
11	Fresh	Fuel	5.0	0	2	54.9	0.0	54.2	379.6
12	Fresh	Fuel	5.0	0	3	53.6	0.0	48.7	371.0
13	Fresh	Fuel	0.0	24	1	55.9	37.6	313.3	16.0
14	Fresh	Fuel	0.0	24	2	56.6	36.0	299.8	15.2
15	Fresh	Fuel	0.0	24	3	56.9	37.6	317.3	18.4
16	Fresh	Fuel	0.5	24	1	56.6	10.4	295.8	135.9
17	Fresh	Fuel	0.5	24	2	56.6	16.0	268.6	78.3
18	Fresh	Fuel	0.5	24	3	56.6	15.2	302.1	111.1
19	Fresh	Fuel	1.0	24	1	56.2	0.0	224.6	165.5
20	Fresh	Fuel	1.0	24	2	55.9	10.4	257.4	157.5
21	Fresh	Fuel	1.0	24	3	56.2	24.0	279.0	140.7
22	Fresh	Fuel	5.0	24	1	56.9	0.0	114.3	384.5
23	Fresh	Fuel	5.0	24	2	55.9	9.6	150.3	285.4
24	Fresh	Fuel	5.0	24	3	55.9	0.0	87.9	386.9
25	Fresh	Fuel	0.0	48	1	54.6	39.2	378.1	23.2
26	Fresh	Fuel	0.0	48	2	56.2	39.2	370.9	24.0
27	Fresh	Fuel	0.0	48	3	55.9	38.4	366.9	22.4
28	Fresh	Fuel	0.5	48	1	55.2	12.8	327.7	118.3
29	Fresh	Fuel	0.5	48	2	55.6	12.8	322.9	121.5
30	Fresh	Fuel	0.5	48	3	56.2	8.0	287.8	118.3
31	Fresh	Fuel	1.0	48	1	56.2	25.6	368.5	81.5
32	Fresh	Fuel	1.0	48	2	56.6	18.4	374.1	127.1
33	Fresh	Fuel	1.0	48	3	56.6	12.0	323.7	139.1
34	Fresh	Fuel	5.0	48	1	56.2	13.6	211.8	310.1
35	Fresh	Fuel	5.0	48	2	56.2	8.0	165.5	402.1
36	Fresh	Fuel	5.0	48	3	55.9	0.0	129.5	416.5
37	Fresh	Fuel	0.0	72	1	56.6	41.6	362.1	24.0
38	Fresh	Fuel	0.0	72	2	56.2	42.4	378.1	25.6
39	Fresh	Fuel	0.0	72	3	55.9	40.8	366.9	24.0
40	Fresh	Fuel	0.5	72	1	56.2	19.2	329.3	97.5
41	Fresh	Fuel	0.5	72	2	56.2	12.0	311.7	109.5
42	Fresh	Fuel	0.5	72	3	56.6	16.8	352.5	127.1
43	Fresh	Fuel	1.0	72	1	56.2	15.2	275.8	151.9
44	Fresh	Fuel	1.0	72	2	56.6	12.8	294.2	168.7
45	Fresh	Fuel	1.0	72	3	56.6	12.8	272.6	134.3
46	Fresh	Fuel	5.0	72	1	56.6	17.6	177.5	259.8
47	Fresh	Fuel	5.0	72	2	56.9	13.6	172.7	312.5
48	Fresh	Fuel	5.0	72	3	56.9	8.8	148.7	334.9

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
49	Fresh	Tech	0.0	0	1	54.1	33.8	274.3	0.0
50	Fresh	Tech	0.0	0	2	53.8	25.9	250.7	0.0
51	Fresh	Tech	0.0	0	3	56.1	29.1	264.1	8.6
52	Fresh	Tech	0.5	0	1	56.4	0.0	193.4	191.0
53	Fresh	Tech	0.5	0	2	56.8	0.0	229.5	150.9
54	Fresh	Tech	0.5	0	3	54.1	0.0	228.7	90.4
55	Fresh	Tech	1.0	0	1	56.4	0.0	40.9	362.3
56	Fresh	Tech	1.0	0	2	54.4	0.0	168.2	169.8
57	Fresh	Tech	1.0	0	3	54.8	0.0	178.4	168.2
58	Fresh	Tech	5.0	0	1	54.4	0.0	0.0	391.4
59	Fresh	Tech	5.0	0	2	56.1	0.0	0.0	385.9
60	Fresh	Tech	5.0	0	3	56.8	0.0	0.0	418.2
61	Fresh	Tech	0.0	24	1	60.4	35.2	299.0	63.1
62	Fresh	Tech	0.0	24	2	61.1	34.4	293.4	31.2
63	Fresh	Tech	0.0	24	3	60.8	33.6	283.0	48.0
64	Fresh	Tech	0.5	24	1	60.4	7.2	223.8	220.6
65	Fresh	Tech	0.5	24	2	59.8	11.2	218.2	165.5
66	Fresh	Tech	0.5	24	3	60.4	12.0	223.0	165.5
67	Fresh	Tech	1.0	24	1	60.1	0.0	111.9	230.2
68	Fresh	Tech	1.0	24	2	60.8	12.8	208.6	208.6
69	Fresh	Tech	1.0	24	3	60.4	8.0	180.6	256.6
70	Fresh	Tech	5.0	24	1	61.1	0.0	95.9	314.9
71	Fresh	Tech	5.0	24	2	61.1	0.0	129.5	307.7
72	Fresh	Tech	5.0	24	3	61.1	0.0	131.1	302.9
73	Fresh	Tech	0.0	48	1	61.1	34.4	335.7	47.2
74	Fresh	Tech	0.0	48	2	60.8	30.4	302.1	41.6
75	Fresh	Tech	0.0	48	3	60.4	28.8	326.9	38.4
76	Fresh	Tech	0.5	48	1	60.8	20.0	282.2	160.7
77	Fresh	Tech	0.5	48	2	61.1	12.0	232.6	189.4
78	Fresh	Tech	0.5	48	3	61.8	12.0	215.8	191.0
79	Fresh	Tech	1.0	48	1	60.8	11.2	200.6	236.6
80	Fresh	Tech	1.0	48	2	60.4	8.0	191.0	316.5
81	Fresh	Tech	1.0	48	3	60.8	10.4	173.5	304.5
82	Fresh	Tech	5.0	48	1	62.1	8.0	151.1	249.4
83	Fresh	Tech	5.0	48	2	61.4	0.0	136.7	334.9
84	Fresh	Tech	5.0	48	3	61.4	0.0	119.1	324.5
85	Fresh	Tech	0.0	72	1	61.1	40.8	332.5	44.8
86	Fresh	Tech	0.0	72	2	61.4	40.0	324.5	35.2
87	Fresh	Tech	0.0	72	3	61.1	41.6	337.3	34.4
88	Fresh	Tech	0.5	72	1	61.8	31.2	311.7	98.3
89	Fresh	Tech	0.5	72	2	60.8	24.0	301.3	103.1
90	Fresh	Tech	0.5	72	3	61.8	19.2	278.2	113.5
91	Fresh	Tech	1.0	72	1	61.8	18.4	237.4	193.4
92	Fresh	Tech	1.0	72	2	60.8	12.8	222.2	173.5
93	Fresh	Tech	1.0	72	3	61.1	12.8	178.3	224.6
94	Fresh	Tech	5.0	72	1	61.4	7.2	131.9	296.6
95	Fresh	Tech	5.0	72	2	62.1	10.4	162.3	342.9
96	Fresh	Tech	5.0	72	3	61.8	7.2	120.7	344.5
97	Fresh	Ultra	0.0	0	1	54.8	25.9	309.7	0.0
98	Fresh	Ultra	0.0	0	2	.	23.6	296.3	0.0
99	Fresh	Ultra	0.0	0	3	54.4	27.5	332.5	0.0

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
100	Fresh	Ultra	0.5	0	1	55.1	0.0	264.1	177.6
101	Fresh	Ultra	0.5	0	2	54.1	0.0	216.2	206.7
102	Fresh	Ultra	0.5	0	3	55.1	0.0	188.6	201.2
103	Fresh	Ultra	1.0	0	1	56.4	0.0	181.6	284.5
104	Fresh	Ultra	1.0	0	2	55.1	0.0	33.0	360.0
105	Fresh	Ultra	1.0	0	3	55.4	0.0	117.1	318.3
106	Fresh	Ultra	5.0	0	1	55.1	0.0	0.0	524.3
107	Fresh	Ultra	5.0	0	2	54.4	0.0	0.0	512.5
108	Fresh	Ultra	5.0	0	3	55.4	0.0	0.0	488.9
109	Fresh	Ultra	0.0	24	1	58.1	32.0	355.6	16.4
110	Fresh	Ultra	0.0	24	2	58.1	32.0	345.8	17.2
111	Fresh	Ultra	0.0	24	3	58.4	29.5	331.0	14.7
112	Fresh	Ultra	0.5	24	1	58.4	18.8	331.0	104.9
113	Fresh	Ultra	0.5	24	2	58.8	18.0	324.5	100.8
114	Fresh	Ultra	0.5	24	3	59.1	23.8	347.4	87.7
115	Fresh	Ultra	1.0	24	1	58.1	14.7	310.5	156.5
116	Fresh	Ultra	1.0	24	2	58.1	16.4	312.2	145.8
117	Fresh	Ultra	1.0	24	3	58.1	18.0	326.1	129.5
118	Fresh	Ultra	5.0	24	1	57.8	10.7	172.9	313.0
119	Fresh	Ultra	5.0	24	2	59.1	9.8	167.1	326.9
120	Fresh	Ultra	5.0	24	3	57.4	13.1	189.3	311.3
121	Fresh	Ultra	0.0	48	1	59.4	39.3	390.0	23.8
122	Fresh	Ultra	0.0	48	2	59.4	36.9	376.9	23.8
123	Fresh	Ultra	0.0	48	3	59.8	36.9	379.4	22.1
124	Fresh	Ultra	0.5	48	1	59.4	27.9	370.3	68.8
125	Fresh	Ultra	0.5	48	2	60.1	30.3	382.6	72.1
126	Fresh	Ultra	0.5	48	3	60.1	23.8	355.6	103.2
127	Fresh	Ultra	1.0	48	1	60.1	28.7	385.9	109.8
128	Fresh	Ultra	1.0	48	2	60.4	27.0	399.0	132.7
129	Fresh	Ultra	1.0	48	3	59.8	21.3	317.9	136.0
130	Fresh	Ultra	5.0	48	1	59.8	14.7	231.1	281.9
131	Fresh	Ultra	5.0	48	2	59.1	16.4	266.3	327.7
132	Fresh	Ultra	5.0	48	3	59.8	16.4	244.2	257.3
133	Fresh	Ultra	0.0	72	1	58.8	37.7	376.1	25.4
134	Fresh	Ultra	0.0	72	2	59.4	36.9	369.5	22.9
135	Fresh	Ultra	0.0	72	3	59.8	38.5	391.6	24.6
136	Fresh	Ultra	0.5	72	1	58.1	28.7	386.7	77.8
137	Fresh	Ultra	0.5	72	2	59.4	29.5	369.5	72.9
138	Fresh	Ultra	0.5	72	3	60.1	27.9	375.3	90.1
139	Fresh	Ultra	1.0	72	1	59.4	23.8	347.4	124.5
140	Fresh	Ultra	1.0	72	2	59.8	25.4	365.4	125.4
141	Fresh	Ultra	1.0	72	3	59.8	19.7	326.1	145.0
142	Fresh	Ultra	5.0	72	1	60.1	26.2	340.0	231.9
143	Fresh	Ultra	5.0	72	2	59.4	20.5	280.2	291.7
144	Fresh	Ultra	5.0	72	3	59.8	15.6	239.2	273.7

The GLM Procedure
Class Level Information

Class	Levels	Values
Hour	4	0 24 48 72
Enz	3	Fuel Tech Ultra
Load	4	0 0.5 1 5

Data for Analysis of DeltaAIS

Number of Observations Read	144
Number of Observations Used	143

Data for Analysis of Maltotriose
Maltose Glucose

Number of Observations Read	144
Number of Observations Used	144

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	919.6330536	19.5666607	54.12	<.0001
Error	95	34.3466667	0.3615439		
Corrected Total	142	953.9797203			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.963996	1.039984	0.601285	57.81678

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	457.9600298	152.6533433	422.23	<.0001
Enz	2	389.7705827	194.8852913	539.04	<.0001
Load	3	3.7277348	1.2425783	3.44	0.0200
Hour*Enz	6	57.0539397	9.5089899	26.30	<.0001
Hour*Load	9	2.9038777	0.3226531	0.89	0.5352
Enz*Load	6	2.9389875	0.4898312	1.35	0.2409
Hour*Enz*Load	18	5.2779014	0.2932167	0.81	0.6831

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	454.3218687	151.4406229	418.87	<.0001
Enz	2	389.4051382	194.7025691	538.53	<.0001
Load	3	3.8061336	1.2687112	3.51	0.0183
Hour*Enz	6	57.0690870	9.5115145	26.31	<.0001
Hour*Load	9	2.8293228	0.3143692	0.87	0.5552
Enz*Load	6	2.9419356	0.4903226	1.36	0.2403
Hour*Enz*Load	18	5.2779014	0.2932167	0.81	0.6831

Least Squares Means

Load	DeltaAIS LSMEAN	LSMEAN Number
0	57.5583333	1
0.5	57.7861111	2
1	57.8111111	3
5	58.0222222	4

Least Squares Means for effect Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		0.1150	0.0807	0.0017
2	0.1150		0.8604	0.0990
3	0.0807	0.8604		0.1396
4	0.0017	0.0990	0.1396	

Hour	Enz	DeltaAIS LSMEAN	LSMEAN Number
0	Fuel	53.7666667	1
0	Tech	55.3500000	2
0	Ultra	54.9916667	3
24	Fuel	56.3500000	4
24	Tech	60.6250000	5
24	Ultra	58.2916667	6
48	Fuel	55.9500000	7
48	Tech	61.0750000	8
48	Ultra	59.7666667	9
72	Fuel	56.4583333	10
72	Tech	61.4166667	11
72	Ultra	59.4916667	12

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		<.0001	<.0001	<.0001	<.0001	<.0001
2	<.0001		0.1600	<.0001	<.0001	<.0001
3	<.0001	0.1600		<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001		<.0001	<.0001
5	<.0001	<.0001	<.0001	<.0001		<.0001
6	<.0001	<.0001	<.0001	<.0001	<.0001	
7	<.0001	0.0164	0.0003	0.1065	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	0.0699	<.0001
9	<.0001	<.0001	<.0001	<.0001	0.0007	<.0001
10	<.0001	<.0001	<.0001	0.6600	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	0.0017	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	7	8	9	10	11	12
1	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
2	0.0164	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001
4	0.1065	<.0001	<.0001	0.6600	<.0001	<.0001
5	<.0001	0.0699	0.0007	<.0001	0.0017	<.0001
6	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
7		<.0001	<.0001	0.0411	<.0001	<.0001
8	<.0001		<.0001	<.0001	0.1672	<.0001
9	<.0001	<.0001		<.0001	<.0001	0.2654
10	0.0411	<.0001	<.0001		<.0001	<.0001
11	<.0001	0.1672	<.0001	<.0001		<.0001
12	<.0001	<.0001	0.2654	<.0001	<.0001	

The GLM Procedure

Dependent Variable: Maltotriose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	23682.71222	503.88749	29.94	<.0001
Error	96	1615.53333	16.82847		
Corrected Total	143	25298.24556			

R-Square	Coeff Var	Root MSE	Maltotriose Mean
0.936140	23.89275	4.102252	17.16944

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	4421.04333	1473.68111	87.57	<.0001
Enz	2	815.50722	407.75361	24.23	<.0001
Load	3	16108.42111	5369.47370	319.07	<.0001
Hour*Enz	6	870.08167	145.01361	8.62	<.0001
Hour*Load	9	408.25222	45.36136	2.70	0.0077
Enz*Load	6	599.50056	99.91676	5.94	<.0001
Hour*Enz*Load	18	459.90611	25.55034	1.52	0.1002

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	4421.04333	1473.68111	87.57	<.0001
Enz	2	815.50722	407.75361	24.23	<.0001
Load	3	16108.42111	5369.47370	319.07	<.0001
Hour*Enz	6	870.08167	145.01361	8.62	<.0001
Hour*Load	9	408.25222	45.36136	2.70	0.0077
Enz*Load	6	599.50056	99.91676	5.94	<.0001
Hour*Enz*Load	18	459.90611	25.55034	1.52	0.1002

Dependent Variable: Maltose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	1451374.812	30880.315	45.05	<.0001
Error	96	65808.340	685.504		
Corrected Total	143	1517183.152			

R-Square	Coeff Var	Root MSE	Maltose Mean
0.956625	10.41602	26.18212	251.3639

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	304096.2461	101365.4154	147.87	<.0001
Enz	2	167903.1268	83951.5634	122.47	<.0001
Load	3	788091.7306	262697.2435	383.22	<.0001
Hour*Enz	6	70891.1560	11815.1927	17.24	<.0001
Hour*Load	9	51324.4689	5702.7188	8.32	<.0001
Enz*Load	6	31076.9049	5179.4841	7.56	<.0001
Hour*Enz*Load	18	37991.1790	2110.6211	3.08	0.0002

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	304096.2461	101365.4154	147.87	<.0001
Enz	2	167903.1268	83951.5634	122.47	<.0001
Load	3	788091.7306	262697.2435	383.22	<.0001
Hour*Enz	6	70891.1560	11815.1927	17.24	<.0001
Hour*Load	9	51324.4689	5702.7188	8.32	<.0001
Enz*Load	6	31076.9049	5179.4841	7.56	<.0001
Hour*Enz*Load	18	37991.1790	2110.6211	3.08	0.0002

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	47	2350140.520	50002.990	56.61	<.0001
Error	96	84789.340	883.222		
Corrected Total	143	2434929.860			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.965178	17.68480	29.71906	168.0486

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	47248.594	15749.531	17.83	<.0001
Enz	2	36809.682	18404.841	20.84	<.0001
Load	3	1973876.010	657958.670	744.95	<.0001
Hour*Enz	6	102998.269	17166.378	19.44	<.0001
Hour*Load	9	75551.985	8394.665	9.50	<.0001
Enz*Load	6	52039.093	8673.182	9.82	<.0001
Hour*Enz*Load	18	61616.887	3423.160	3.88	<.0001

Dependent Variable: Glucose

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	47248.594	15749.531	17.83	<.0001
Enz	2	36809.682	18404.841	20.84	<.0001
Load	3	1973876.010	657958.670	744.95	<.0001
Hour*Enz	6	102998.269	17166.378	19.44	<.0001
Hour*Load	9	75551.985	8394.665	9.50	<.0001
Enz*Load	6	52039.093	8673.182	9.82	<.0001
Hour*Enz*Load	18	61616.887	3423.160	3.88	<.0001

The GLM Procedure
Least Squares Means

Hour	Enz	Maltotriose LSMEAN	LSMEAN Number
0	Fuel	12.1833333	1
0	Tech	7.4000000	2
0	Ultra	6.4166667	3
24	Fuel	16.4000000	4
24	Tech	12.8666667	5
24	Ultra	19.7333333	6
48	Fuel	19.0000000	7
48	Tech	14.6000000	8
48	Ultra	26.6333333	9
72	Fuel	21.1333333	10
72	Tech	22.1333333	11
72	Ultra	27.5333333	12

Least Squares Means for effect Hour*Enz
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: Maltotriose

i/j	1	2	3	4	5	6
1		0.0053	0.0009	0.0135	0.6842	<.0001
2	0.0053		0.5585	<.0001	0.0015	<.0001
3	0.0009	0.5585		<.0001	0.0002	<.0001
4	0.0135	<.0001	<.0001		0.0375	0.0494
5	0.6842	0.0015	0.0002	0.0375		<.0001
6	<.0001	<.0001	<.0001	0.0494	<.0001	
7	<.0001	<.0001	<.0001	0.1238	0.0004	0.6625
8	0.1523	<.0001	<.0001	0.2852	0.3033	0.0028
9	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
10	<.0001	<.0001	<.0001	0.0057	<.0001	0.4053
11	<.0001	<.0001	<.0001	0.0009	<.0001	0.1551
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Dependent Variable: Maltotriose

i/j	7	8	9	10	11	12
1	<.0001	0.1523	<.0001	<.0001	<.0001	<.0001
2	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	0.1238	0.2852	<.0001	0.0057	0.0009	<.0001
5	0.0004	0.3033	<.0001	<.0001	<.0001	<.0001
6	0.6625	0.0028	<.0001	0.4053	0.1551	<.0001
7		0.0100	<.0001	0.2058	0.0644	<.0001
8	0.0100		<.0001	0.0002	<.0001	<.0001
9	<.0001	<.0001		0.0014	0.0085	0.5922
10	0.2058	0.0002	0.0014		0.5518	0.0002
11	0.0644	<.0001	0.0085	0.5518		0.0017
12	<.0001	<.0001	0.5922	0.0002	0.0017	

The GLM Procedure
Least Squares Means

Hour	Load	Maltotriose LSMEAN	LSMEAN Number
0	0	29.0777778	1
0	0.5	3.2333333	2
0	1	2.3555556	3
0	5	0.0000000	4
24	0	34.2111111	5
24	0.5	14.7333333	6
24	1	11.5888889	7
24	5	4.8000000	8
48	0	35.9444444	9
48	0.5	17.7333333	10
48	1	18.0666667	11
48	5	8.5666667	12
72	0	40.0333333	13
72	0.5	23.1666667	14
72	1	17.0777778	15
72	5	14.1222222	16

Dependent Variable: Maltotriose

i/j	1	2	3	4	5	6
1		<.0001	<.0001	<.0001	0.0093	<.0001
2	<.0001		0.6509	0.0978	<.0001	<.0001
3	<.0001	0.6509		0.2262	<.0001	<.0001
4	<.0001	0.0978	0.2262		<.0001	<.0001
5	0.0093	<.0001	<.0001	<.0001		<.0001
6	<.0001	<.0001	<.0001	<.0001	<.0001	
7	<.0001	<.0001	<.0001	<.0001	<.0001	0.1072
8	<.0001	0.4199	0.2093	0.0148	<.0001	<.0001
9	0.0006	<.0001	<.0001	<.0001	0.3723	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	0.1241
11	<.0001	<.0001	<.0001	<.0001	<.0001	0.0880
12	<.0001	0.0070	0.0018	<.0001	<.0001	0.0019
13	<.0001	<.0001	<.0001	<.0001	0.0033	<.0001
14	0.0029	<.0001	<.0001	<.0001	<.0001	<.0001
15	<.0001	<.0001	<.0001	<.0001	<.0001	0.2284
16	<.0001	<.0001	<.0001	<.0001	<.0001	0.7527

i/j	7	8	9	10	11	12
1	<.0001	<.0001	0.0006	<.0001	<.0001	<.0001
2	<.0001	0.4199	<.0001	<.0001	<.0001	0.0070
3	<.0001	0.2093	<.0001	<.0001	<.0001	0.0018
4	<.0001	0.0148	<.0001	<.0001	<.0001	<.0001
5	<.0001	<.0001	0.3723	<.0001	<.0001	<.0001
6	0.1072	<.0001	<.0001	0.1241	0.0880	0.0019
7		0.0007	<.0001	0.0020	0.0012	0.1214
8	0.0007		<.0001	<.0001	<.0001	0.0544
9	<.0001	<.0001		<.0001	<.0001	<.0001
10	0.0020	<.0001	<.0001		0.8635	<.0001
11	0.0012	<.0001	<.0001	0.8635		<.0001
12	0.1214	0.0544	<.0001	<.0001	<.0001	
13	<.0001	<.0001	0.0371	<.0001	<.0001	<.0001
14	<.0001	<.0001	<.0001	0.0060	0.0097	<.0001
15	0.0055	<.0001	<.0001	0.7354	0.6103	<.0001
16	0.1933	<.0001	<.0001	0.0649	0.0441	0.0050

i/j	13	14	15	16
1	<.0001	0.0029	<.0001	<.0001
2	<.0001	<.0001	<.0001	<.0001
3	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001
5	0.0033	<.0001	<.0001	<.0001
6	<.0001	<.0001	0.2284	0.7527
7	<.0001	<.0001	0.0055	0.1933
8	<.0001	<.0001	<.0001	<.0001
9	0.0371	<.0001	<.0001	<.0001
10	<.0001	0.0060	0.7354	0.0649
11	<.0001	0.0097	0.6103	0.0441
12	<.0001	<.0001	<.0001	0.0050
13		<.0001	<.0001	<.0001
14	<.0001		0.0022	<.0001
15	<.0001	0.0022		0.1297
16	<.0001	<.0001	0.1297	

Enz	Load	Maltotriose LSMEAN	LSMEAN Number
Fuel	0	37.3916667	1
Fuel	0.5	12.6916667	2
Fuel	1	12.7000000	3
Fuel	5	5.9333333	4
Tech	0	34.0000000	5
Tech	0.5	12.4000000	6
Tech	1	7.8666667	7
Tech	5	2.7333333	8
Ultra	0	33.0583333	9
Ultra	0.5	19.0583333	10
Ultra	1	16.2500000	11
Ultra	5	11.9500000	12

Least Squares Means for effect Enz*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Maltotriose

i/j	1	2	3	4	5	6
1		<.0001	<.0001	<.0001	0.0456	<.0001
2	<.0001		0.9960	0.0001	<.0001	0.8621
3	<.0001	0.9960		0.0001	<.0001	0.8582
4	<.0001	0.0001	0.0001		<.0001	0.0002
5	0.0456	<.0001	<.0001	<.0001		<.0001
6	<.0001	0.8621	0.8582	0.0002	<.0001	
7	<.0001	0.0049	0.0048	0.2512	<.0001	0.0080
8	<.0001	<.0001	<.0001	0.0590	<.0001	<.0001
9	0.0112	<.0001	<.0001	<.0001	0.5752	<.0001
10	<.0001	0.0003	0.0003	<.0001	<.0001	0.0001
11	<.0001	0.0362	0.0366	<.0001	<.0001	0.0237
12	<.0001	0.6589	0.6553	0.0005	<.0001	0.7887

i/j	7	8	9	10	11	12
1	<.0001	<.0001	0.0112	<.0001	<.0001	<.0001
2	0.0049	<.0001	<.0001	0.0003	0.0362	0.6589
3	0.0048	<.0001	<.0001	0.0003	0.0366	0.6553
4	0.2512	0.0590	<.0001	<.0001	<.0001	0.0005
5	<.0001	<.0001	0.5752	<.0001	<.0001	<.0001
6	0.0080	<.0001	<.0001	0.0001	0.0237	0.7887
7		0.0028	<.0001	<.0001	<.0001	0.0166
8	0.0028		<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001		<.0001	<.0001	<.0001
10	<.0001	<.0001	<.0001		0.0968	<.0001
11	<.0001	<.0001	<.0001	0.0968		0.0118
12	0.0166	<.0001	<.0001	<.0001	0.0118	

Hour	Enz	Load	Maltose LSMEAN	LSMEAN Number
0	Fuel	0	296.066667	1
0	Fuel	0.5	286.900000	2
0	Fuel	1	258.833333	3
0	Fuel	5	46.866667	4
0	Tech	0	263.033333	5
0	Tech	0.5	217.200000	6
0	Tech	1	129.166667	7
0	Tech	5	0.000000	8
0	Ultra	0	312.833333	9
0	Ultra	0.5	222.966667	10
0	Ultra	1	110.566667	11
0	Ultra	5	0.000000	12
24	Fuel	0	310.133333	13
24	Fuel	0.5	288.833333	14
24	Fuel	1	253.666667	15
24	Fuel	5	117.500000	16
24	Tech	0	291.800000	17
24	Tech	0.5	221.666667	18
24	Tech	1	167.033333	19
24	Tech	5	118.833333	20
24	Ultra	0	344.133333	21
24	Ultra	0.5	334.300000	22
24	Ultra	1	316.266667	23
24	Ultra	5	176.433333	24
48	Fuel	0	371.966667	25
48	Fuel	0.5	312.800000	26
48	Fuel	1	355.433333	27
48	Fuel	5	168.933333	28
48	Tech	0	321.566667	29
48	Tech	0.5	243.533333	30
48	Tech	1	188.366667	31
48	Tech	5	135.633333	32
48	Ultra	0	382.100000	33
48	Ultra	0.5	369.500000	34
48	Ultra	1	367.600000	35
48	Ultra	5	247.200000	36
72	Fuel	0	369.033333	37
72	Fuel	0.5	331.166667	38
72	Fuel	1	280.866667	39
72	Fuel	5	166.300000	40
72	Tech	0	331.433333	41
72	Tech	0.5	297.066667	42
72	Tech	1	212.633333	43
72	Tech	5	138.300000	44
72	Ultra	0	379.066667	45
72	Ultra	0.5	377.166667	46
72	Ultra	1	346.300000	47
72	Ultra	5	286.466667	48

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Maltose

i/j	1	2	3	4	5	6	7
1		0.6690	0.0848	<.0001	0.1256	0.0004	<.0001
2	0.6690		0.1923	<.0001	0.2670	0.0015	<.0001
3	0.0848	0.1923		<.0001	0.8447	0.0544	<.0001
4	<.0001	<.0001	<.0001		<.0001	<.0001	0.0002
5	0.1256	0.2670	0.8447	<.0001		0.0346	<.0001
6	0.0004	0.0015	0.0544	<.0001	0.0346		<.0001
7	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	
8	<.0001	<.0001	<.0001	0.0308	<.0001	<.0001	<.0001
9	0.4348	0.2281	0.0132	<.0001	0.0219	<.0001	<.0001
10	0.0009	0.0035	0.0966	<.0001	0.0639	0.7879	<.0001
11	<.0001	<.0001	<.0001	0.0037	<.0001	<.0001	0.3864
12	<.0001	<.0001	<.0001	0.0308	<.0001	<.0001	<.0001
13	0.5121	0.2798	0.0183	<.0001	0.0300	<.0001	<.0001
14	0.7358	0.9281	0.1637	<.0001	0.2304	0.0012	<.0001
15	0.0502	0.1233	0.8095	<.0001	0.6623	0.0913	<.0001
16	<.0001	<.0001	<.0001	0.0013	<.0001	<.0001	0.5865
17	0.8422	0.8192	0.1263	<.0001	0.1816	0.0007	<.0001
18	0.0008	0.0029	0.0853	<.0001	0.0559	0.8349	<.0001
19	<.0001	<.0001	<.0001	<.0001	<.0001	0.0210	0.0797
20	<.0001	<.0001	<.0001	0.0011	<.0001	<.0001	0.6299
21	0.0268	0.0087	0.0001	<.0001	0.0003	<.0001	<.0001
22	0.0769	0.0290	0.0006	<.0001	0.0012	<.0001	<.0001
23	0.3471	0.1727	0.0085	<.0001	0.0145	<.0001	<.0001
24	<.0001	<.0001	0.0002	<.0001	0.0001	0.0595	0.0294
25	0.0006	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001
26	0.4357	0.2287	0.0132	<.0001	0.0220	<.0001	<.0001
27	0.0066	0.0018	<.0001	<.0001	<.0001	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	0.0262	0.0659
29	0.2359	0.1082	0.0042	<.0001	0.0074	<.0001	<.0001
30	0.0158	0.0453	0.4759	<.0001	0.3640	0.2210	<.0001
31	<.0001	<.0001	0.0014	<.0001	0.0007	0.1806	0.0067
32	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	0.7629
33	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
34	0.0009	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001
35	0.0012	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001
36	0.0245	0.0664	0.5876	<.0001	0.4607	0.1637	<.0001
37	0.0009	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001
38	0.1039	0.0411	0.0010	<.0001	0.0019	<.0001	<.0001
39	0.4788	0.7784	0.3053	<.0001	0.4062	0.0037	<.0001
40	<.0001	<.0001	<.0001	<.0001	<.0001	0.0192	0.0856
41	0.1013	0.0399	0.0010	<.0001	0.0019	<.0001	<.0001
42	0.9628	0.6355	0.0769	<.0001	0.1147	0.0003	<.0001
43	0.0002	0.0008	0.0332	<.0001	0.0204	0.8313	0.0002
44	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004	0.6702
45	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
46	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
47	0.0208	0.0066	<.0001	<.0001	0.0002	<.0001	<.0001
48	0.6544	0.9839	0.1992	<.0001	0.2758	0.0016	<.0001

Dependent Variable: Maltose

i/j	8	9	10	11	12	13	14
1	<.0001	0.4348	0.0009	<.0001	<.0001	0.5121	0.7358
2	<.0001	0.2281	0.0035	<.0001	<.0001	0.2798	0.9281
3	<.0001	0.0132	0.0966	<.0001	<.0001	0.0183	0.1637
4	0.0308	<.0001	<.0001	0.0037	0.0308	<.0001	<.0001
5	<.0001	0.0219	0.0639	<.0001	<.0001	0.0300	0.2304
6	<.0001	<.0001	0.7879	<.0001	<.0001	<.0001	0.0012
7	<.0001	<.0001	<.0001	0.3864	<.0001	<.0001	<.0001
8		<.0001	<.0001	<.0001	1.0000	<.0001	<.0001
9	<.0001		<.0001	<.0001	<.0001	0.8998	0.2644
10	<.0001	<.0001		<.0001	<.0001	<.0001	0.0027
11	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
12	1.0000	<.0001	<.0001	<.0001		<.0001	<.0001
13	<.0001	0.8998	<.0001	<.0001	<.0001		0.3216
14	<.0001	0.2644	0.0027	<.0001	<.0001	0.3216	
15	<.0001	0.0068	0.1542	<.0001	<.0001	0.0096	0.1032
16	<.0001	<.0001	<.0001	0.7464	<.0001	<.0001	<.0001
17	<.0001	0.3276	0.0018	<.0001	<.0001	0.3933	0.8899
18	<.0001	<.0001	0.9516	<.0001	<.0001	<.0001	0.0022
19	<.0001	<.0001	0.0103	0.0096	<.0001	<.0001	<.0001
20	<.0001	<.0001	<.0001	0.6998	<.0001	<.0001	<.0001
21	<.0001	0.1464	<.0001	<.0001	<.0001	0.1150	0.0112
22	<.0001	0.3178	<.0001	<.0001	<.0001	0.2611	0.0360
23	<.0001	0.8727	<.0001	<.0001	<.0001	0.7748	0.2025
24	<.0001	<.0001	0.0320	0.0027	<.0001	<.0001	<.0001
25	<.0001	0.0068	<.0001	<.0001	<.0001	0.0047	0.0002
26	<.0001	0.9988	<.0001	<.0001	<.0001	0.9010	0.2650
27	<.0001	0.0491	<.0001	<.0001	<.0001	0.0367	0.0024
28	<.0001	<.0001	0.0131	0.0075	<.0001	<.0001	<.0001
29	<.0001	0.6838	<.0001	<.0001	<.0001	0.5940	0.1290
30	<.0001	0.0016	0.3384	<.0001	<.0001	0.0024	0.0367
31	<.0001	<.0001	0.1088	0.0004	<.0001	<.0001	<.0001
32	<.0001	<.0001	<.0001	0.2439	<.0001	<.0001	<.0001
33	<.0001	0.0016	<.0001	<.0001	<.0001	0.0011	<.0001
34	<.0001	0.0094	<.0001	<.0001	<.0001	0.0066	0.0003
35	<.0001	0.0120	<.0001	<.0001	<.0001	0.0085	0.0004
36	<.0001	0.0028	0.2598	<.0001	<.0001	0.0041	0.0544
37	<.0001	0.0100	<.0001	<.0001	<.0001	0.0070	0.0003
38	<.0001	0.3933	<.0001	<.0001	<.0001	0.3276	0.0505
39	<.0001	0.1381	0.0080	<.0001	<.0001	0.1742	0.7102
40	<.0001	<.0001	0.0094	0.0106	<.0001	<.0001	<.0001
41	<.0001	0.3864	<.0001	<.0001	<.0001	0.3216	0.0491
42	<.0001	0.4626	0.0008	<.0001	<.0001	0.5425	0.7010
43	<.0001	<.0001	0.6299	<.0001	<.0001	<.0001	0.0006
44	<.0001	<.0001	0.0001	0.1976	<.0001	<.0001	<.0001
45	<.0001	0.0026	<.0001	<.0001	<.0001	0.0017	<.0001
46	<.0001	0.0033	<.0001	<.0001	<.0001	0.0023	<.0001
47	<.0001	0.1208	<.0001	<.0001	<.0001	0.0939	0.0085
48	<.0001	0.2204	0.0038	<.0001	<.0001	0.2710	0.9121

Dependent Variable: Maltose

i/j	15	16	17	18	19	20	21
1	0.0502	<.0001	0.8422	0.0008	<.0001	<.0001	0.0268
2	0.1233	<.0001	0.8192	0.0029	<.0001	<.0001	0.0087
3	0.8095	<.0001	0.1263	0.0853	<.0001	<.0001	0.0001
4	<.0001	0.0013	<.0001	<.0001	<.0001	0.0011	<.0001
5	0.6623	<.0001	0.1816	0.0559	<.0001	<.0001	0.0003
6	0.0913	<.0001	0.0007	0.8349	0.0210	<.0001	<.0001
7	<.0001	0.5865	<.0001	<.0001	0.0797	0.6299	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.0068	<.0001	0.3276	<.0001	<.0001	<.0001	0.1464
10	0.1542	<.0001	0.0018	0.9516	0.0103	<.0001	<.0001
11	<.0001	0.7464	<.0001	<.0001	0.0096	0.6998	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.0096	<.0001	0.3933	<.0001	<.0001	<.0001	0.1150
14	0.1032	<.0001	0.8899	0.0022	<.0001	<.0001	0.0112
15		<.0001	0.0776	0.1377	0.0001	<.0001	<.0001
16	<.0001		<.0001	<.0001	0.0226	0.9504	<.0001
17	0.0776	<.0001		0.0014	<.0001	<.0001	0.0162
18	0.1377	<.0001	0.0014		0.0122	<.0001	<.0001
19	0.0001	0.0226	<.0001	0.0122		0.0264	<.0001
20	<.0001	0.9504	<.0001	<.0001	0.0264		<.0001
21	<.0001	<.0001	0.0162	<.0001	<.0001	<.0001	
22	0.0003	<.0001	0.0497	<.0001	<.0001	<.0001	0.6466
23	0.0043	<.0001	0.2553	<.0001	<.0001	<.0001	0.1955
24	0.0005	0.0070	<.0001	0.0369	0.6611	0.0083	<.0001
25	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	0.1960
26	0.0068	<.0001	0.3284	<.0001	<.0001	<.0001	0.1460
27	<.0001	<.0001	0.0037	<.0001	<.0001	<.0001	0.5983
28	0.0001	0.0180	<.0001	0.0154	0.9294	0.0212	<.0001
29	0.0020	<.0001	0.1670	<.0001	<.0001	<.0001	0.2938
30	0.6366	<.0001	0.0262	0.3089	0.0005	<.0001	<.0001
31	0.0029	0.0013	<.0001	0.1226	0.3208	0.0016	<.0001
32	<.0001	0.3984	<.0001	0.0001	0.1451	0.4339	<.0001
33	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0789
34	<.0001	<.0001	0.0004	<.0001	<.0001	<.0001	0.2383
35	<.0001	<.0001	0.0006	<.0001	<.0001	<.0001	0.2751
36	0.7629	<.0001	0.0396	0.2353	0.0003	<.0001	<.0001
37	<.0001	<.0001	0.0005	<.0001	<.0001	<.0001	0.2470
38	0.0005	<.0001	0.0686	<.0001	<.0001	<.0001	0.5456
39	0.2063	<.0001	0.6102	0.0067	<.0001	<.0001	0.0039
40	<.0001	0.0247	<.0001	0.0111	0.9727	0.0287	<.0001
41	0.0004	<.0001	0.0668	<.0001	<.0001	<.0001	0.5539
42	0.0451	<.0001	0.8059	0.0006	<.0001	<.0001	0.0301
43	0.0579	<.0001	0.0004	0.6736	0.0355	<.0001	<.0001
44	<.0001	0.3330	<.0001	0.0002	0.1821	0.3648	<.0001
45	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1055
46	<.0001	<.0001	0.0001	<.0001	<.0001	<.0001	0.1256
47	<.0001	<.0001	0.0124	<.0001	<.0001	<.0001	0.9195
48	0.1282	<.0001	0.8035	0.0031	<.0001	<.0001	0.0083

Dependent Variable: Maltose

i/j	22	23	24	25	26	27	28
1	0.0769	0.3471	<.0001	0.0006	0.4357	0.0066	<.0001
2	0.0290	0.1727	<.0001	0.0001	0.2287	0.0018	<.0001
3	0.0006	0.0085	0.0002	<.0001	0.0132	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	0.0012	0.0145	0.0001	<.0001	0.0220	<.0001	<.0001
6	<.0001	<.0001	0.0595	<.0001	<.0001	<.0001	0.0262
7	<.0001	<.0001	0.0294	<.0001	<.0001	<.0001	0.0659
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.3178	0.8727	<.0001	0.0068	0.9988	0.0491	<.0001
10	<.0001	<.0001	0.0320	<.0001	<.0001	<.0001	0.0131
11	<.0001	<.0001	0.0027	<.0001	<.0001	<.0001	0.0075
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.2611	0.7748	<.0001	0.0047	0.9010	0.0367	<.0001
14	0.0360	0.2025	<.0001	0.0002	0.2650	0.0024	<.0001
15	0.0003	0.0043	0.0005	<.0001	0.0068	<.0001	0.0001
16	<.0001	<.0001	0.0070	<.0001	<.0001	<.0001	0.0180
17	0.0497	0.2553	<.0001	0.0003	0.3284	0.0037	<.0001
18	<.0001	<.0001	0.0369	<.0001	<.0001	<.0001	0.0154
19	<.0001	<.0001	0.6611	<.0001	<.0001	<.0001	0.9294
20	<.0001	<.0001	0.0083	<.0001	<.0001	<.0001	0.0212
21	0.6466	0.1955	<.0001	0.1960	0.1460	0.5983	<.0001
22		0.4010	<.0001	0.0813	0.3171	0.3254	<.0001
23	0.4010		<.0001	0.0106	0.8715	0.0700	<.0001
24	<.0001	<.0001		<.0001	<.0001	<.0001	0.7265
25	0.0813	0.0106	<.0001		0.0068	0.4412	<.0001
26	0.3171	0.8715	<.0001	0.0068		0.0490	<.0001
27	0.3254	0.0700	<.0001	0.4412	0.0490		<.0001
28	<.0001	<.0001	0.7265	<.0001	<.0001	<.0001	
29	0.5528	0.8047	<.0001	0.0204	0.6827	0.1164	<.0001
30	<.0001	0.0010	0.0023	<.0001	0.0016	<.0001	0.0007
31	<.0001	<.0001	0.5780	<.0001	<.0001	<.0001	0.3656
32	<.0001	<.0001	0.0593	<.0001	<.0001	<.0001	0.1226
33	0.0277	0.0027	<.0001	0.6366	0.0016	0.2153	<.0001
34	0.1029	0.0145	<.0001	0.9084	0.0094	0.5121	<.0001
35	0.1226	0.0183	<.0001	0.8386	0.0119	0.5706	<.0001
36	<.0001	0.0017	0.0013	<.0001	0.0028	<.0001	0.0004
37	0.1075	0.0153	<.0001	0.8911	0.0099	0.5262	<.0001
38	0.8838	0.4875	<.0001	0.0593	0.3924	0.2591	<.0001
39	0.0141	0.1010	<.0001	<.0001	0.1385	0.0007	<.0001
40	<.0001	<.0001	0.6366	<.0001	<.0001	<.0001	0.9022
41	0.8936	0.4798	<.0001	0.0610	0.3856	0.2644	<.0001
42	0.0848	0.3714	<.0001	0.0007	0.4635	0.0075	<.0001
43	<.0001	<.0001	0.0936	<.0001	<.0001	<.0001	0.0437
44	<.0001	<.0001	0.0776	<.0001	<.0001	<.0001	0.1551
45	0.0389	0.0041	<.0001	0.7405	0.0025	0.2717	<.0001
46	0.0478	0.0054	<.0001	0.8083	0.0033	0.3119	<.0001
47	0.5759	0.1633	<.0001	0.2328	0.1204	0.6702	<.0001
48	0.0276	0.1665	<.0001	0.0001	0.2210	0.0017	<.0001

Dependent Variable: Maltose

i/j	29	30	31	32	33	34	35
1	0.2359	0.0158	<.0001	<.0001	0.0001	0.0009	0.0012
2	0.1082	0.0453	<.0001	<.0001	<.0001	0.0002	0.0003
3	0.0042	0.4759	0.0014	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	0.0074	0.3640	0.0007	<.0001	<.0001	<.0001	<.0001
6	<.0001	0.2210	0.1806	0.0002	<.0001	<.0001	<.0001
7	<.0001	<.0001	0.0067	0.7629	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.6838	0.0016	<.0001	<.0001	0.0016	0.0094	0.0120
10	<.0001	0.3384	0.1088	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	0.0004	0.2439	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.5940	0.0024	<.0001	<.0001	0.0011	0.0066	0.0085
14	0.1290	0.0367	<.0001	<.0001	<.0001	0.0003	0.0004
15	0.0020	0.6366	0.0029	<.0001	<.0001	<.0001	<.0001
16	<.0001	<.0001	0.0013	0.3984	<.0001	<.0001	<.0001
17	0.1670	0.0262	<.0001	<.0001	<.0001	0.0004	0.0006
18	<.0001	0.3089	0.1226	0.0001	<.0001	<.0001	<.0001
19	<.0001	0.0005	0.3208	0.1451	<.0001	<.0001	<.0001
20	<.0001	<.0001	0.0016	0.4339	<.0001	<.0001	<.0001
21	0.2938	<.0001	<.0001	<.0001	0.0789	0.2383	0.2751
22	0.5528	<.0001	<.0001	<.0001	0.0277	0.1029	0.1226
23	0.8047	0.0010	<.0001	<.0001	0.0027	0.0145	0.0183
24	<.0001	0.0023	0.5780	0.0593	<.0001	<.0001	<.0001
25	0.0204	<.0001	<.0001	<.0001	0.6366	0.9084	0.8386
26	0.6827	0.0016	<.0001	<.0001	0.0016	0.0094	0.0119
27	0.1164	<.0001	<.0001	<.0001	0.2153	0.5121	0.5706
28	<.0001	0.0007	0.3656	0.1226	<.0001	<.0001	<.0001
29		0.0004	<.0001	<.0001	0.0056	0.0272	0.0338
30	0.0004		0.0114	<.0001	<.0001	<.0001	<.0001
31	<.0001	0.0114		0.0154	<.0001	<.0001	<.0001
32	<.0001	<.0001	0.0154		<.0001	<.0001	<.0001
33	0.0056	<.0001	<.0001	<.0001		0.5570	0.4992
34	0.0272	<.0001	<.0001	<.0001	0.5570		0.9294
35	0.0338	<.0001	<.0001	<.0001	0.4992	0.9294	
36	0.0008	0.8642	0.0071	<.0001	<.0001	<.0001	<.0001
37	0.0287	<.0001	<.0001	<.0001	0.5425	0.9826	0.9467
38	0.6544	<.0001	<.0001	<.0001	0.0192	0.0761	0.0916
39	0.0599	0.0839	<.0001	<.0001	<.0001	<.0001	0.0001
40	<.0001	0.0005	0.3046	0.1547	<.0001	<.0001	<.0001
41	0.6455	<.0001	<.0001	<.0001	0.0198	0.0781	0.0939
42	0.2546	0.0140	<.0001	<.0001	0.0001	0.0010	0.0014
43	<.0001	0.1516	0.2591	0.0005	<.0001	<.0001	<.0001
44	<.0001	<.0001	0.0212	0.9010	<.0001	<.0001	<.0001
45	0.0084	<.0001	<.0001	<.0001	0.8875	0.6555	0.5929
46	0.0108	<.0001	<.0001	<.0001	0.8180	0.7207	0.6555
47	0.2502	<.0001	<.0001	<.0001	0.0973	0.2805	0.3216
48	0.1039	0.0474	<.0001	<.0001	<.0001	0.0002	0.0003

Dependent Variable: Maltose

i/j	36	37	38	39	40	41	42
1	0.0245	0.0009	0.1039	0.4788	<.0001	0.1013	0.9628
2	0.0664	0.0002	0.0411	0.7784	<.0001	0.0399	0.6355
3	0.5876	<.0001	0.0010	0.3053	<.0001	0.0010	0.0769
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	0.4607	<.0001	0.0019	0.4062	<.0001	0.0019	0.1147
6	0.1637	<.0001	<.0001	0.0037	0.0192	<.0001	0.0003
7	<.0001	<.0001	<.0001	<.0001	0.0856	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.0028	0.0100	0.3933	0.1381	<.0001	0.3864	0.4626
10	0.2598	<.0001	<.0001	0.0080	0.0094	<.0001	0.0008
11	<.0001	<.0001	<.0001	<.0001	0.0106	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.0041	0.0070	0.3276	0.1742	<.0001	0.3216	0.5425
14	0.0544	0.0003	0.0505	0.7102	<.0001	0.0491	0.7010
15	0.7629	<.0001	0.0005	0.2063	<.0001	0.0004	0.0451
16	<.0001	<.0001	<.0001	<.0001	0.0247	<.0001	<.0001
17	0.0396	0.0005	0.0686	0.6102	<.0001	0.0668	0.8059
18	0.2353	<.0001	<.0001	0.0067	0.0111	<.0001	0.0006
19	0.0003	<.0001	<.0001	<.0001	0.9727	<.0001	<.0001
20	<.0001	<.0001	<.0001	<.0001	0.0287	<.0001	<.0001
21	<.0001	0.2470	0.5456	0.0039	<.0001	0.5539	0.0301
22	<.0001	0.1075	0.8838	0.0141	<.0001	0.8936	0.0848
23	0.0017	0.0153	0.4875	0.1010	<.0001	0.4798	0.3714
24	0.0013	<.0001	<.0001	<.0001	0.6366	<.0001	<.0001
25	<.0001	0.8911	0.0593	<.0001	<.0001	0.0610	0.0007
26	0.0028	0.0099	0.3924	0.1385	<.0001	0.3856	0.4635
27	<.0001	0.5262	0.2591	0.0007	<.0001	0.2644	0.0075
28	0.0004	<.0001	<.0001	<.0001	0.9022	<.0001	<.0001
29	0.0008	0.0287	0.6544	0.0599	<.0001	0.6455	0.2546
30	0.8642	<.0001	<.0001	0.0839	0.0005	<.0001	0.0140
31	0.0071	<.0001	<.0001	<.0001	0.3046	<.0001	<.0001
32	<.0001	<.0001	<.0001	<.0001	0.1547	<.0001	<.0001
33	<.0001	0.5425	0.0192	<.0001	<.0001	0.0198	0.0001
34	<.0001	0.9826	0.0761	<.0001	<.0001	0.0781	0.0010
35	<.0001	0.9467	0.0916	0.0001	<.0001	0.0939	0.0014
36		<.0001	0.0002	0.1186	0.0003	0.0002	0.0218
37	<.0001		0.0797	<.0001	<.0001	0.0818	0.0011
38	0.0002	0.0797		0.0207	<.0001	0.9901	0.1140
39	0.1186	<.0001	0.0207		<.0001	0.0200	0.4504
40	0.0003	<.0001	<.0001	<.0001		<.0001	<.0001
41	0.0002	0.0818	0.9901	0.0200	<.0001		0.1112
42	0.0218	0.0011	0.1140	0.4504	<.0001	0.1112	
43	0.1092	<.0001	<.0001	0.0019	0.0327	<.0001	0.0001
44	<.0001	<.0001	<.0001	<.0001	0.1934	<.0001	<.0001
45	<.0001	0.6399	0.0274	<.0001	<.0001	0.0282	0.0002
46	<.0001	0.7044	0.0339	<.0001	<.0001	0.0349	0.0003
47	<.0001	0.2903	0.4807	0.0029	<.0001	0.4885	0.0234
48	0.0693	0.0002	0.0392	0.7939	<.0001	0.0380	0.6211

Dependent Variable: Maltose

i/j	43	44	45	46	47	48
1	0.0002	<.0001	0.0002	0.0003	0.0208	0.6544
2	0.0008	<.0001	<.0001	<.0001	0.0066	0.9839
3	0.0332	<.0001	<.0001	<.0001	<.0001	0.1992
4	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
5	0.0204	<.0001	<.0001	<.0001	0.0002	0.2758
6	0.8313	0.0004	<.0001	<.0001	<.0001	0.0016
7	0.0002	0.6702	<.0001	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001	0.0026	0.0033	0.1208	0.2204
10	0.6299	0.0001	<.0001	<.0001	<.0001	0.0038
11	<.0001	0.1976	<.0001	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	0.0017	0.0023	0.0939	0.2710
14	0.0006	<.0001	<.0001	<.0001	0.0085	0.9121
15	0.0579	<.0001	<.0001	<.0001	<.0001	0.1282
16	<.0001	0.3330	<.0001	<.0001	<.0001	<.0001
17	0.0004	<.0001	<.0001	0.0001	0.0124	0.8035
18	0.6736	0.0002	<.0001	<.0001	<.0001	0.0031
19	0.0355	0.1821	<.0001	<.0001	<.0001	<.0001
20	<.0001	0.3648	<.0001	<.0001	<.0001	<.0001
21	<.0001	<.0001	0.1055	0.1256	0.9195	0.0083
22	<.0001	<.0001	0.0389	0.0478	0.5759	0.0276
23	<.0001	<.0001	0.0041	0.0054	0.1633	0.1665
24	0.0936	0.0776	<.0001	<.0001	<.0001	<.0001
25	<.0001	<.0001	0.7405	0.8083	0.2328	0.0001
26	<.0001	<.0001	0.0025	0.0033	0.1204	0.2210
27	<.0001	<.0001	0.2717	0.3119	0.6702	0.0017
28	0.0437	0.1551	<.0001	<.0001	<.0001	<.0001
29	<.0001	<.0001	0.0084	0.0108	0.2502	0.1039
30	0.1516	<.0001	<.0001	<.0001	<.0001	0.0474
31	0.2591	0.0212	<.0001	<.0001	<.0001	<.0001
32	0.0005	0.9010	<.0001	<.0001	<.0001	<.0001
33	<.0001	<.0001	0.8875	0.8180	0.0973	<.0001
34	<.0001	<.0001	0.6555	0.7207	0.2805	0.0002
35	<.0001	<.0001	0.5929	0.6555	0.3216	0.0003
36	0.1092	<.0001	<.0001	<.0001	<.0001	0.0693
37	<.0001	<.0001	0.6399	0.7044	0.2903	0.0002
38	<.0001	<.0001	0.0274	0.0339	0.4807	0.0392
39	0.0019	<.0001	<.0001	<.0001	0.0029	0.7939
40	0.0327	0.1934	<.0001	<.0001	<.0001	<.0001
41	<.0001	<.0001	0.0282	0.0349	0.4885	0.0380
42	0.0001	<.0001	0.0002	0.0003	0.0234	0.6211
43		0.0008	<.0001	<.0001	<.0001	0.0008
44	0.0008		<.0001	<.0001	<.0001	<.0001
45	<.0001	<.0001		0.9294	0.1286	<.0001
46	<.0001	<.0001	0.9294		0.1520	<.0001
47	<.0001	<.0001	0.1286	0.1520		0.0062
48	0.0008	<.0001	<.0001	<.0001	0.0062	

Hour	Enz	Load	Glucose LSMEAN	LSMEAN Number
0	Fuel	0	-0.000000	1
0	Fuel	0.5	70.466667	2
0	Fuel	1	103.233333	3
0	Fuel	5	384.600000	4
0	Tech	0	2.866667	5
0	Tech	0.5	144.100000	6
0	Tech	1	233.433333	7
0	Tech	5	398.500000	8
0	Ultra	0	-0.000000	9
0	Ultra	0.5	195.166667	10
0	Ultra	1	320.933333	11
0	Ultra	5	508.566667	12
24	Fuel	0	16.533333	13
24	Fuel	0.5	108.433333	14
24	Fuel	1	154.566667	15
24	Fuel	5	352.266667	16
24	Tech	0	47.433333	17
24	Tech	0.5	183.866667	18
24	Tech	1	231.800000	19
24	Tech	5	308.500000	20
24	Ultra	0	16.100000	21
24	Ultra	0.5	97.800000	22
24	Ultra	1	143.933333	23
24	Ultra	5	317.066667	24
48	Fuel	0	23.200000	25
48	Fuel	0.5	119.366667	26
48	Fuel	1	115.900000	27
48	Fuel	5	376.233333	28
48	Tech	0	42.400000	29
48	Tech	0.5	180.366667	30
48	Tech	1	285.866667	31
48	Tech	5	302.933333	32
48	Ultra	0	23.233333	33
48	Ultra	0.5	81.366667	34
48	Ultra	1	126.166667	35
48	Ultra	5	288.966667	36
72	Fuel	0	24.533333	37
72	Fuel	0.5	111.366667	38
72	Fuel	1	151.633333	39
72	Fuel	5	302.400000	40
72	Tech	0	38.133333	41
72	Tech	0.5	104.966667	42
72	Tech	1	197.166667	43
72	Tech	5	328.000000	44
72	Ultra	0	24.300000	45
72	Ultra	0.5	80.266667	46
72	Ultra	1	131.633333	47
72	Ultra	5	265.766667	48

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	1	2	3	4	5	6	7
1		0.0046	<.0001	<.0001	0.9062	<.0001	<.0001
2	0.0046		0.1801	<.0001	0.0064	0.0031	<.0001
3	<.0001	0.1801		<.0001	<.0001	0.0954	<.0001
4	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
5	0.9062	0.0064	<.0001	<.0001		<.0001	<.0001
6	<.0001	0.0031	0.0954	<.0001	<.0001		0.0004
7	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004	
8	<.0001	<.0001	<.0001	0.5681	<.0001	<.0001	<.0001
9	1.0000	0.0046	<.0001	<.0001	0.9062	<.0001	<.0001
10	<.0001	<.0001	0.0003	<.0001	<.0001	0.0379	0.1181
11	<.0001	<.0001	<.0001	0.0101	<.0001	<.0001	0.0005
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.4973	0.0286	0.0006	<.0001	0.5746	<.0001	<.0001
14	<.0001	0.1210	0.8308	<.0001	<.0001	0.1449	<.0001
15	<.0001	0.0008	0.0370	<.0001	<.0001	0.6672	0.0016
16	<.0001	<.0001	<.0001	0.1859	<.0001	<.0001	<.0001
17	0.0535	0.3449	0.0236	<.0001	0.0694	0.0001	<.0001
18	<.0001	<.0001	0.0013	<.0001	<.0001	0.1045	0.0438
19	<.0001	<.0001	<.0001	<.0001	<.0001	0.0005	0.9465
20	<.0001	<.0001	<.0001	0.0023	<.0001	<.0001	0.0026
21	0.5086	0.0274	0.0005	<.0001	0.5868	<.0001	<.0001
22	0.0001	0.2628	0.8233	<.0001	0.0002	0.0594	<.0001
23	<.0001	0.0032	0.0967	<.0001	<.0001	0.9945	0.0004
24	<.0001	<.0001	<.0001	0.0065	<.0001	<.0001	0.0008
25	0.3414	0.0543	0.0014	<.0001	0.4041	<.0001	<.0001
26	<.0001	0.0467	0.5077	<.0001	<.0001	0.3106	<.0001
27	<.0001	0.0642	0.6029	<.0001	<.0001	0.2481	<.0001
28	<.0001	<.0001	<.0001	0.7310	<.0001	<.0001	<.0001
29	0.0838	0.2503	0.0139	<.0001	0.1065	<.0001	<.0001
30	<.0001	<.0001	0.0020	<.0001	<.0001	0.1383	0.0312
31	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0332
32	<.0001	<.0001	<.0001	0.0011	<.0001	<.0001	0.0051
33	0.3407	0.0545	0.0014	<.0001	0.4034	<.0001	<.0001
34	0.0011	0.6543	0.3698	<.0001	0.0017	0.0112	<.0001
35	<.0001	0.0239	0.3470	<.0001	<.0001	0.4617	<.0001
36	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	0.0243
37	0.3145	0.0614	0.0016	<.0001	0.3741	<.0001	<.0001
38	<.0001	0.0951	0.7382	<.0001	<.0001	0.1805	<.0001
39	<.0001	0.0012	0.0489	<.0001	<.0001	0.7569	0.0011
40	<.0001	<.0001	<.0001	0.0010	<.0001	<.0001	0.0055
41	0.1194	0.1859	0.0086	<.0001	0.1494	<.0001	<.0001
42	<.0001	0.1583	0.9432	<.0001	<.0001	0.1101	<.0001
43	<.0001	<.0001	0.0002	<.0001	<.0001	0.0312	0.1383
44	<.0001	<.0001	<.0001	0.0218	<.0001	<.0001	0.0002
45	0.3191	0.0601	0.0016	<.0001	0.3793	<.0001	<.0001
46	0.0013	0.6872	0.3463	<.0001	0.0019	0.0099	<.0001
47	<.0001	0.0134	0.2447	<.0001	<.0001	0.6086	<.0001
48	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1859

Dependent Variable: Glucose

i/j	8	9	10	11	12	13	14
1	<.0001	1.0000	<.0001	<.0001	<.0001	0.4973	<.0001
2	<.0001	0.0046	<.0001	<.0001	<.0001	0.0286	0.1210
3	<.0001	<.0001	0.0003	<.0001	<.0001	0.0006	0.8308
4	0.5681	<.0001	<.0001	0.0101	<.0001	<.0001	<.0001
5	<.0001	0.9062	<.0001	<.0001	<.0001	0.5746	<.0001
6	<.0001	<.0001	0.0379	<.0001	<.0001	<.0001	0.1449
7	<.0001	<.0001	0.1181	0.0005	<.0001	<.0001	<.0001
8		<.0001	<.0001	0.0019	<.0001	<.0001	<.0001
9	<.0001		<.0001	<.0001	<.0001	0.4973	<.0001
10	<.0001	<.0001		<.0001	<.0001	<.0001	0.0006
11	0.0019	<.0001	<.0001		<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
13	<.0001	0.4973	<.0001	<.0001	<.0001		0.0003
14	<.0001	<.0001	0.0006	<.0001	<.0001	0.0003	
15	<.0001	<.0001	0.0976	<.0001	<.0001	<.0001	0.0603
16	0.0597	<.0001	<.0001	0.1997	<.0001	<.0001	<.0001
17	<.0001	0.0535	<.0001	<.0001	<.0001	0.2059	0.0136
18	<.0001	<.0001	0.6425	<.0001	<.0001	<.0001	0.0025
19	<.0001	<.0001	0.1344	0.0004	<.0001	<.0001	<.0001
20	0.0003	<.0001	<.0001	0.6096	<.0001	<.0001	<.0001
21	<.0001	0.5086	<.0001	<.0001	<.0001	0.9858	0.0002
22	<.0001	0.0001	0.0001	<.0001	<.0001	0.0012	0.6622
23	<.0001	<.0001	0.0373	<.0001	<.0001	<.0001	0.1467
24	0.0011	<.0001	<.0001	0.8737	<.0001	<.0001	<.0001
25	<.0001	0.3414	<.0001	<.0001	<.0001	0.7841	0.0007
26	<.0001	<.0001	0.0024	<.0001	<.0001	<.0001	0.6533
27	<.0001	<.0001	0.0015	<.0001	<.0001	<.0001	0.7590
28	0.3611	<.0001	<.0001	0.0249	<.0001	<.0001	<.0001
29	<.0001	0.0838	<.0001	<.0001	<.0001	0.2891	0.0077
30	<.0001	<.0001	0.5434	<.0001	<.0001	<.0001	0.0038
31	<.0001	<.0001	0.0003	0.1517	<.0001	<.0001	<.0001
32	0.0002	<.0001	<.0001	0.4600	<.0001	<.0001	<.0001
33	<.0001	0.3407	<.0001	<.0001	<.0001	0.7831	0.0007
34	<.0001	0.0011	<.0001	<.0001	<.0001	0.0089	0.2674
35	<.0001	<.0001	0.0055	<.0001	<.0001	<.0001	0.4667
36	<.0001	<.0001	0.0002	0.1908	<.0001	<.0001	<.0001
37	<.0001	0.3145	<.0001	<.0001	<.0001	0.7424	0.0008
38	<.0001	<.0001	0.0008	<.0001	<.0001	0.0002	0.9040
39	<.0001	<.0001	0.0760	<.0001	<.0001	<.0001	0.0782
40	0.0001	<.0001	<.0001	0.4469	<.0001	<.0001	<.0001
41	<.0001	0.1194	<.0001	<.0001	<.0001	0.3756	0.0047
42	<.0001	<.0001	0.0003	<.0001	<.0001	0.0004	0.8867
43	<.0001	<.0001	0.9345	<.0001	<.0001	<.0001	0.0004
44	0.0046	<.0001	<.0001	0.7715	<.0001	<.0001	<.0001
45	<.0001	0.3191	<.0001	<.0001	<.0001	0.7496	0.0008
46	<.0001	0.0013	<.0001	<.0001	<.0001	0.0100	0.2486
47	<.0001	<.0001	0.0103	<.0001	<.0001	<.0001	0.3414
48	<.0001	<.0001	0.0045	0.0252	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	15	16	17	18	19	20	21
1	<.0001	<.0001	0.0535	<.0001	<.0001	<.0001	0.5086
2	0.0008	<.0001	0.3449	<.0001	<.0001	<.0001	0.0274
3	0.0370	<.0001	0.0236	0.0013	<.0001	<.0001	0.0005
4	<.0001	0.1859	<.0001	<.0001	<.0001	0.0023	<.0001
5	<.0001	<.0001	0.0694	<.0001	<.0001	<.0001	0.5868
6	0.6672	<.0001	0.0001	0.1045	0.0005	<.0001	<.0001
7	0.0016	<.0001	<.0001	0.0438	0.9465	0.0026	<.0001
8	<.0001	0.0597	<.0001	<.0001	<.0001	0.0003	<.0001
9	<.0001	<.0001	0.0535	<.0001	<.0001	<.0001	0.5086
10	0.0976	<.0001	<.0001	0.6425	0.1344	<.0001	<.0001
11	<.0001	0.1997	<.0001	<.0001	0.0004	0.6096	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	0.2059	<.0001	<.0001	<.0001	0.9858
14	0.0603	<.0001	0.0136	0.0025	<.0001	<.0001	0.0002
15		<.0001	<.0001	0.2302	0.0020	<.0001	<.0001
16	<.0001		<.0001	<.0001	<.0001	0.0744	<.0001
17	<.0001	<.0001		<.0001	<.0001	<.0001	0.1997
18	0.2302	<.0001	<.0001		0.0511	<.0001	<.0001
19	0.0020	<.0001	<.0001	0.0511		0.0021	<.0001
20	<.0001	0.0744	<.0001	<.0001	0.0021		<.0001
21	<.0001	<.0001	0.1997	<.0001	<.0001	<.0001	
22	0.0214	<.0001	0.0406	0.0006	<.0001	<.0001	0.0011
23	0.6622	<.0001	0.0001	0.1031	0.0005	<.0001	<.0001
24	<.0001	0.1501	<.0001	<.0001	0.0007	0.7248	<.0001
25	<.0001	<.0001	0.3205	<.0001	<.0001	<.0001	0.7705
26	0.1501	<.0001	0.0038	0.0092	<.0001	<.0001	<.0001
27	0.1143	<.0001	0.0058	0.0062	<.0001	<.0001	<.0001
28	<.0001	0.3258	<.0001	<.0001	<.0001	0.0063	<.0001
29	<.0001	<.0001	0.8361	<.0001	<.0001	<.0001	0.2811
30	0.2903	<.0001	<.0001	0.8856	0.0366	<.0001	<.0001
31	<.0001	0.0074	<.0001	<.0001	0.0282	0.3533	<.0001
32	<.0001	0.0448	<.0001	<.0001	0.0042	0.8190	<.0001
33	<.0001	<.0001	0.3211	<.0001	<.0001	<.0001	0.7694
34	0.0033	<.0001	0.1652	<.0001	<.0001	<.0001	0.0084
35	0.2447	<.0001	0.0016	0.0194	<.0001	<.0001	<.0001
36	<.0001	0.0105	<.0001	<.0001	0.0205	0.4228	<.0001
37	<.0001	<.0001	0.3477	<.0001	<.0001	<.0001	0.7289
38	0.0782	<.0001	0.0098	0.0036	<.0001	<.0001	0.0002
39	0.9040	<.0001	<.0001	0.1872	0.0013	<.0001	<.0001
40	<.0001	0.0426	<.0001	<.0001	0.0045	0.8021	<.0001
41	<.0001	<.0001	0.7024	<.0001	<.0001	<.0001	0.3661
42	0.0437	<.0001	0.0197	0.0016	<.0001	<.0001	0.0004
43	0.0824	<.0001	<.0001	0.5849	0.1567	<.0001	<.0001
44	<.0001	0.3198	<.0001	<.0001	0.0001	0.4236	<.0001
45	<.0001	<.0001	0.3428	<.0001	<.0001	<.0001	0.7362
46	0.0029	<.0001	0.1792	<.0001	<.0001	<.0001	0.0096
47	0.3470	<.0001	0.0008	0.0339	<.0001	<.0001	<.0001
48	<.0001	0.0006	<.0001	0.0011	0.1648	0.0814	<.0001

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	22	23	24	25	26	27	28
1	0.0001	<.0001	<.0001	0.3414	<.0001	<.0001	<.0001
2	0.2628	0.0032	<.0001	0.0543	0.0467	0.0642	<.0001
3	0.8233	0.0967	<.0001	0.0014	0.5077	0.6029	<.0001
4	<.0001	<.0001	0.0065	<.0001	<.0001	<.0001	0.7310
5	0.0002	<.0001	<.0001	0.4041	<.0001	<.0001	<.0001
6	0.0594	0.9945	<.0001	<.0001	0.3106	0.2481	<.0001
7	<.0001	0.0004	0.0008	<.0001	<.0001	<.0001	<.0001
8	<.0001	<.0001	0.0011	<.0001	<.0001	<.0001	0.3611
9	0.0001	<.0001	<.0001	0.3414	<.0001	<.0001	<.0001
10	0.0001	0.0373	<.0001	<.0001	0.0024	0.0015	<.0001
11	<.0001	<.0001	0.8737	<.0001	<.0001	<.0001	0.0249
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.0012	<.0001	<.0001	0.7841	<.0001	<.0001	<.0001
14	0.6622	0.1467	<.0001	0.0007	0.6533	0.7590	<.0001
15	0.0214	0.6622	<.0001	<.0001	0.1501	0.1143	<.0001
16	<.0001	<.0001	0.1501	<.0001	<.0001	<.0001	0.3258
17	0.0406	0.0001	<.0001	0.3205	0.0038	0.0058	<.0001
18	0.0006	0.1031	<.0001	<.0001	0.0092	0.0062	<.0001
19	<.0001	0.0005	0.0007	<.0001	<.0001	<.0001	<.0001
20	<.0001	<.0001	0.7248	<.0001	<.0001	<.0001	0.0063
21	0.0011	<.0001	<.0001	0.7705	<.0001	<.0001	<.0001
22		0.0603	<.0001	0.0027	0.3763	0.4575	<.0001
23	0.0603		<.0001	<.0001	0.3139	0.2508	<.0001
24	<.0001	<.0001		<.0001	<.0001	<.0001	0.0166
25	0.0027	<.0001	<.0001		0.0001	0.0002	<.0001
26	0.3763	0.3139	<.0001	0.0001		0.8867	<.0001
27	0.4575	0.2508	<.0001	0.0002	0.8867		<.0001
28	<.0001	<.0001	0.0166	<.0001	<.0001	<.0001	
29	0.0246	<.0001	<.0001	0.4308	0.0020	0.0032	<.0001
30	0.0010	0.1365	<.0001	<.0001	0.0136	0.0092	<.0001
31	<.0001	<.0001	0.2016	<.0001	<.0001	<.0001	0.0003
32	<.0001	<.0001	0.5616	<.0001	<.0001	<.0001	0.0032
33	0.0028	<.0001	<.0001	0.9989	0.0001	0.0002	<.0001
34	0.4999	0.0114	<.0001	0.0185	0.1206	0.1579	<.0001
35	0.2453	0.4658	<.0001	<.0001	0.7799	0.6732	<.0001
36	<.0001	<.0001	0.2497	<.0001	<.0001	<.0001	0.0005
37	0.0032	<.0001	<.0001	0.9563	0.0002	0.0003	<.0001
38	0.5774	0.1827	<.0001	0.0005	0.7424	0.8522	<.0001
39	0.0289	0.7517	<.0001	<.0001	0.1868	0.1441	<.0001
40	<.0001	<.0001	0.5470	<.0001	<.0001	<.0001	0.0030
41	0.0157	<.0001	<.0001	0.5397	0.0012	0.0018	<.0001
42	0.7684	0.1116	<.0001	0.0011	0.5543	0.6533	<.0001
43	<.0001	0.0307	<.0001	<.0001	0.0018	0.0012	<.0001
44	<.0001	<.0001	0.6533	<.0001	<.0001	<.0001	0.0497
45	0.0032	<.0001	<.0001	0.9639	0.0002	0.0003	<.0001
46	0.4717	0.0101	<.0001	0.0207	0.1104	0.1452	<.0001
47	0.1664	0.6134	<.0001	<.0001	0.6144	0.5183	<.0001
48	<.0001	<.0001	0.0371	<.0001	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	29	30	31	32	33	34	35
1	0.0838	<.0001	<.0001	<.0001	0.3407	0.0011	<.0001
2	0.2503	<.0001	<.0001	<.0001	0.0545	0.6543	0.0239
3	0.0139	0.0020	<.0001	<.0001	0.0014	0.3698	0.3470
4	<.0001	<.0001	<.0001	0.0011	<.0001	<.0001	<.0001
5	0.1065	<.0001	<.0001	<.0001	0.4034	0.0017	<.0001
6	<.0001	0.1383	<.0001	<.0001	<.0001	0.0112	0.4617
7	<.0001	0.0312	0.0332	0.0051	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001
9	0.0838	<.0001	<.0001	<.0001	0.3407	0.0011	<.0001
10	<.0001	0.5434	0.0003	<.0001	<.0001	<.0001	0.0055
11	<.0001	<.0001	0.1517	0.4600	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.2891	<.0001	<.0001	<.0001	0.7831	0.0089	<.0001
14	0.0077	0.0038	<.0001	<.0001	0.0007	0.2674	0.4667
15	<.0001	0.2903	<.0001	<.0001	<.0001	0.0033	0.2447
16	<.0001	<.0001	0.0074	0.0448	<.0001	<.0001	<.0001
17	0.8361	<.0001	<.0001	<.0001	0.3211	0.1652	0.0016
18	<.0001	0.8856	<.0001	<.0001	<.0001	<.0001	0.0194
19	<.0001	0.0366	0.0282	0.0042	<.0001	<.0001	<.0001
20	<.0001	<.0001	0.3533	0.8190	<.0001	<.0001	<.0001
21	0.2811	<.0001	<.0001	<.0001	0.7694	0.0084	<.0001
22	0.0246	0.0010	<.0001	<.0001	0.0028	0.4999	0.2453
23	<.0001	0.1365	<.0001	<.0001	<.0001	0.0114	0.4658
24	<.0001	<.0001	0.2016	0.5616	<.0001	<.0001	<.0001
25	0.4308	<.0001	<.0001	<.0001	0.9989	0.0185	<.0001
26	0.0020	0.0136	<.0001	<.0001	0.0001	0.1206	0.7799
27	0.0032	0.0092	<.0001	<.0001	0.0002	0.1579	0.6732
28	<.0001	<.0001	0.0003	0.0032	<.0001	<.0001	<.0001
29		<.0001	<.0001	<.0001	0.4315	0.1116	0.0008
30	<.0001		<.0001	<.0001	<.0001	<.0001	0.0278
31	<.0001	<.0001		0.4836	<.0001	<.0001	<.0001
32	<.0001	<.0001	0.4836		<.0001	<.0001	<.0001
33	0.4315	<.0001	<.0001	<.0001		0.0185	<.0001
34	0.1116	<.0001	<.0001	<.0001	0.0185		0.0679
35	0.0008	0.0278	<.0001	<.0001	<.0001	0.0679	
36	<.0001	<.0001	0.8986	0.5662	<.0001	<.0001	<.0001
37	0.4633	<.0001	<.0001	<.0001	0.9574	0.0212	<.0001
38	0.0055	0.0055	<.0001	<.0001	0.0005	0.2194	0.5434
39	<.0001	0.2393	<.0001	<.0001	<.0001	0.0047	0.2966
40	<.0001	<.0001	0.4973	0.9825	<.0001	<.0001	<.0001
41	0.8608	<.0001	<.0001	<.0001	0.5406	0.0780	0.0005
42	0.0114	0.0025	<.0001	<.0001	0.0011	0.3332	0.3845
43	<.0001	0.4904	0.0004	<.0001	<.0001	<.0001	0.0043
44	<.0001	<.0001	0.0857	0.3042	<.0001	<.0001	<.0001
45	0.4575	<.0001	<.0001	<.0001	0.9650	0.0207	<.0001
46	0.1219	<.0001	<.0001	<.0001	0.0208	0.9639	0.0616
47	0.0004	0.0474	<.0001	<.0001	<.0001	0.0410	0.8222
48	<.0001	0.0007	0.4095	0.1289	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	36	37	38	39	40	41	42
1	<.0001	0.3145	<.0001	<.0001	<.0001	0.1194	<.0001
2	<.0001	0.0614	0.0951	0.0012	<.0001	0.1859	0.1583
3	<.0001	0.0016	0.7382	0.0489	<.0001	0.0086	0.9432
4	0.0002	<.0001	<.0001	<.0001	0.0010	<.0001	<.0001
5	<.0001	0.3741	<.0001	<.0001	<.0001	0.1494	<.0001
6	<.0001	<.0001	0.1805	0.7569	<.0001	<.0001	0.1101
7	0.0243	<.0001	<.0001	0.0011	0.0055	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001
9	<.0001	0.3145	<.0001	<.0001	<.0001	0.1194	<.0001
10	0.0002	<.0001	0.0008	0.0760	<.0001	<.0001	0.0003
11	0.1908	<.0001	<.0001	<.0001	0.4469	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	0.7424	0.0002	<.0001	<.0001	0.3756	0.0004
14	<.0001	0.0008	0.9040	0.0782	<.0001	0.0047	0.8867
15	<.0001	<.0001	0.0782	0.9040	<.0001	<.0001	0.0437
16	0.0105	<.0001	<.0001	<.0001	0.0426	<.0001	<.0001
17	<.0001	0.3477	0.0098	<.0001	<.0001	0.7024	0.0197
18	<.0001	<.0001	0.0036	0.1872	<.0001	<.0001	0.0016
19	0.0205	<.0001	<.0001	0.0013	0.0045	<.0001	<.0001
20	0.4228	<.0001	<.0001	<.0001	0.8021	<.0001	<.0001
21	<.0001	0.7289	0.0002	<.0001	<.0001	0.3661	0.0004
22	<.0001	0.0032	0.5774	0.0289	<.0001	0.0157	0.7684
23	<.0001	<.0001	0.1827	0.7517	<.0001	<.0001	0.1116
24	0.2497	<.0001	<.0001	<.0001	0.5470	<.0001	<.0001
25	<.0001	0.9563	0.0005	<.0001	<.0001	0.5397	0.0011
26	<.0001	0.0002	0.7424	0.1868	<.0001	0.0012	0.5543
27	<.0001	0.0003	0.8522	0.1441	<.0001	0.0018	0.6533
28	0.0005	<.0001	<.0001	<.0001	0.0030	<.0001	<.0001
29	<.0001	0.4633	0.0055	<.0001	<.0001	0.8608	0.0114
30	<.0001	<.0001	0.0055	0.2393	<.0001	<.0001	0.0025
31	0.8986	<.0001	<.0001	<.0001	0.4973	<.0001	<.0001
32	0.5662	<.0001	<.0001	<.0001	0.9825	<.0001	<.0001
33	<.0001	0.9574	0.0005	<.0001	<.0001	0.5406	0.0011
34	<.0001	0.0212	0.2194	0.0047	<.0001	0.0780	0.3332
35	<.0001	<.0001	0.5434	0.2966	<.0001	0.0005	0.3845
36		<.0001	<.0001	<.0001	0.5811	<.0001	<.0001
37	<.0001		0.0005	<.0001	<.0001	0.5765	0.0013
38	<.0001	0.0005		0.1003	<.0001	0.0033	0.7925
39	<.0001	<.0001	0.1003		<.0001	<.0001	0.0574
40	0.5811	<.0001	<.0001	<.0001		<.0001	<.0001
41	<.0001	0.5765	0.0033	<.0001	<.0001		0.0070
42	<.0001	0.0013	0.7925	0.0574	<.0001	0.0070	
43	0.0003	<.0001	0.0006	0.0636	<.0001	<.0001	0.0003
44	0.1110	<.0001	<.0001	<.0001	0.2941	<.0001	<.0001
45	<.0001	0.9923	0.0005	<.0001	<.0001	0.5700	0.0013
46	<.0001	0.0238	0.2031	0.0041	<.0001	0.0857	0.3113
47	<.0001	<.0001	0.4057	0.4119	<.0001	0.0002	0.2745
48	0.3414	<.0001	<.0001	<.0001	0.1344	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Load
Dependent Variable: Glucose

i/j	43	44	45	46	47	48
1	<.0001	<.0001	0.3191	0.0013	<.0001	<.0001
2	<.0001	<.0001	0.0601	0.6872	0.0134	<.0001
3	0.0002	<.0001	0.0016	0.3463	0.2447	<.0001
4	<.0001	0.0218	<.0001	<.0001	<.0001	<.0001
5	<.0001	<.0001	0.3793	0.0019	<.0001	<.0001
6	0.0312	<.0001	<.0001	0.0099	0.6086	<.0001
7	0.1383	0.0002	<.0001	<.0001	<.0001	0.1859
8	<.0001	0.0046	<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001	0.3191	0.0013	<.0001	<.0001
10	0.9345	<.0001	<.0001	<.0001	0.0103	0.0045
11	<.0001	0.7715	<.0001	<.0001	<.0001	0.0252
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	0.7496	0.0100	<.0001	<.0001
14	0.0004	<.0001	0.0008	0.2486	0.3414	<.0001
15	0.0824	<.0001	<.0001	0.0029	0.3470	<.0001
16	<.0001	0.3198	<.0001	<.0001	<.0001	0.0006
17	<.0001	<.0001	0.3428	0.1792	0.0008	<.0001
18	0.5849	<.0001	<.0001	<.0001	0.0339	0.0011
19	0.1567	0.0001	<.0001	<.0001	<.0001	0.1648
20	<.0001	0.4236	<.0001	<.0001	<.0001	0.0814
21	<.0001	<.0001	0.7362	0.0096	<.0001	<.0001
22	<.0001	<.0001	0.0032	0.4717	0.1664	<.0001
23	0.0307	<.0001	<.0001	0.0101	0.6134	<.0001
24	<.0001	0.6533	<.0001	<.0001	<.0001	0.0371
25	<.0001	<.0001	0.9639	0.0207	<.0001	<.0001
26	0.0018	<.0001	0.0002	0.1104	0.6144	<.0001
27	0.0012	<.0001	0.0003	0.1452	0.5183	<.0001
28	<.0001	0.0497	<.0001	<.0001	<.0001	<.0001
29	<.0001	<.0001	0.4575	0.1219	0.0004	<.0001
30	0.4904	<.0001	<.0001	<.0001	0.0474	0.0007
31	0.0004	0.0857	<.0001	<.0001	<.0001	0.4095
32	<.0001	0.3042	<.0001	<.0001	<.0001	0.1289
33	<.0001	<.0001	0.9650	0.0208	<.0001	<.0001
34	<.0001	<.0001	0.0207	0.9639	0.0410	<.0001
35	0.0043	<.0001	<.0001	0.0616	0.8222	<.0001
36	0.0003	0.1110	<.0001	<.0001	<.0001	0.3414
37	<.0001	<.0001	0.9923	0.0238	<.0001	<.0001
38	0.0006	<.0001	0.0005	0.2031	0.4057	<.0001
39	0.0636	<.0001	<.0001	0.0041	0.4119	<.0001
40	<.0001	0.2941	<.0001	<.0001	<.0001	0.1344
41	<.0001	<.0001	0.5700	0.0857	0.0002	<.0001
42	0.0003	<.0001	0.0013	0.3113	0.2745	<.0001
43		<.0001	<.0001	<.0001	0.0082	0.0057
44	<.0001		<.0001	<.0001	<.0001	0.0119
45	<.0001	<.0001		0.0232	<.0001	<.0001
46	<.0001	<.0001	0.0232		0.0369	<.0001
47	0.0082	<.0001	<.0001	0.0369		<.0001
48	0.0057	0.0119	<.0001	<.0001	<.0001	

Appendix B.3 Comparison of Flour and Fresh ISP

```
title 'Saccharification on FTA-94 SWP: Sugars and Change in Starch';
data Saccharification032008;
input Prep$ Enz$ Load Hour Rep DeltaAIS Maltotriose Maltose Glucose;
datalines;
Fresh Fuel  0     0     1     51.9  33.8  287.7 0
Fresh Fuel  0     0     2     53.6  29.1  297.1 0
Fresh Fuel  0     0     3     54.6  33    303.4 0
Fresh Fuel  0.5   0     1     53.9  0     286.9 81.7
Fresh Fuel  0.5   0     2     53.6  15.7  296.3 65.2
Fresh Fuel  0.5   0     3     53.2  13.4  277.5 64.5
Fresh Fuel  1     0     1     53.2  0     246   139.1
Fresh Fuel  1     0     2     53.2  0     256.2 130.5
Fresh Fuel  1     0     3     54.6  21.2  274.3 40.1
Fresh Fuel  5     0     1     54.9  0     37.7  403.2
Fresh Fuel  5     0     2     54.9  0     54.2  379.6
Fresh Fuel  5     0     3     53.6  0     48.7  371
Fresh Fuel  0     24    1     55.9  37.6  313.3 16
Fresh Fuel  0     24    2     56.6  36    299.8 15.2
Fresh Fuel  0     24    3     56.9  37.6  317.3 18.4
Fresh Fuel  0.5   24    1     56.6  10.4  295.8 135.9
Fresh Fuel  0.5   24    2     56.6  16    268.6 78.3
Fresh Fuel  0.5   24    3     56.6  15.2  302.1 111.1
Fresh Fuel  1     24    1     56.2  0     224.6 165.5
Fresh Fuel  1     24    2     55.9  10.4  257.4 157.5
Fresh Fuel  1     24    3     56.2  24    279   140.7
Fresh Fuel  5     24    1     56.9  0     114.3 384.5
Fresh Fuel  5     24    2     55.9  9.6   150.3 285.4
Fresh Fuel  5     24    3     55.9  0     87.9  386.9
Fresh Fuel  0     48    1     54.6  39.2  378.1 23.2
Fresh Fuel  0     48    2     56.2  39.2  370.9 24
Fresh Fuel  0     48    3     55.9  38.4  366.9 22.4
Fresh Fuel  0.5   48    1     55.2  12.8  327.7 118.3
Fresh Fuel  0.5   48    2     55.6  12.8  322.9 121.5
Fresh Fuel  0.5   48    3     56.2  8     287.8 118.3
Fresh Fuel  1     48    1     56.2  25.6  368.5 81.5
Fresh Fuel  1     48    2     56.6  18.4  374.1 127.1
Fresh Fuel  1     48    3     56.6  12    323.7 139.1
Fresh Fuel  5     48    1     56.2  13.6  211.8 310.1
Fresh Fuel  5     48    2     56.2  8     165.5 402.1
Fresh Fuel  5     48    3     55.9  0     129.5 416.5
Fresh Fuel  0     72    1     56.6  41.6  362.1 24
Fresh Fuel  0     72    2     56.2  42.4  378.1 25.6
Fresh Fuel  0     72    3     55.9  40.8  366.9 24
Fresh Fuel  0.5   72    1     56.2  19.2  329.3 97.5
Fresh Fuel  0.5   72    2     56.2  12    311.7 109.5
Fresh Fuel  0.5   72    3     56.6  16.8  352.5 127.1
Fresh Fuel  1     72    1     56.2  15.2  275.8 151.9
Fresh Fuel  1     72    2     56.6  12.8  294.2 168.7
Fresh Fuel  1     72    3     56.6  12.8  272.6 134.3
Fresh Fuel  5     72    1     56.6  17.6  177.5 259.8
```

Fresh Fuel	5	72	2	56.9	13.6	172.7	312.5
Fresh Fuel	5	72	3	56.9	8.8	148.7	334.9
Fresh Tech	0	0	1	54.1	33.8	274.3	0
Fresh Tech	0	0	2	53.8	25.9	250.7	0
Fresh Tech	0	0	3	56.1	29.1	264.1	8.6
Fresh Tech	0.5	0	1	56.4	0	193.4	191
Fresh Tech	0.5	0	2	56.8	0	229.5	150.9
Fresh Tech	0.5	0	3	54.1	0	228.7	90.4
Fresh Tech	1	0	1	56.4	0	40.9	362.3
Fresh Tech	1	0	2	54.4	0	168.2	169.8
Fresh Tech	1	0	3	54.8	0	178.4	168.2
Fresh Tech	5	0	1	54.4	0	0	391.4
Fresh Tech	5	0	2	56.1	0	0	385.9
Fresh Tech	5	0	3	56.8	0	0	418.2
Fresh Tech	0	24	1	60.4	35.2	299	63.1
Fresh Tech	0	24	2	61.1	34.4	293.4	31.2
Fresh Tech	0	24	3	60.8	33.6	283	48
Fresh Tech	0.5	24	1	60.4	7.2	223.8	220.6
Fresh Tech	0.5	24	2	59.8	11.2	218.2	165.5
Fresh Tech	0.5	24	3	60.4	12	223	165.5
Fresh Tech	1	24	1	60.1	0	111.9	230.2
Fresh Tech	1	24	2	60.8	12.8	208.6	208.6
Fresh Tech	1	24	3	60.4	8	180.6	256.6
Fresh Tech	5	24	1	61.1	0	95.9	314.9
Fresh Tech	5	24	2	61.1	0	129.5	307.7
Fresh Tech	5	24	3	61.1	0	131.1	302.9
Fresh Tech	0	48	1	61.1	34.4	335.7	47.2
Fresh Tech	0	48	2	60.8	30.4	302.1	41.6
Fresh Tech	0	48	3	60.4	28.8	326.9	38.4
Fresh Tech	0.5	48	1	60.8	20	282.2	160.7
Fresh Tech	0.5	48	2	61.1	12	232.6	189.4
Fresh Tech	0.5	48	3	61.8	12	215.8	191
Fresh Tech	1	48	1	60.8	11.2	200.6	236.6
Fresh Tech	1	48	2	60.4	8	191	316.5
Fresh Tech	1	48	3	60.8	10.4	173.5	304.5
Fresh Tech	5	48	1	62.1	8	151.1	249.4
Fresh Tech	5	48	2	61.4	0	136.7	334.9
Fresh Tech	5	48	3	61.4	0	119.1	324.5
Fresh Tech	0	72	1	61.1	40.8	332.5	44.8
Fresh Tech	0	72	2	61.4	40	324.5	35.2
Fresh Tech	0	72	3	61.1	41.6	337.3	34.4
Fresh Tech	0.5	72	1	61.8	31.2	311.7	98.3
Fresh Tech	0.5	72	2	60.8	24	301.3	103.1
Fresh Tech	0.5	72	3	61.8	19.2	278.2	113.5
Fresh Tech	1	72	1	61.8	18.4	237.4	193.4
Fresh Tech	1	72	2	60.8	12.8	222.2	173.5
Fresh Tech	1	72	3	61.1	12.8	178.3	224.6
Fresh Tech	5	72	1	61.4	7.2	131.9	296.6
Fresh Tech	5	72	2	62.1	10.4	162.3	342.9
Fresh Tech	5	72	3	61.8	7.2	120.7	344.5
Fresh Ultra	0	0	1	54.8	25.9	309.7	0
Fresh Ultra	0	0	2	.	23.6	296.3	0
Fresh Ultra	0	0	3	54.4	27.5	332.5	0

Fresh	Ultra	0.5	0	1	55.1	0	264.1	177.6
Fresh	Ultra	0.5	0	2	54.1	0	216.2	206.7
Fresh	Ultra	0.5	0	3	55.1	0	188.6	201.2
Fresh	Ultra	1	0	1	56.4	0	181.6	284.5
Fresh	Ultra	1	0	2	55.1	0	33	360
Fresh	Ultra	1	0	3	55.4	0	117.1	318.3
Fresh	Ultra	5	0	1	55.1	0	0	524.3
Fresh	Ultra	5	0	2	54.4	0	0	512.5
Fresh	Ultra	5	0	3	55.4	0	0	488.9
Fresh	Ultra	0	24	1	58.1	32	355.6	16.4
Fresh	Ultra	0	24	2	58.1	32	345.8	17.2
Fresh	Ultra	0	24	3	58.4	29.5	331	14.7
Fresh	Ultra	0.5	24	1	58.4	18.8	331	104.9
Fresh	Ultra	0.5	24	2	58.8	18	324.5	100.8
Fresh	Ultra	0.5	24	3	59.1	23.8	347.4	87.7
Fresh	Ultra	1	24	1	58.1	14.7	310.5	156.5
Fresh	Ultra	1	24	2	58.1	16.4	312.2	145.8
Fresh	Ultra	1	24	3	58.1	18	326.1	129.5
Fresh	Ultra	5	24	1	57.8	10.7	172.9	313
Fresh	Ultra	5	24	2	59.1	9.8	167.1	326.9
Fresh	Ultra	5	24	3	57.4	13.1	189.3	311.3
Fresh	Ultra	0	48	1	59.4	39.3	390	23.8
Fresh	Ultra	0	48	2	59.4	36.9	376.9	23.8
Fresh	Ultra	0	48	3	59.8	36.9	379.4	22.1
Fresh	Ultra	0.5	48	1	59.4	27.9	370.3	68.8
Fresh	Ultra	0.5	48	2	60.1	30.3	382.6	72.1
Fresh	Ultra	0.5	48	3	60.1	23.8	355.6	103.2
Fresh	Ultra	1	48	1	60.1	28.7	385.9	109.8
Fresh	Ultra	1	48	2	60.4	27	399	132.7
Fresh	Ultra	1	48	3	59.8	21.3	317.9	136
Fresh	Ultra	5	48	1	59.8	14.7	231.1	281.9
Fresh	Ultra	5	48	2	59.1	16.4	266.3	327.7
Fresh	Ultra	5	48	3	59.8	16.4	244.2	257.3
Fresh	Ultra	0	72	1	58.8	37.7	376.1	25.4
Fresh	Ultra	0	72	2	59.4	36.9	369.5	22.9
Fresh	Ultra	0	72	3	59.8	38.5	391.6	24.6
Fresh	Ultra	0.5	72	1	58.1	28.7	386.7	77.8
Fresh	Ultra	0.5	72	2	59.4	29.5	369.5	72.9
Fresh	Ultra	0.5	72	3	60.1	27.9	375.3	90.1
Fresh	Ultra	1	72	1	59.4	23.8	347.4	124.5
Fresh	Ultra	1	72	2	59.8	25.4	365.4	125.4
Fresh	Ultra	1	72	3	59.8	19.7	326.1	145.0
Fresh	Ultra	5	72	1	60.1	26.2	340.0	231.9
Fresh	Ultra	5	72	2	59.4	20.5	280.2	291.7
Fresh	Ultra	5	72	3	59.8	15.6	239.2	273.7
Dry	Fuel	0	0	1	50.3	46.8	247.6	12.8
Dry	Fuel	0	0	2	50	42.8	233.6	12.4
Dry	Fuel	0	0	3	51	46.4	276.4	16
Dry	Fuel	0.5	0	1	51.3	26	274.8	74
Dry	Fuel	0.5	0	2	50.7	22	280.4	88.4
Dry	Fuel	0.5	0	3	50.3	22	272.4	77.6
Dry	Fuel	1	0	1	49.7	4	258.4	120.8
Dry	Fuel	1	0	2	50	8	270	112.8

Dry	Fuel	1	0	3	49.7	3.6	252.4	124
Dry	Fuel	5	0	1	51.3	0	74.4	343.6
Dry	Fuel	5	0	2	49	0	70.4	368.4
Dry	Fuel	5	0	3	49.7	0	44.8	380.4
Dry	Fuel	0	24	1	52	49.2	285.2	34.7
Dry	Fuel	0	24	2	53	51.7	278.6	28.5
Dry	Fuel	0	24	3	53.7	47.5	261.6	28.1
Dry	Fuel	0.5	24	1	52.7	11.6	255.4	144.3
Dry	Fuel	0.5	24	2	53	5.4	252.5	174
Dry	Fuel	0.5	24	3	52	0	219.1	188.1
Dry	Fuel	1	24	1	53	0	203.8	250.9
Dry	Fuel	1	24	2	52.7	0	199.2	231.5
Dry	Fuel	1	24	3	52.3	4.1	152.9	267
Dry	Fuel	5	24	1	49.3	0	22.7	468.7
Dry	Fuel	5	24	2	52	0	24.4	448.5
Dry	Fuel	5	24	3	54.3	0	18.6	474.1
Dry	Fuel	0	48	1	50	43	241.8	25.2
Dry	Fuel	0	48	2	50	58.7	298	30.6
Dry	Fuel	0	48	3	51.7	60.3	296.8	30.2
Dry	Fuel	0.5	48	1	52	7.9	233.1	198
Dry	Fuel	0.5	48	2	51.7	0	250.1	222
Dry	Fuel	0.5	48	3	51.7	3.3	245.9	195.5
Dry	Fuel	1	48	1	51.3	0	118.2	337.7
Dry	Fuel	1	48	2	50.3	0	164.5	312.5
Dry	Fuel	1	48	3	52.3	0	171.5	298
Dry	Fuel	5	48	1	52.3	0	19	491
Dry	Fuel	5	48	2	52	0	14.9	523.7
Dry	Fuel	5	48	3	51.7	0	14.1	527.4
Dry	Fuel	0	72	1	52.7	57.5	273.6	37.2
Dry	Fuel	0	72	2	53	54.6	279.8	31
Dry	Fuel	0	72	3	53	61.6	304.6	31.8
Dry	Fuel	0.5	72	1	53.7	0	222.4	240.6
Dry	Fuel	0.5	72	2	53.3	0	251.7	207.9
Dry	Fuel	0.5	72	3	53	8.3	247.6	180.2
Dry	Fuel	1	72	1	53	0	150.5	296.8
Dry	Fuel	1	72	2	53.3	0	183.9	279
Dry	Fuel	1	72	3	53	7	184.8	233.9
Dry	Fuel	5	72	1	53.3	0	14.5	503.9
Dry	Fuel	5	72	2	52.3	0	36.8	469.5
Dry	Fuel	5	72	3	53	0	18.2	506.3
Dry	Tech	0	0	1	48.4	39.2	260.4	12.8
Dry	Tech	0	0	2	47.8	43.2	278.4	13.2
Dry	Tech	0	0	3	50.1	31.6	209.6	10
Dry	Tech	0.5	0	1	49.4	0	212.8	221.2
Dry	Tech	0.5	0	2	49.4	0	212.4	222.8
Dry	Tech	0.5	0	3	49.4	0	168	267.6
Dry	Tech	1	0	1	48.4	0	37.6	417.2
Dry	Tech	1	0	2	48.4	0	41.2	394.8
Dry	Tech	1	0	3	49.1	0	19.2	429.6
Dry	Tech	5	0	1	49.8	0	0	484.8
Dry	Tech	5	0	2	50.4	0	0	492
Dry	Tech	5	0	3	50.1	0	0	478.8
Dry	Tech	0	24	1	51.4	30.2	300.1	78.9

Dry	Tech	0	24	2	51.4	47.1	280.7	35.5
Dry	Tech	0	24	3	51.1	45.9	279	31.4
Dry	Tech	0.5	24	1	50.8	0	168.2	258.3
Dry	Tech	0.5	24	2	51.4	4.5	194.3	220.3
Dry	Tech	0.5	24	3	51.8	0	166.2	257.5
Dry	Tech	1	24	1	52.1	0	78.1	365
Dry	Tech	1	24	2	52.1	0	100.4	376.1
Dry	Tech	1	24	3	52.1	0	102.5	369.9
Dry	Tech	5	24	1	51.4	0	16.1	516.7
Dry	Tech	5	24	2	52.1	0	9.9	482.8
Dry	Tech	5	24	3	51.8	0	18.2	500.1
Dry	Tech	0	48	1	51.4	49.6	281.5	37.2
Dry	Tech	0	48	2	51.4	48.4	269.9	25.6
Dry	Tech	0	48	3	51.4	54.1	291	25.2
Dry	Tech	0.5	48	1	51.8	0	202.9	259.2
Dry	Tech	0.5	48	2	51.4	0	205	261.2
Dry	Tech	0.5	48	3	51.8	0	188.1	267.4
Dry	Tech	1	48	1	52.1	0	100	368.3
Dry	Tech	1	48	2	52.1	0	110.8	363.7
Dry	Tech	1	48	3	51.8	0	78.9	360.4
Dry	Tech	5	48	1	52.1	0	12	451.8
Dry	Tech	5	48	2	51.8	0	12	524.1
Dry	Tech	5	48	3	51.4	0	10.7	540.2
Dry	Tech	0	72	1	49.8	48.4	279	38
Dry	Tech	0	72	2	50.1	54.1	300.5	31
Dry	Tech	0	72	3	50.1	56.2	298.4	30.2
Dry	Tech	0.5	72	1	50.4	0	202.9	243
Dry	Tech	0.5	72	2	49.4	0	203.4	272.4
Dry	Tech	0.5	72	3	50.1	0	188.9	248.8
Dry	Tech	1	72	1	48.1	0	99.2	369.9
Dry	Tech	1	72	2	50.4	0	104.6	370.3
Dry	Tech	1	72	3	50.1	0	64.1	450.1
Dry	Tech	5	72	1	49.8	0	12.8	575.8
Dry	Tech	5	72	2	50.1	0	11.6	546
Dry	Tech	5	72	3	50.4	0	10.7	527
Dry	Ultra	0	0	1	.	59.6	374.8	19.2
Dry	Ultra	0	0	2	48.2	18	186.8	44
Dry	Ultra	0	0	3	50.2	32	216	32.4
Dry	Ultra	0.5	0	1	49.2	8.8	274	110
Dry	Ultra	0.5	0	2	49.6	2.8	253.6	117.2
Dry	Ultra	0.5	0	3	50.9	0	254	120.8
Dry	Ultra	1	0	1	50.2	0	224.8	176.4
Dry	Ultra	1	0	2	51.2	0	228.8	185.2
Dry	Ultra	1	0	3	49.6	0	195.2	197.2
Dry	Ultra	5	0	1	49.6	5.2	0	424.4
Dry	Ultra	5	0	2	50.9	4.4	10.4	408.8
Dry	Ultra	5	0	3	50.6	6.4	0	475.2
Dry	Ultra	0	24	1	53.6	46.4	268.2	23.4
Dry	Ultra	0	24	2	52.2	49.4	292.5	24.3
Dry	Ultra	0	24	3	52.2	48.1	278.6	21.7
Dry	Ultra	0.5	24	1	52.2	13.9	264.8	194.6
Dry	Ultra	0.5	24	2	51.9	10	242.7	192.4
Dry	Ultra	0.5	24	3	51.9	13	238.3	211.9

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Dry    Ultra 1      24     1      52.2   7.4    175.5 263.5
Dry    Ultra 1      24     2      52.2   6.5    196.3 266.1
Dry    Ultra 1      24     3      52.2   7.8    180.7 296
Dry    Ultra 5      24     1      52.6   8.2    45.9  495.7
Dry    Ultra 5      24     2      52.2   7.4    26.9  491.8
Dry    Ultra 5      24     3      51.9   7.4    34.7  499.6
Dry    Ultra 0      48     1      51.2   65     341.9 29
Dry    Ultra 0      48     2      51.9   56.3   295.1 22.1
Dry    Ultra 0      48     3      51.9   51.6   292.1 28.6
Dry    Ultra 0.5    48     1      52.2   15.6   250   196.7
Dry    Ultra 0.5    48     2      51.9   10.4   248.3 209.3
Dry    Ultra 0.5    48     3      51.9   14.7   240.9 218.8
Dry    Ultra 1      48     1      52.6   8.7    187.2 307.7
Dry    Ultra 1      48     2      51.2   6.5    170.3 354.5
Dry    Ultra 1      48     3      52.6   6.1    171.6 293.8
Dry    Ultra 5      48     1      52.2   6.9    27.3  515.7
Dry    Ultra 5      48     2      52.9   6.9    35.1  517.8
Dry    Ultra 5      48     3      52.2   6.9    46.4  507.9
Dry    Ultra 0      72     1      51.2   59.4   318.1 30.8
Dry    Ultra 0      72     2      52.9   53.7   292.1 29.9
Dry    Ultra 0      72     3      51.2   55.5   302.9 32.1
Dry    Ultra 0.5    72     1      52.6   18.2   250.9 172.5
Dry    Ultra 0.5    72     2      51.9   23.8   253.9 148.2
Dry    Ultra 0.5    72     3      52.2   13.4   234   219.3
Dry    Ultra 1      72     1      51.9   6.9    211.5 277.3
Dry    Ultra 1      72     2      51.9   7.8    195   273.4
Dry    Ultra 1      72     3      53.6   10.4   179   275.6
Dry    Ultra 5      72     1      52.6   6.5    36.4  474.9
Dry    Ultra 5      72     2      52.6   10     58.5  478.4
Dry    Ultra 5      72     3      51.9   5.6    49.8  437.2
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
      class Hour Enz Prep Load;
      model DeltaAIS Maltotriose Maltose Glucose = Hour Enz Prep Load
Hour*Enz*Prep*Load;
      lsmeans Hour Enz Prep Load Hour*Enz*Prep*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Saccharification on FTA-94 SWP: Sugars and Change in Starch

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
1	Fresh	Fuel	0.0	0	1	51.9	33.8	287.7	0.0
2	Fresh	Fuel	0.0	0	2	53.6	29.1	297.1	0.0
3	Fresh	Fuel	0.0	0	3	54.6	33.0	303.4	0.0
4	Fresh	Fuel	0.5	0	1	53.9	0.0	286.9	81.7
5	Fresh	Fuel	0.5	0	2	53.6	15.7	296.3	65.2
6	Fresh	Fuel	0.5	0	3	53.2	13.4	277.5	64.5
7	Fresh	Fuel	1.0	0	1	53.2	0.0	246.0	139.1
8	Fresh	Fuel	1.0	0	2	53.2	0.0	256.2	130.5
9	Fresh	Fuel	1.0	0	3	54.6	21.2	274.3	40.1
10	Fresh	Fuel	5.0	0	1	54.9	0.0	37.7	403.2
11	Fresh	Fuel	5.0	0	2	54.9	0.0	54.2	379.6
12	Fresh	Fuel	5.0	0	3	53.6	0.0	48.7	371.0
13	Fresh	Fuel	0.0	24	1	55.9	37.6	313.3	16.0
14	Fresh	Fuel	0.0	24	2	56.6	36.0	299.8	15.2
15	Fresh	Fuel	0.0	24	3	56.9	37.6	317.3	18.4
16	Fresh	Fuel	0.5	24	1	56.6	10.4	295.8	135.9
17	Fresh	Fuel	0.5	24	2	56.6	16.0	268.6	78.3
18	Fresh	Fuel	0.5	24	3	56.6	15.2	302.1	111.1
19	Fresh	Fuel	1.0	24	1	56.2	0.0	224.6	165.5
20	Fresh	Fuel	1.0	24	2	55.9	10.4	257.4	157.5
21	Fresh	Fuel	1.0	24	3	56.2	24.0	279.0	140.7
22	Fresh	Fuel	5.0	24	1	56.9	0.0	114.3	384.5
23	Fresh	Fuel	5.0	24	2	55.9	9.6	150.3	285.4
24	Fresh	Fuel	5.0	24	3	55.9	0.0	87.9	386.9
25	Fresh	Fuel	0.0	48	1	54.6	39.2	378.1	23.2
26	Fresh	Fuel	0.0	48	2	56.2	39.2	370.9	24.0
27	Fresh	Fuel	0.0	48	3	55.9	38.4	366.9	22.4
28	Fresh	Fuel	0.5	48	1	55.2	12.8	327.7	118.3
29	Fresh	Fuel	0.5	48	2	55.6	12.8	322.9	121.5
30	Fresh	Fuel	0.5	48	3	56.2	8.0	287.8	118.3
31	Fresh	Fuel	1.0	48	1	56.2	25.6	368.5	81.5
32	Fresh	Fuel	1.0	48	2	56.6	18.4	374.1	127.1
33	Fresh	Fuel	1.0	48	3	56.6	12.0	323.7	139.1
34	Fresh	Fuel	5.0	48	1	56.2	13.6	211.8	310.1
35	Fresh	Fuel	5.0	48	2	56.2	8.0	165.5	402.1
36	Fresh	Fuel	5.0	48	3	55.9	0.0	129.5	416.5
37	Fresh	Fuel	0.0	72	1	56.6	41.6	362.1	24.0
38	Fresh	Fuel	0.0	72	2	56.2	42.4	378.1	25.6
39	Fresh	Fuel	0.0	72	3	55.9	40.8	366.9	24.0
40	Fresh	Fuel	0.5	72	1	56.2	19.2	329.3	97.5
41	Fresh	Fuel	0.5	72	2	56.2	12.0	311.7	109.5
42	Fresh	Fuel	0.5	72	3	56.6	16.8	352.5	127.1
43	Fresh	Fuel	1.0	72	1	56.2	15.2	275.8	151.9
44	Fresh	Fuel	1.0	72	2	56.6	12.8	294.2	168.7
45	Fresh	Fuel	1.0	72	3	56.6	12.8	272.6	134.3
46	Fresh	Fuel	5.0	72	1	56.6	17.6	177.5	259.8
47	Fresh	Fuel	5.0	72	2	56.9	13.6	172.7	312.5
48	Fresh	Fuel	5.0	72	3	56.9	8.8	148.7	334.9

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
49	Fresh	Tech	0.0	0	1	54.1	33.8	274.3	0.0
50	Fresh	Tech	0.0	0	2	53.8	25.9	250.7	0.0
51	Fresh	Tech	0.0	0	3	56.1	29.1	264.1	8.6
52	Fresh	Tech	0.5	0	1	56.4	0.0	193.4	191.0
53	Fresh	Tech	0.5	0	2	56.8	0.0	229.5	150.9
54	Fresh	Tech	0.5	0	3	54.1	0.0	228.7	90.4
55	Fresh	Tech	1.0	0	1	56.4	0.0	40.9	362.3
56	Fresh	Tech	1.0	0	2	54.4	0.0	168.2	169.8
57	Fresh	Tech	1.0	0	3	54.8	0.0	178.4	168.2
58	Fresh	Tech	5.0	0	1	54.4	0.0	0.0	391.4
59	Fresh	Tech	5.0	0	2	56.1	0.0	0.0	385.9
60	Fresh	Tech	5.0	0	3	56.8	0.0	0.0	418.2
61	Fresh	Tech	0.0	24	1	60.4	35.2	299.0	63.1
62	Fresh	Tech	0.0	24	2	61.1	34.4	293.4	31.2
63	Fresh	Tech	0.0	24	3	60.8	33.6	283.0	48.0
64	Fresh	Tech	0.5	24	1	60.4	7.2	223.8	220.6
65	Fresh	Tech	0.5	24	2	59.8	11.2	218.2	165.5
66	Fresh	Tech	0.5	24	3	60.4	12.0	223.0	165.5
67	Fresh	Tech	1.0	24	1	60.1	0.0	111.9	230.2
68	Fresh	Tech	1.0	24	2	60.8	12.8	208.6	208.6
69	Fresh	Tech	1.0	24	3	60.4	8.0	180.6	256.6
70	Fresh	Tech	5.0	24	1	61.1	0.0	95.9	314.9
71	Fresh	Tech	5.0	24	2	61.1	0.0	129.5	307.7
72	Fresh	Tech	5.0	24	3	61.1	0.0	131.1	302.9
73	Fresh	Tech	0.0	48	1	61.1	34.4	335.7	47.2
74	Fresh	Tech	0.0	48	2	60.8	30.4	302.1	41.6
75	Fresh	Tech	0.0	48	3	60.4	28.8	326.9	38.4
76	Fresh	Tech	0.5	48	1	60.8	20.0	282.2	160.7
77	Fresh	Tech	0.5	48	2	61.1	12.0	232.6	189.4
78	Fresh	Tech	0.5	48	3	61.8	12.0	215.8	191.0
79	Fresh	Tech	1.0	48	1	60.8	11.2	200.6	236.6
80	Fresh	Tech	1.0	48	2	60.4	8.0	191.0	316.5
81	Fresh	Tech	1.0	48	3	60.8	10.4	173.5	304.5
82	Fresh	Tech	5.0	48	1	62.1	8.0	151.1	249.4
83	Fresh	Tech	5.0	48	2	61.4	0.0	136.7	334.9
84	Fresh	Tech	5.0	48	3	61.4	0.0	119.1	324.5
85	Fresh	Tech	0.0	72	1	61.1	40.8	332.5	44.8
86	Fresh	Tech	0.0	72	2	61.4	40.0	324.5	35.2
87	Fresh	Tech	0.0	72	3	61.1	41.6	337.3	34.4
88	Fresh	Tech	0.5	72	1	61.8	31.2	311.7	98.3
89	Fresh	Tech	0.5	72	2	60.8	24.0	301.3	103.1
90	Fresh	Tech	0.5	72	3	61.8	19.2	278.2	113.5
91	Fresh	Tech	1.0	72	1	61.8	18.4	237.4	193.4
92	Fresh	Tech	1.0	72	2	60.8	12.8	222.2	173.5
93	Fresh	Tech	1.0	72	3	61.1	12.8	178.3	224.6
94	Fresh	Tech	5.0	72	1	61.4	7.2	131.9	296.6
95	Fresh	Tech	5.0	72	2	62.1	10.4	162.3	342.9
96	Fresh	Tech	5.0	72	3	61.8	7.2	120.7	344.5
97	Fresh	Ultra	0.0	0	1	54.8	25.9	309.7	0.0
98	Fresh	Ultra	0.0	0	2	.	23.6	296.3	0.0

Obs	Prep	Enz	Load	Hour	Rep	AIS	Delta Maltotriose	Maltose	Glucose
99	Fresh	Ultra	0.0	0	3	54.4	27.5	332.5	0.0
100	Fresh	Ultra	0.5	0	1	55.1	0.0	264.1	177.6
101	Fresh	Ultra	0.5	0	2	54.1	0.0	216.2	206.7
102	Fresh	Ultra	0.5	0	3	55.1	0.0	188.6	201.2
103	Fresh	Ultra	1.0	0	1	56.4	0.0	181.6	284.5
104	Fresh	Ultra	1.0	0	2	55.1	0.0	33.0	360.0
105	Fresh	Ultra	1.0	0	3	55.4	0.0	117.1	318.3
106	Fresh	Ultra	5.0	0	1	55.1	0.0	0.0	524.3
107	Fresh	Ultra	5.0	0	2	54.4	0.0	0.0	512.5
108	Fresh	Ultra	5.0	0	3	55.4	0.0	0.0	488.9
109	Fresh	Ultra	0.0	24	1	58.1	32.0	355.6	16.4
110	Fresh	Ultra	0.0	24	2	58.1	32.0	345.8	17.2
111	Fresh	Ultra	0.0	24	3	58.4	29.5	331.0	14.7
112	Fresh	Ultra	0.5	24	1	58.4	18.8	331.0	104.9
113	Fresh	Ultra	0.5	24	2	58.8	18.0	324.5	100.8
114	Fresh	Ultra	0.5	24	3	59.1	23.8	347.4	87.7
115	Fresh	Ultra	1.0	24	1	58.1	14.7	310.5	156.5
116	Fresh	Ultra	1.0	24	2	58.1	16.4	312.2	145.8
117	Fresh	Ultra	1.0	24	3	58.1	18.0	326.1	129.5
118	Fresh	Ultra	5.0	24	1	57.8	10.7	172.9	313.0
119	Fresh	Ultra	5.0	24	2	59.1	9.8	167.1	326.9
120	Fresh	Ultra	5.0	24	3	57.4	13.1	189.3	311.3
121	Fresh	Ultra	0.0	48	1	59.4	39.3	390.0	23.8
122	Fresh	Ultra	0.0	48	2	59.4	36.9	376.9	23.8
123	Fresh	Ultra	0.0	48	3	59.8	36.9	379.4	22.1
124	Fresh	Ultra	0.5	48	1	59.4	27.9	370.3	68.8
125	Fresh	Ultra	0.5	48	2	60.1	30.3	382.6	72.1
126	Fresh	Ultra	0.5	48	3	60.1	23.8	355.6	103.2
127	Fresh	Ultra	1.0	48	1	60.1	28.7	385.9	109.8
128	Fresh	Ultra	1.0	48	2	60.4	27.0	399.0	132.7
129	Fresh	Ultra	1.0	48	3	59.8	21.3	317.9	136.0
130	Fresh	Ultra	5.0	48	1	59.8	14.7	231.1	281.9
131	Fresh	Ultra	5.0	48	2	59.1	16.4	266.3	327.7
132	Fresh	Ultra	5.0	48	3	59.8	16.4	244.2	257.3
133	Fresh	Ultra	0.0	72	1	58.8	37.7	376.1	25.4
134	Fresh	Ultra	0.0	72	2	59.4	36.9	369.5	22.9
135	Fresh	Ultra	0.0	72	3	59.8	38.5	391.6	24.6
136	Fresh	Ultra	0.5	72	1	58.1	28.7	386.7	77.8
137	Fresh	Ultra	0.5	72	2	59.4	29.5	369.5	72.9
138	Fresh	Ultra	0.5	72	3	60.1	27.9	375.3	90.1
139	Fresh	Ultra	1.0	72	1	59.4	23.8	347.4	124.5
140	Fresh	Ultra	1.0	72	2	59.8	25.4	365.4	125.4
141	Fresh	Ultra	1.0	72	3	59.8	19.7	326.1	145.0
142	Fresh	Ultra	5.0	72	1	60.1	26.2	340.0	231.9
143	Fresh	Ultra	5.0	72	2	59.4	20.5	280.2	291.7
144	Fresh	Ultra	5.0	72	3	59.8	15.6	239.2	273.7
145	Dry	Fuel	0.0	0	1	50.3	46.8	247.6	12.8
146	Dry	Fuel	0.0	0	2	50.0	42.8	233.6	12.4
147	Dry	Fuel	0.0	0	3	51.0	46.4	276.4	16.0
148	Dry	Fuel	0.5	0	1	51.3	26.0	274.8	74.0

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
149	Dry	Fuel	0.5	0	2	50.7	22.0	280.4	88.4
150	Dry	Fuel	0.5	0	3	50.3	22.0	272.4	77.6
151	Dry	Fuel	1.0	0	1	49.7	4.0	258.4	120.8
152	Dry	Fuel	1.0	0	2	50.0	8.0	270.0	112.8
153	Dry	Fuel	1.0	0	3	49.7	3.6	252.4	124.0
154	Dry	Fuel	5.0	0	1	51.3	0.0	74.4	343.6
155	Dry	Fuel	5.0	0	2	49.0	0.0	70.4	368.4
156	Dry	Fuel	5.0	0	3	49.7	0.0	44.8	380.4
157	Dry	Fuel	0.0	24	1	52.0	49.2	285.2	34.7
158	Dry	Fuel	0.0	24	2	53.0	51.7	278.6	28.5
159	Dry	Fuel	0.0	24	3	53.7	47.5	261.6	28.1
160	Dry	Fuel	0.5	24	1	52.7	11.6	255.4	144.3
161	Dry	Fuel	0.5	24	2	53.0	5.4	252.5	174.0
162	Dry	Fuel	0.5	24	3	52.0	0.0	219.1	188.1
163	Dry	Fuel	1.0	24	1	53.0	0.0	203.8	250.9
164	Dry	Fuel	1.0	24	2	52.7	0.0	199.2	231.5
165	Dry	Fuel	1.0	24	3	52.3	4.1	152.9	267.0
166	Dry	Fuel	5.0	24	1	49.3	0.0	22.7	468.7
167	Dry	Fuel	5.0	24	2	52.0	0.0	24.4	448.5
168	Dry	Fuel	5.0	24	3	54.3	0.0	18.6	474.1
169	Dry	Fuel	0.0	48	1	50.0	43.0	241.8	25.2
170	Dry	Fuel	0.0	48	2	50.0	58.7	298.0	30.6
171	Dry	Fuel	0.0	48	3	51.7	60.3	296.8	30.2
172	Dry	Fuel	0.5	48	1	52.0	7.9	233.1	198.0
173	Dry	Fuel	0.5	48	2	51.7	0.0	250.1	222.0
174	Dry	Fuel	0.5	48	3	51.7	3.3	245.9	195.5
175	Dry	Fuel	1.0	48	1	51.3	0.0	118.2	337.7
176	Dry	Fuel	1.0	48	2	50.3	0.0	164.5	312.5
177	Dry	Fuel	1.0	48	3	52.3	0.0	171.5	298.0
178	Dry	Fuel	5.0	48	1	52.3	0.0	19.0	491.0
179	Dry	Fuel	5.0	48	2	52.0	0.0	14.9	523.7
180	Dry	Fuel	5.0	48	3	51.7	0.0	14.1	527.4
181	Dry	Fuel	0.0	72	1	52.7	57.5	273.6	37.2
182	Dry	Fuel	0.0	72	2	53.0	54.6	279.8	31.0
183	Dry	Fuel	0.0	72	3	53.0	61.6	304.6	31.8
184	Dry	Fuel	0.5	72	1	53.7	0.0	222.4	240.6
185	Dry	Fuel	0.5	72	2	53.3	0.0	251.7	207.9
186	Dry	Fuel	0.5	72	3	53.0	8.3	247.6	180.2
187	Dry	Fuel	1.0	72	1	53.0	0.0	150.5	296.8
188	Dry	Fuel	1.0	72	2	53.3	0.0	183.9	279.0
189	Dry	Fuel	1.0	72	3	53.0	7.0	184.8	233.9
190	Dry	Fuel	5.0	72	1	53.3	0.0	14.5	503.9
191	Dry	Fuel	5.0	72	2	52.3	0.0	36.8	469.5
192	Dry	Fuel	5.0	72	3	53.0	0.0	18.2	506.3
193	Dry	Tech	0.0	0	1	48.4	39.2	260.4	12.8
194	Dry	Tech	0.0	0	2	47.8	43.2	278.4	13.2
195	Dry	Tech	0.0	0	3	50.1	31.6	209.6	10.0
196	Dry	Tech	0.5	0	1	49.4	0.0	212.8	221.2
197	Dry	Tech	0.5	0	2	49.4	0.0	212.4	222.8
198	Dry	Tech	0.5	0	3	49.4	0.0	168.0	267.6

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
199	Dry	Tech	1.0	0	1	48.4	0.0	37.6	417.2
200	Dry	Tech	1.0	0	2	48.4	0.0	41.2	394.8
201	Dry	Tech	1.0	0	3	49.1	0.0	19.2	429.6
202	Dry	Tech	5.0	0	1	49.8	0.0	0.0	484.8
203	Dry	Tech	5.0	0	2	50.4	0.0	0.0	492.0
204	Dry	Tech	5.0	0	3	50.1	0.0	0.0	478.8
205	Dry	Tech	0.0	24	1	51.4	30.2	300.1	78.9
206	Dry	Tech	0.0	24	2	51.4	47.1	280.7	35.5
207	Dry	Tech	0.0	24	3	51.1	45.9	279.0	31.4
208	Dry	Tech	0.5	24	1	50.8	0.0	168.2	258.3
209	Dry	Tech	0.5	24	2	51.4	4.5	194.3	220.3
210	Dry	Tech	0.5	24	3	51.8	0.0	166.2	257.5
211	Dry	Tech	1.0	24	1	52.1	0.0	78.1	365.0
212	Dry	Tech	1.0	24	2	52.1	0.0	100.4	376.1
213	Dry	Tech	1.0	24	3	52.1	0.0	102.5	369.9
214	Dry	Tech	5.0	24	1	51.4	0.0	16.1	516.7
215	Dry	Tech	5.0	24	2	52.1	0.0	9.9	482.8
216	Dry	Tech	5.0	24	3	51.8	0.0	18.2	500.1
217	Dry	Tech	0.0	48	1	51.4	49.6	281.5	37.2
218	Dry	Tech	0.0	48	2	51.4	48.4	269.9	25.6
219	Dry	Tech	0.0	48	3	51.4	54.1	291.0	25.2
220	Dry	Tech	0.5	48	1	51.8	0.0	202.9	259.2
221	Dry	Tech	0.5	48	2	51.4	0.0	205.0	261.2
222	Dry	Tech	0.5	48	3	51.8	0.0	188.1	267.4
223	Dry	Tech	1.0	48	1	52.1	0.0	100.0	368.3
224	Dry	Tech	1.0	48	2	52.1	0.0	110.8	363.7
225	Dry	Tech	1.0	48	3	51.8	0.0	78.9	360.4
226	Dry	Tech	5.0	48	1	52.1	0.0	12.0	451.8
227	Dry	Tech	5.0	48	2	51.8	0.0	12.0	524.1
228	Dry	Tech	5.0	48	3	51.4	0.0	10.7	540.2
229	Dry	Tech	0.0	72	1	49.8	48.4	279.0	38.0
230	Dry	Tech	0.0	72	2	50.1	54.1	300.5	31.0
231	Dry	Tech	0.0	72	3	50.1	56.2	298.4	30.2
232	Dry	Tech	0.5	72	1	50.4	0.0	202.9	243.0
233	Dry	Tech	0.5	72	2	49.4	0.0	203.4	272.4
234	Dry	Tech	0.5	72	3	50.1	0.0	188.9	248.8
235	Dry	Tech	1.0	72	1	48.1	0.0	99.2	369.9
236	Dry	Tech	1.0	72	2	50.4	0.0	104.6	370.3
237	Dry	Tech	1.0	72	3	50.1	0.0	64.1	450.1
238	Dry	Tech	5.0	72	1	49.8	0.0	12.8	575.8
239	Dry	Tech	5.0	72	2	50.1	0.0	11.6	546.0
240	Dry	Tech	5.0	72	3	50.4	0.0	10.7	527.0
241	Dry	Ultra	0.0	0	1	.	59.6	374.8	19.2
242	Dry	Ultra	0.0	0	2	48.2	18.0	186.8	44.0
243	Dry	Ultra	0.0	0	3	50.2	32.0	216.0	32.4
244	Dry	Ultra	0.5	0	1	49.2	8.8	274.0	110.0
245	Dry	Ultra	0.5	0	2	49.6	2.8	253.6	117.2
246	Dry	Ultra	0.5	0	3	50.9	0.0	254.0	120.8
247	Dry	Ultra	1.0	0	1	50.2	0.0	224.8	176.4
248	Dry	Ultra	1.0	0	2	51.2	0.0	228.8	185.2

Obs	Prep	Enz	Load	Hour	Rep	Delta AIS	Maltotriose	Maltose	Glucose
249	Dry	Ultra	1.0	0	3	49.6	0.0	195.2	197.2
250	Dry	Ultra	5.0	0	1	49.6	5.2	0.0	424.4
251	Dry	Ultra	5.0	0	2	50.9	4.4	10.4	408.8
252	Dry	Ultra	5.0	0	3	50.6	6.4	0.0	475.2
253	Dry	Ultra	0.0	24	1	53.6	46.4	268.2	23.4
254	Dry	Ultra	0.0	24	2	52.2	49.4	292.5	24.3
255	Dry	Ultra	0.0	24	3	52.2	48.1	278.6	21.7
256	Dry	Ultra	0.5	24	1	52.2	13.9	264.8	194.6
257	Dry	Ultra	0.5	24	2	51.9	10.0	242.7	192.4
258	Dry	Ultra	0.5	24	3	51.9	13.0	238.3	211.9
259	Dry	Ultra	1.0	24	1	52.2	7.4	175.5	263.5
260	Dry	Ultra	1.0	24	2	52.2	6.5	196.3	266.1
261	Dry	Ultra	1.0	24	3	52.2	7.8	180.7	296.0
262	Dry	Ultra	5.0	24	1	52.6	8.2	45.9	495.7
263	Dry	Ultra	5.0	24	2	52.2	7.4	26.9	491.8
264	Dry	Ultra	5.0	24	3	51.9	7.4	34.7	499.6
265	Dry	Ultra	0.0	48	1	51.2	65.0	341.9	29.0
266	Dry	Ultra	0.0	48	2	51.9	56.3	295.1	22.1
267	Dry	Ultra	0.0	48	3	51.9	51.6	292.1	28.6
268	Dry	Ultra	0.5	48	1	52.2	15.6	250.0	196.7
269	Dry	Ultra	0.5	48	2	51.9	10.4	248.3	209.3
270	Dry	Ultra	0.5	48	3	51.9	14.7	240.9	218.8
271	Dry	Ultra	1.0	48	1	52.6	8.7	187.2	307.7
272	Dry	Ultra	1.0	48	2	51.2	6.5	170.3	354.5
273	Dry	Ultra	1.0	48	3	52.6	6.1	171.6	293.8
274	Dry	Ultra	5.0	48	1	52.2	6.9	27.3	515.7
275	Dry	Ultra	5.0	48	2	52.9	6.9	35.1	517.8
276	Dry	Ultra	5.0	48	3	52.2	6.9	46.4	507.9
277	Dry	Ultra	0.0	72	1	51.2	59.4	318.1	30.8
278	Dry	Ultra	0.0	72	2	52.9	53.7	292.1	29.9
279	Dry	Ultra	0.0	72	3	51.2	55.5	302.9	32.1
280	Dry	Ultra	0.5	72	1	52.6	18.2	250.9	172.5
281	Dry	Ultra	0.5	72	2	51.9	23.8	253.9	148.2
282	Dry	Ultra	0.5	72	3	52.2	13.4	234.0	219.3
283	Dry	Ultra	1.0	72	1	51.9	6.9	211.5	277.3
284	Dry	Ultra	1.0	72	2	51.9	7.8	195.0	273.4
285	Dry	Ultra	1.0	72	3	53.6	10.4	179.0	275.6
286	Dry	Ultra	5.0	72	1	52.6	6.5	36.4	474.9
287	Dry	Ultra	5.0	72	2	52.6	10.0	58.5	478.4
288	Dry	Ultra	5.0	72	3	51.9	5.6	49.8	437.2

The GLM Procedure
Class Level Information

Class	Levels	Values
Hour	4	0 24 48 72
Enz	3	Fuel Tech Ultra
Prep	2	Dry Fresh
Load	4	0 0.5 1 5

Data for Analysis of DeltaAIS

Number of Observations Read	288
Number of Observations Used	286

Data for Analysis of Maltotriose
Maltose Glucose

Number of Observations Read	288
Number of Observations Used	288

The GLM Procedure

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	95	7150252.123	75265.812	120.27	<.0001
Error	192	120152.847	625.796		
Corrected Total	287	7270404.970			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.983474	11.93881	25.01592	209.5344

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Hour	3	11096.483	3698.828	5.91	0.0007
Enz	2	158715.602	79357.801	126.81	<.0001
Prep	1	495667.758	495667.758	792.06	<.0001
Load	3	5680109.844	1893369.948	3025.54	<.0001
Hour*Enz*Prep*Load	86	804662.435	9356.540	14.95	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hour	3	11096.483	3698.828	5.91	0.0007
Enz	2	158715.602	79357.801	126.81	<.0001
Prep	1	495667.758	495667.758	792.06	<.0001
Load	3	5680109.844	1893369.948	3025.54	<.0001
Hour*Enz*Prep*Load	86	804662.435	9356.540	14.95	<.0001

The GLM Procedure
Least Squares Means

Hour	Enz	Prep	Load	Glucose LSMEAN	LSMEAN Number
0	Fuel	Dry	0	13.733333	1
0	Fuel	Dry	0.5	80.000000	2
0	Fuel	Dry	1	119.200000	3
0	Fuel	Dry	5	364.133333	4
0	Fuel	Fresh	0	-0.000000	5
0	Fuel	Fresh	0.5	70.466667	6
0	Fuel	Fresh	1	103.233333	7
0	Fuel	Fresh	5	384.600000	8
0	Tech	Dry	0	12.000000	9
0	Tech	Dry	0.5	237.200000	10
0	Tech	Dry	1	413.866667	11
0	Tech	Dry	5	485.200000	12
0	Tech	Fresh	0	2.866667	13
0	Tech	Fresh	0.5	144.100000	14
0	Tech	Fresh	1	233.433333	15
0	Tech	Fresh	5	398.500000	16
0	Ultra	Dry	0	31.866667	17
0	Ultra	Dry	0.5	116.000000	18
0	Ultra	Dry	1	186.266667	19
0	Ultra	Dry	5	436.133333	20
0	Ultra	Fresh	0	-0.000000	21
0	Ultra	Fresh	0.5	195.166667	22
0	Ultra	Fresh	1	320.933333	23
0	Ultra	Fresh	5	508.566667	24
24	Fuel	Dry	0	30.433333	25
24	Fuel	Dry	0.5	168.800000	26
24	Fuel	Dry	1	249.800000	27
24	Fuel	Dry	5	463.766667	28
24	Fuel	Fresh	0	16.533333	29
24	Fuel	Fresh	0.5	108.433333	30
24	Fuel	Fresh	1	154.566667	31
24	Fuel	Fresh	5	352.266667	32
24	Tech	Dry	0	48.600000	33
24	Tech	Dry	0.5	245.366667	34
24	Tech	Dry	1	370.333333	35
24	Tech	Dry	5	499.866667	36
24	Tech	Fresh	0	47.433333	37
24	Tech	Fresh	0.5	183.866667	38
24	Tech	Fresh	1	231.800000	39
24	Tech	Fresh	5	308.500000	40
24	Ultra	Dry	0	23.133333	41
24	Ultra	Dry	0.5	199.633333	42
24	Ultra	Dry	1	275.200000	43
24	Ultra	Dry	5	495.700000	44
24	Ultra	Fresh	0	16.100000	45
24	Ultra	Fresh	0.5	97.800000	46
24	Ultra	Fresh	1	143.933333	47

Hour	Enz	Prep	Load	Glucose LSMEAN	LSMEAN Number
24	Ultra	Fresh	5	317.066667	48
48	Fuel	Dry	0	28.666667	49
48	Fuel	Dry	0.5	205.166667	50
48	Fuel	Dry	1	316.066667	51
48	Fuel	Dry	5	514.033333	52
48	Fuel	Fresh	0	23.200000	53
48	Fuel	Fresh	0.5	119.366667	54
48	Fuel	Fresh	1	115.900000	55
48	Fuel	Fresh	5	376.233333	56
48	Tech	Dry	0	29.333333	57
48	Tech	Dry	0.5	262.600000	58
48	Tech	Dry	1	364.133333	59
48	Tech	Dry	5	505.366667	60
48	Tech	Fresh	0	42.400000	61
48	Tech	Fresh	0.5	180.366667	62
48	Tech	Fresh	1	285.866667	63
48	Tech	Fresh	5	302.933333	64
48	Ultra	Dry	0	26.566667	65
48	Ultra	Dry	0.5	208.266667	66
48	Ultra	Dry	1	318.666667	67
48	Ultra	Dry	5	513.800000	68
48	Ultra	Fresh	0	23.233333	69
48	Ultra	Fresh	0.5	81.366667	70
48	Ultra	Fresh	1	126.166667	71
48	Ultra	Fresh	5	288.966667	72
72	Fuel	Dry	0	33.333333	73
72	Fuel	Dry	0.5	209.566667	74
72	Fuel	Dry	1	269.900000	75
72	Fuel	Dry	5	493.233333	76
72	Fuel	Fresh	0	24.533333	77
72	Fuel	Fresh	0.5	111.366667	78
72	Fuel	Fresh	1	151.633333	79
72	Fuel	Fresh	5	302.400000	80
72	Tech	Dry	0	33.066667	81
72	Tech	Dry	0.5	254.733333	82
72	Tech	Dry	1	396.766667	83
72	Tech	Dry	5	549.600000	84
72	Tech	Fresh	0	38.133333	85
72	Tech	Fresh	0.5	104.966667	86
72	Tech	Fresh	1	197.166667	87
72	Tech	Fresh	5	328.000000	88
72	Ultra	Dry	0	30.933333	89
72	Ultra	Dry	0.5	180.000000	90
72	Ultra	Dry	1	275.433333	91
72	Ultra	Dry	5	463.500000	92
72	Ultra	Fresh	0	24.300000	93
72	Ultra	Fresh	0.5	80.266667	94
72	Ultra	Fresh	1	131.633333	95
72	Ultra	Fresh	5	265.766667	96

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	1	2	3	4	5	6	7
1		0.0014	<.0001	<.0001	0.5022	0.0060	<.0001
2	0.0014		0.0564	<.0001	0.0001	0.6412	0.2568
3	<.0001	0.0564		<.0001	<.0001	0.0180	0.4354
4	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
5	0.5022	0.0001	<.0001	<.0001		0.0007	<.0001
6	0.0060	0.6412	0.0180	<.0001	0.0007		0.1103
7	<.0001	0.2568	0.4354	<.0001	<.0001	0.1103	
8	<.0001	<.0001	<.0001	0.3176	<.0001	<.0001	<.0001
9	0.9325	0.0010	<.0001	<.0001	0.5576	0.0047	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	0.0158	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.5953	0.0002	<.0001	<.0001	0.8885	0.0011	<.0001
14	<.0001	0.0020	0.2243	<.0001	<.0001	0.0004	0.0468
15	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
16	<.0001	<.0001	<.0001	0.0941	<.0001	<.0001	<.0001
17	0.3758	0.0195	<.0001	<.0001	0.1204	0.0603	0.0006
18	<.0001	0.0796	0.8757	<.0001	<.0001	0.0270	0.5327
19	<.0001	<.0001	0.0012	<.0001	<.0001	<.0001	<.0001
20	<.0001	<.0001	<.0001	0.0005	<.0001	<.0001	<.0001
21	0.5022	0.0001	<.0001	<.0001	1.0000	0.0007	<.0001
22	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001
23	<.0001	<.0001	<.0001	0.0357	<.0001	<.0001	<.0001
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
25	0.4146	0.0162	<.0001	<.0001	0.1379	0.0514	0.0005
26	<.0001	<.0001	0.0161	<.0001	<.0001	<.0001	0.0016
27	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29	0.8911	0.0022	<.0001	<.0001	0.4193	0.0090	<.0001
30	<.0001	0.1655	0.5987	<.0001	<.0001	0.0646	0.7993
31	<.0001	0.0003	0.0850	<.0001	<.0001	<.0001	0.0128
32	<.0001	<.0001	<.0001	0.5619	<.0001	<.0001	<.0001
33	0.0894	0.1259	0.0007	<.0001	0.0183	0.2857	0.0081
34	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
35	<.0001	<.0001	<.0001	0.7618	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	0.1006	0.1125	0.0006	<.0001	0.0213	0.2609	0.0069
38	<.0001	<.0001	0.0018	<.0001	<.0001	<.0001	0.0001
39	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
40	<.0001	<.0001	<.0001	0.0071	<.0001	<.0001	<.0001
41	0.6459	0.0059	<.0001	<.0001	0.2588	0.0215	0.0001
42	<.0001	<.0001	0.0001	<.0001	<.0001	<.0001	<.0001
43	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	0.9079	0.0020	<.0001	<.0001	0.4315	0.0084	<.0001
46	<.0001	0.3846	0.2961	<.0001	<.0001	0.1824	0.7905

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	8	9	10	11	12	13	14
1	<.0001	0.9325	<.0001	<.0001	<.0001	0.5953	<.0001
2	<.0001	0.0010	<.0001	<.0001	<.0001	0.0002	0.0020
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.2243
4	0.3176	<.0001	<.0001	0.0158	<.0001	<.0001	<.0001
5	<.0001	0.5576	<.0001	<.0001	<.0001	0.8885	<.0001
6	<.0001	0.0047	<.0001	<.0001	<.0001	0.0011	0.0004
7	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0468
8		<.0001	<.0001	0.1535	<.0001	<.0001	<.0001
9	<.0001		<.0001	<.0001	<.0001	0.6553	<.0001
10	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
11	0.1535	<.0001	<.0001		0.0006	<.0001	<.0001
12	<.0001	<.0001	<.0001	0.0006		<.0001	<.0001
13	<.0001	0.6553	<.0001	<.0001	<.0001		<.0001
14	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	
15	<.0001	<.0001	0.8539	<.0001	<.0001	<.0001	<.0001
16	0.4970	<.0001	<.0001	0.4528	<.0001	<.0001	<.0001
17	<.0001	0.3320	<.0001	<.0001	<.0001	0.1573	<.0001
18	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1705
19	<.0001	<.0001	0.0135	<.0001	<.0001	<.0001	0.0403
20	0.0124	<.0001	<.0001	0.2770	0.0172	<.0001	<.0001
21	<.0001	0.5576	<.0001	<.0001	<.0001	0.8885	<.0001
22	<.0001	<.0001	0.0410	<.0001	<.0001	<.0001	0.0133
23	0.0021	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
24	<.0001	<.0001	<.0001	<.0001	0.2540	<.0001	<.0001
25	<.0001	0.3679	<.0001	<.0001	<.0001	0.1787	<.0001
26	<.0001	<.0001	0.0010	<.0001	<.0001	<.0001	0.2280
27	<.0001	<.0001	0.5380	<.0001	<.0001	<.0001	<.0001
28	0.0001	<.0001	<.0001	0.0155	0.2953	<.0001	<.0001
29	<.0001	0.8246	<.0001	<.0001	<.0001	0.5042	<.0001
30	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0824
31	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.6089
32	0.1151	<.0001	<.0001	0.0029	<.0001	<.0001	<.0001
33	<.0001	0.0747	<.0001	<.0001	<.0001	0.0263	<.0001
34	<.0001	<.0001	0.6897	<.0001	<.0001	<.0001	<.0001
35	0.4857	<.0001	<.0001	0.0343	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	0.4736	<.0001	<.0001
37	<.0001	0.0844	<.0001	<.0001	<.0001	0.0303	<.0001
38	<.0001	<.0001	0.0097	<.0001	<.0001	<.0001	0.0530
39	<.0001	<.0001	0.7918	<.0001	<.0001	<.0001	<.0001
40	0.0003	<.0001	0.0006	<.0001	<.0001	<.0001	<.0001
41	<.0001	0.5863	<.0001	<.0001	<.0001	0.3223	<.0001
42	<.0001	<.0001	0.0674	<.0001	<.0001	<.0001	0.0072
43	<.0001	<.0001	0.0644	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	0.6078	<.0001	<.0001
45	<.0001	0.8411	<.0001	<.0001	<.0001	0.5178	<.0001
46	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0245

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	15	16	17	18	19	20	21
1	<.0001	<.0001	0.3758	<.0001	<.0001	<.0001	0.5022
2	<.0001	<.0001	0.0195	0.0796	<.0001	<.0001	0.0001
3	<.0001	<.0001	<.0001	0.8757	0.0012	<.0001	<.0001
4	<.0001	0.0941	<.0001	<.0001	<.0001	0.0005	<.0001
5	<.0001	<.0001	0.1204	<.0001	<.0001	<.0001	1.0000
6	<.0001	<.0001	0.0603	0.0270	<.0001	<.0001	0.0007
7	<.0001	<.0001	0.0006	0.5327	<.0001	<.0001	<.0001
8	<.0001	0.4970	<.0001	<.0001	<.0001	0.0124	<.0001
9	<.0001	<.0001	0.3320	<.0001	<.0001	<.0001	0.5576
10	0.8539	<.0001	<.0001	<.0001	0.0135	<.0001	<.0001
11	<.0001	0.4528	<.0001	<.0001	<.0001	0.2770	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	0.0172	<.0001
13	<.0001	<.0001	0.1573	<.0001	<.0001	<.0001	0.8885
14	<.0001	<.0001	<.0001	0.1705	0.0403	<.0001	<.0001
15		<.0001	<.0001	<.0001	0.0220	<.0001	<.0001
16	<.0001		<.0001	<.0001	<.0001	0.0669	<.0001
17	<.0001	<.0001		<.0001	<.0001	<.0001	0.1204
18	<.0001	<.0001	<.0001		0.0007	<.0001	<.0001
19	0.0220	<.0001	<.0001	0.0007		<.0001	<.0001
20	<.0001	0.0669	<.0001	<.0001	<.0001		<.0001
21	<.0001	<.0001	0.1204	<.0001	<.0001	<.0001	
22	0.0625	<.0001	<.0001	0.0001	0.6635	<.0001	<.0001
23	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001
24	<.0001	<.0001	<.0001	<.0001	<.0001	0.0005	<.0001
25	<.0001	<.0001	0.9441	<.0001	<.0001	<.0001	0.1379
26	0.0018	<.0001	<.0001	0.0105	0.3935	<.0001	<.0001
27	0.4240	<.0001	<.0001	<.0001	0.0022	<.0001	<.0001
28	<.0001	0.0016	<.0001	<.0001	<.0001	0.1777	<.0001
29	<.0001	<.0001	0.4538	<.0001	<.0001	<.0001	0.4193
30	<.0001	<.0001	0.0002	0.7115	0.0002	<.0001	<.0001
31	0.0002	<.0001	<.0001	0.0605	0.1223	<.0001	<.0001
32	<.0001	0.0247	<.0001	<.0001	<.0001	<.0001	<.0001
33	<.0001	<.0001	0.4137	0.0012	<.0001	<.0001	0.0183
34	0.5597	<.0001	<.0001	<.0001	0.0043	<.0001	<.0001
35	<.0001	0.1695	<.0001	<.0001	<.0001	0.0015	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	0.0021	<.0001
37	<.0001	<.0001	0.4469	0.0010	<.0001	<.0001	0.0213
38	0.0162	<.0001	<.0001	0.0011	0.9066	<.0001	<.0001
39	0.9363	<.0001	<.0001	<.0001	0.0270	<.0001	<.0001
40	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
41	<.0001	<.0001	0.6694	<.0001	<.0001	<.0001	0.2588
42	0.0996	<.0001	<.0001	<.0001	0.5136	<.0001	<.0001
43	0.0422	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	0.0040	<.0001
45	<.0001	<.0001	0.4411	<.0001	<.0001	<.0001	0.4315
46	<.0001	<.0001	0.0015	0.3740	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	22	23	24	25	26	27	28
1	<.0001	<.0001	<.0001	0.4146	<.0001	<.0001	<.0001
2	<.0001	<.0001	<.0001	0.0162	<.0001	<.0001	<.0001
3	0.0003	<.0001	<.0001	<.0001	0.0161	<.0001	<.0001
4	<.0001	0.0357	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	<.0001	<.0001	0.1379	<.0001	<.0001	<.0001
6	<.0001	<.0001	<.0001	0.0514	<.0001	<.0001	<.0001
7	<.0001	<.0001	<.0001	0.0005	0.0016	<.0001	<.0001
8	<.0001	0.0021	<.0001	<.0001	<.0001	<.0001	0.0001
9	<.0001	<.0001	<.0001	0.3679	<.0001	<.0001	<.0001
10	0.0410	<.0001	<.0001	<.0001	0.0010	0.5380	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0155
12	<.0001	<.0001	0.2540	<.0001	<.0001	<.0001	0.2953
13	<.0001	<.0001	<.0001	0.1787	<.0001	<.0001	<.0001
14	0.0133	<.0001	<.0001	<.0001	0.2280	<.0001	<.0001
15	0.0625	<.0001	<.0001	<.0001	0.0018	0.4240	<.0001
16	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001	0.0016
17	<.0001	<.0001	<.0001	0.9441	<.0001	<.0001	<.0001
18	0.0001	<.0001	<.0001	<.0001	0.0105	<.0001	<.0001
19	0.6635	<.0001	<.0001	<.0001	0.3935	0.0022	<.0001
20	<.0001	<.0001	0.0005	<.0001	<.0001	<.0001	0.1777
21	<.0001	<.0001	<.0001	0.1379	<.0001	<.0001	<.0001
22		<.0001	<.0001	<.0001	0.1983	0.0081	<.0001
23	<.0001		<.0001	<.0001	<.0001	0.0006	<.0001
24	<.0001	<.0001		<.0001	<.0001	<.0001	0.0295
25	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
26	0.1983	<.0001	<.0001	<.0001		0.0001	<.0001
27	0.0081	0.0006	<.0001	<.0001	0.0001		<.0001
28	<.0001	<.0001	0.0295	<.0001	<.0001	<.0001	
29	<.0001	<.0001	<.0001	0.4970	<.0001	<.0001	<.0001
30	<.0001	<.0001	<.0001	0.0002	0.0035	<.0001	<.0001
31	0.0483	<.0001	<.0001	<.0001	0.4867	<.0001	<.0001
32	<.0001	0.1267	<.0001	<.0001	<.0001	<.0001	<.0001
33	<.0001	<.0001	<.0001	0.3749	<.0001	<.0001	<.0001
34	0.0149	0.0003	<.0001	<.0001	0.0002	0.8284	<.0001
35	<.0001	0.0165	<.0001	<.0001	<.0001	<.0001	<.0001
36	<.0001	<.0001	0.6706	<.0001	<.0001	<.0001	0.0787
37	<.0001	<.0001	<.0001	0.4063	<.0001	<.0001	<.0001
38	0.5807	<.0001	<.0001	<.0001	0.4616	0.0015	<.0001
39	0.0745	<.0001	<.0001	<.0001	0.0023	0.3793	<.0001
40	<.0001	0.5434	<.0001	<.0001	<.0001	0.0045	<.0001
41	<.0001	<.0001	<.0001	0.7212	<.0001	<.0001	<.0001
42	0.8271	<.0001	<.0001	<.0001	0.1328	0.0149	<.0001
43	0.0001	0.0263	<.0001	<.0001	<.0001	0.2152	<.0001
44	<.0001	<.0001	0.5295	<.0001	<.0001	<.0001	0.1196
45	<.0001	<.0001	<.0001	0.4837	<.0001	<.0001	<.0001
46	<.0001	<.0001	<.0001	0.0012	0.0006	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	29	30	31	32	33	34	35
1	0.8911	<.0001	<.0001	<.0001	0.0894	<.0001	<.0001
2	0.0022	0.1655	0.0003	<.0001	0.1259	<.0001	<.0001
3	<.0001	0.5987	0.0850	<.0001	0.0007	<.0001	<.0001
4	<.0001	<.0001	<.0001	0.5619	<.0001	<.0001	0.7618
5	0.4193	<.0001	<.0001	<.0001	0.0183	<.0001	<.0001
6	0.0090	0.0646	<.0001	<.0001	0.2857	<.0001	<.0001
7	<.0001	0.7993	0.0128	<.0001	0.0081	<.0001	<.0001
8	<.0001	<.0001	<.0001	0.1151	<.0001	<.0001	0.4857
9	0.8246	<.0001	<.0001	<.0001	0.0747	<.0001	<.0001
10	<.0001	<.0001	<.0001	<.0001	<.0001	0.6897	<.0001
11	<.0001	<.0001	<.0001	0.0029	<.0001	<.0001	0.0343
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.5042	<.0001	<.0001	<.0001	0.0263	<.0001	<.0001
14	<.0001	0.0824	0.6089	<.0001	<.0001	<.0001	<.0001
15	<.0001	<.0001	0.0002	<.0001	<.0001	0.5597	<.0001
16	<.0001	<.0001	<.0001	0.0247	<.0001	<.0001	0.1695
17	0.4538	0.0002	<.0001	<.0001	0.4137	<.0001	<.0001
18	<.0001	0.7115	0.0605	<.0001	0.0012	<.0001	<.0001
19	<.0001	0.0002	0.1223	<.0001	<.0001	0.0043	<.0001
20	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0015
21	0.4193	<.0001	<.0001	<.0001	0.0183	<.0001	<.0001
22	<.0001	<.0001	0.0483	<.0001	<.0001	0.0149	<.0001
23	<.0001	<.0001	<.0001	0.1267	<.0001	0.0003	0.0165
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
25	0.4970	0.0002	<.0001	<.0001	0.3749	<.0001	<.0001
26	<.0001	0.0035	0.4867	<.0001	<.0001	0.0002	<.0001
27	<.0001	<.0001	<.0001	<.0001	<.0001	0.8284	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29		<.0001	<.0001	<.0001	0.1181	<.0001	<.0001
30	<.0001		0.0250	<.0001	0.0038	<.0001	<.0001
31	<.0001	0.0250		<.0001	<.0001	<.0001	<.0001
32	<.0001	<.0001	<.0001		<.0001	<.0001	0.3775
33	0.1181	0.0038	<.0001	<.0001		<.0001	<.0001
34	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
35	<.0001	<.0001	<.0001	0.3775	<.0001	<.0001	
36	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	0.1320	0.0032	<.0001	<.0001	0.9545	<.0001	<.0001
38	<.0001	0.0003	0.1531	<.0001	<.0001	0.0030	<.0001
39	<.0001	<.0001	0.0002	<.0001	<.0001	0.5074	<.0001
40	<.0001	<.0001	<.0001	0.0334	<.0001	0.0023	0.0028
41	0.7470	<.0001	<.0001	<.0001	0.2140	<.0001	<.0001
42	<.0001	<.0001	0.0285	<.0001	<.0001	0.0263	<.0001
43	<.0001	<.0001	<.0001	0.0002	<.0001	0.1458	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	0.9831	<.0001	<.0001	<.0001	0.1132	<.0001	<.0001
46	<.0001	0.6032	0.0060	<.0001	0.0170	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	36	37	38	39	40	41	42
1	<.0001	0.1006	<.0001	<.0001	<.0001	0.6459	<.0001
2	<.0001	0.1125	<.0001	<.0001	<.0001	0.0059	<.0001
3	<.0001	0.0006	0.0018	<.0001	<.0001	<.0001	0.0001
4	<.0001	<.0001	<.0001	<.0001	0.0071	<.0001	<.0001
5	<.0001	0.0213	<.0001	<.0001	<.0001	0.2588	<.0001
6	<.0001	0.2609	<.0001	<.0001	<.0001	0.0215	<.0001
7	<.0001	0.0069	0.0001	<.0001	<.0001	0.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001
9	<.0001	0.0844	<.0001	<.0001	<.0001	0.5863	<.0001
10	<.0001	<.0001	0.0097	0.7918	0.0006	<.0001	0.0674
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
12	0.4736	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	0.0303	<.0001	<.0001	<.0001	0.3223	<.0001
14	<.0001	<.0001	0.0530	<.0001	<.0001	<.0001	0.0072
15	<.0001	<.0001	0.0162	0.9363	0.0003	<.0001	0.0996
16	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
17	<.0001	0.4469	<.0001	<.0001	<.0001	0.6694	<.0001
18	<.0001	0.0010	0.0011	<.0001	<.0001	<.0001	<.0001
19	<.0001	<.0001	0.9066	0.0270	<.0001	<.0001	0.5136
20	0.0021	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
21	<.0001	0.0213	<.0001	<.0001	<.0001	0.2588	<.0001
22	<.0001	<.0001	0.5807	0.0745	<.0001	<.0001	0.8271
23	<.0001	<.0001	<.0001	<.0001	0.5434	<.0001	<.0001
24	0.6706	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
25	<.0001	0.4063	<.0001	<.0001	<.0001	0.7212	<.0001
26	<.0001	<.0001	0.4616	0.0023	<.0001	<.0001	0.1328
27	<.0001	<.0001	0.0015	0.3793	0.0045	<.0001	0.0149
28	0.0787	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29	<.0001	0.1320	<.0001	<.0001	<.0001	0.7470	<.0001
30	<.0001	0.0032	0.0003	<.0001	<.0001	<.0001	<.0001
31	<.0001	<.0001	0.1531	0.0002	<.0001	<.0001	0.0285
32	<.0001	<.0001	<.0001	<.0001	0.0334	<.0001	<.0001
33	<.0001	0.9545	<.0001	<.0001	<.0001	0.2140	<.0001
34	<.0001	<.0001	0.0030	0.5074	0.0023	<.0001	0.0263
35	<.0001	<.0001	<.0001	<.0001	0.0028	<.0001	<.0001
36		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	<.0001		<.0001	<.0001	<.0001	0.2356	<.0001
38	<.0001	<.0001		0.0200	<.0001	<.0001	0.4411
39	<.0001	<.0001	0.0200		0.0002	<.0001	0.1169
40	<.0001	<.0001	<.0001	0.0002		<.0001	<.0001
41	<.0001	0.2356	<.0001	<.0001	<.0001		<.0001
42	<.0001	<.0001	0.4411	0.1169	<.0001	<.0001	
43	<.0001	<.0001	<.0001	0.0349	0.1047	<.0001	0.0003
44	0.8386	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	<.0001	0.1267	<.0001	<.0001	<.0001	0.7310	<.0001
46	<.0001	0.0145	<.0001	<.0001	<.0001	0.0003	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	43	44	45	46	47	48	49
1	<.0001	<.0001	0.9079	<.0001	<.0001	<.0001	0.4656
2	<.0001	<.0001	0.0020	0.3846	0.0020	<.0001	0.0128
3	<.0001	<.0001	<.0001	0.2961	0.2274	<.0001	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001	0.0223	<.0001
5	<.0001	<.0001	0.4315	<.0001	<.0001	<.0001	0.1621
6	<.0001	<.0001	0.0084	0.1824	0.0004	<.0001	0.0421
7	<.0001	<.0001	<.0001	0.7905	0.0477	<.0001	0.0003
8	<.0001	<.0001	<.0001	<.0001	<.0001	0.0011	<.0001
9	<.0001	<.0001	0.8411	<.0001	<.0001	<.0001	0.4155
10	0.0644	<.0001	<.0001	<.0001	<.0001	0.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
12	<.0001	0.6078	<.0001	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	0.5178	<.0001	<.0001	<.0001	0.2081
14	<.0001	<.0001	<.0001	0.0245	0.9935	<.0001	<.0001
15	0.0422	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
17	<.0001	<.0001	0.4411	0.0015	<.0001	<.0001	0.8757
18	<.0001	<.0001	<.0001	0.3740	0.1730	<.0001	<.0001
19	<.0001	<.0001	<.0001	<.0001	0.0395	<.0001	<.0001
20	<.0001	0.0040	<.0001	<.0001	<.0001	<.0001	<.0001
21	<.0001	<.0001	0.4315	<.0001	<.0001	<.0001	0.1621
22	0.0001	<.0001	<.0001	<.0001	0.0130	<.0001	<.0001
23	0.0263	<.0001	<.0001	<.0001	<.0001	0.8501	<.0001
24	<.0001	0.5295	<.0001	<.0001	<.0001	<.0001	<.0001
25	<.0001	<.0001	0.4837	0.0012	<.0001	<.0001	0.9312
26	<.0001	<.0001	<.0001	0.0006	0.2249	<.0001	<.0001
27	0.2152	<.0001	<.0001	<.0001	<.0001	0.0012	<.0001
28	<.0001	0.1196	<.0001	<.0001	<.0001	<.0001	<.0001
29	<.0001	<.0001	0.9831	<.0001	<.0001	<.0001	0.5532
30	<.0001	<.0001	<.0001	0.6032	0.0838	<.0001	0.0001
31	<.0001	<.0001	<.0001	0.0060	0.6032	<.0001	<.0001
32	0.0002	<.0001	<.0001	<.0001	<.0001	0.0864	<.0001
33	<.0001	<.0001	0.1132	0.0170	<.0001	<.0001	0.3303
34	0.1458	<.0001	<.0001	<.0001	<.0001	0.0006	<.0001
35	<.0001	<.0001	<.0001	<.0001	<.0001	0.0098	<.0001
36	<.0001	0.8386	<.0001	<.0001	<.0001	<.0001	<.0001
37	<.0001	<.0001	0.1267	0.0145	<.0001	<.0001	0.3594
38	<.0001	<.0001	<.0001	<.0001	0.0520	<.0001	<.0001
39	0.0349	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
40	0.1047	<.0001	<.0001	<.0001	<.0001	0.6754	<.0001
41	<.0001	<.0001	0.7310	0.0003	<.0001	<.0001	0.7868
42	0.0003	<.0001	<.0001	<.0001	0.0070	<.0001	<.0001
43		<.0001	<.0001	<.0001	<.0001	0.0417	<.0001
44	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001
45	<.0001	<.0001		<.0001	<.0001	<.0001	0.5391
46	<.0001	<.0001	<.0001		0.0250	<.0001	0.0009

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	50	51	52	53	54	55	56
1	<.0001	<.0001	<.0001	0.6435	<.0001	<.0001	<.0001
2	<.0001	<.0001	<.0001	0.0060	0.0554	0.0804	<.0001
3	<.0001	<.0001	<.0001	<.0001	0.9935	0.8718	<.0001
4	<.0001	0.0196	<.0001	<.0001	<.0001	<.0001	0.5543
5	<.0001	<.0001	<.0001	0.2574	<.0001	<.0001	<.0001
6	<.0001	<.0001	<.0001	0.0217	0.0176	0.0273	<.0001
7	<.0001	<.0001	<.0001	0.0001	0.4306	0.5359	<.0001
8	<.0001	0.0010	<.0001	<.0001	<.0001	<.0001	0.6825
9	<.0001	<.0001	<.0001	0.5841	<.0001	<.0001	<.0001
10	0.1185	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0669
12	<.0001	<.0001	0.1597	<.0001	<.0001	<.0001	<.0001
13	<.0001	<.0001	<.0001	0.3207	<.0001	<.0001	<.0001
14	0.0032	<.0001	<.0001	<.0001	0.2274	0.1690	<.0001
15	0.1680	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.2770
17	<.0001	<.0001	<.0001	0.6718	<.0001	<.0001	<.0001
18	<.0001	<.0001	<.0001	<.0001	0.8693	0.9961	<.0001
19	0.3560	<.0001	<.0001	<.0001	0.0013	0.0007	<.0001
20	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001	0.0038
21	<.0001	<.0001	<.0001	0.2574	<.0001	<.0001	<.0001
22	0.6250	<.0001	<.0001	<.0001	0.0003	0.0001	<.0001
23	<.0001	0.8119	<.0001	<.0001	<.0001	<.0001	0.0074
24	<.0001	<.0001	0.7893	<.0001	<.0001	<.0001	<.0001
25	<.0001	<.0001	<.0001	0.7236	<.0001	<.0001	<.0001
26	0.0766	<.0001	<.0001	<.0001	0.0164	0.0103	<.0001
27	0.0301	0.0014	<.0001	<.0001	<.0001	<.0001	<.0001
28	<.0001	<.0001	0.0147	<.0001	<.0001	<.0001	<.0001
29	<.0001	<.0001	<.0001	0.7445	<.0001	<.0001	<.0001
30	<.0001	<.0001	<.0001	<.0001	0.5931	0.7151	<.0001
31	0.0141	<.0001	<.0001	<.0001	0.0864	0.0599	<.0001
32	<.0001	0.0779	<.0001	<.0001	<.0001	<.0001	0.2421
33	<.0001	<.0001	<.0001	0.2152	0.0007	0.0012	<.0001
34	0.0505	0.0007	<.0001	<.0001	<.0001	<.0001	<.0001
35	<.0001	0.0086	<.0001	<.0001	<.0001	<.0001	0.7730
36	<.0001	<.0001	0.4888	<.0001	<.0001	<.0001	<.0001
37	<.0001	<.0001	<.0001	0.2369	0.0005	0.0010	<.0001
38	0.2983	<.0001	<.0001	<.0001	0.0018	0.0011	<.0001
39	0.1938	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
40	<.0001	0.7115	<.0001	<.0001	<.0001	<.0001	0.0011
41	<.0001	<.0001	<.0001	0.9974	<.0001	<.0001	<.0001
42	0.7868	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001
43	0.0007	0.0468	<.0001	<.0001	<.0001	<.0001	<.0001
44	<.0001	<.0001	0.3705	<.0001	<.0001	<.0001	<.0001
45	<.0001	<.0001	<.0001	0.7285	<.0001	<.0001	<.0001
46	<.0001	<.0001	<.0001	0.0003	0.2924	0.3766	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	57	58	59	60	61	62	63
1	0.4460	<.0001	<.0001	<.0001	0.1621	<.0001	<.0001
2	0.0140	<.0001	<.0001	<.0001	0.0672	<.0001	<.0001
3	<.0001	<.0001	<.0001	<.0001	0.0002	0.0031	<.0001
4	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001	0.0002
5	0.1526	<.0001	<.0001	<.0001	0.0392	<.0001	<.0001
6	0.0454	<.0001	<.0001	<.0001	0.1710	<.0001	<.0001
7	0.0004	<.0001	<.0001	<.0001	0.0033	0.0002	<.0001
8	<.0001	<.0001	0.3176	<.0001	<.0001	<.0001	<.0001
9	0.3972	<.0001	<.0001	<.0001	0.1383	<.0001	<.0001
10	<.0001	0.2152	<.0001	<.0001	<.0001	0.0059	0.0182
11	<.0001	<.0001	0.0158	<.0001	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	0.3247	<.0001	<.0001	<.0001
13	0.1966	<.0001	<.0001	<.0001	0.0544	<.0001	<.0001
14	<.0001	<.0001	<.0001	<.0001	<.0001	0.0774	<.0001
15	<.0001	0.1549	<.0001	<.0001	<.0001	0.0101	0.0110
16	<.0001	<.0001	0.0941	<.0001	<.0001	<.0001	<.0001
17	0.9014	<.0001	<.0001	<.0001	0.6067	<.0001	<.0001
18	<.0001	<.0001	<.0001	<.0001	0.0004	0.0019	<.0001
19	<.0001	0.0002	<.0001	<.0001	<.0001	0.7730	<.0001
20	<.0001	<.0001	0.0005	0.0008	<.0001	<.0001	<.0001
21	0.1526	<.0001	<.0001	<.0001	0.0392	<.0001	<.0001
22	<.0001	0.0011	<.0001	<.0001	<.0001	0.4696	<.0001
23	<.0001	0.0048	0.0357	<.0001	<.0001	<.0001	0.0876
24	<.0001	<.0001	<.0001	0.8757	<.0001	<.0001	<.0001
25	0.9571	<.0001	<.0001	<.0001	0.5586	<.0001	<.0001
26	<.0001	<.0001	<.0001	<.0001	<.0001	0.5719	<.0001
27	<.0001	0.5316	<.0001	<.0001	<.0001	0.0008	0.0790
28	<.0001	<.0001	<.0001	0.0431	<.0001	<.0001	<.0001
29	0.5316	<.0001	<.0001	<.0001	0.2069	<.0001	<.0001
30	0.0001	<.0001	<.0001	<.0001	0.0014	0.0005	<.0001
31	<.0001	<.0001	<.0001	<.0001	<.0001	0.2081	<.0001
32	<.0001	<.0001	0.5619	<.0001	<.0001	<.0001	0.0014
33	0.3467	<.0001	<.0001	<.0001	0.7618	<.0001	<.0001
34	<.0001	0.3999	<.0001	<.0001	<.0001	0.0017	0.0488
35	<.0001	<.0001	0.7618	<.0001	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	0.7880	<.0001	<.0001	<.0001
37	0.3766	<.0001	<.0001	<.0001	0.8056	<.0001	<.0001
38	<.0001	0.0002	<.0001	<.0001	<.0001	0.8641	<.0001
39	<.0001	0.1332	<.0001	<.0001	<.0001	0.0126	0.0088
40	<.0001	0.0258	0.0071	<.0001	<.0001	<.0001	0.2692
41	0.7618	<.0001	<.0001	<.0001	0.3467	<.0001	<.0001
42	<.0001	0.0024	<.0001	<.0001	<.0001	0.3467	<.0001
43	<.0001	0.5380	<.0001	<.0001	<.0001	<.0001	0.6021
44	<.0001	<.0001	<.0001	0.6366	<.0001	<.0001	<.0001
45	0.5178	<.0001	<.0001	<.0001	0.1994	<.0001	<.0001
46	0.0010	<.0001	<.0001	<.0001	0.0073	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	64	65	66	67	68	69	70
1	<.0001	0.5306	<.0001	<.0001	<.0001	0.6424	0.0011
2	<.0001	0.0096	<.0001	<.0001	<.0001	0.0060	0.9467
3	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0655
4	0.0031	<.0001	<.0001	0.0272	<.0001	<.0001	<.0001
5	<.0001	0.1949	<.0001	<.0001	<.0001	0.2568	<.0001
6	<.0001	0.0329	<.0001	<.0001	<.0001	0.0218	0.5942
7	<.0001	0.0002	<.0001	<.0001	<.0001	0.0001	0.2857
8	<.0001	<.0001	<.0001	0.0015	<.0001	<.0001	<.0001
9	<.0001	0.4766	<.0001	<.0001	<.0001	0.5830	0.0008
10	0.0015	<.0001	0.1582	<.0001	<.0001	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	0.1631	<.0001	<.0001
13	<.0001	0.2474	<.0001	<.0001	<.0001	0.3200	0.0002
14	<.0001	<.0001	0.0019	<.0001	<.0001	<.0001	0.0024
15	0.0008	<.0001	0.2194	<.0001	<.0001	<.0001	<.0001
16	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001	<.0001
17	<.0001	0.7955	<.0001	<.0001	<.0001	0.6730	0.0163
18	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0916
19	<.0001	<.0001	0.2828	<.0001	<.0001	<.0001	<.0001
20	<.0001	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001
21	<.0001	0.1949	<.0001	<.0001	<.0001	0.2568	<.0001
22	<.0001	<.0001	0.5221	<.0001	<.0001	<.0001	<.0001
23	0.3793	<.0001	<.0001	0.9118	<.0001	<.0001	<.0001
24	<.0001	<.0001	<.0001	<.0001	0.7981	<.0001	<.0001
25	<.0001	0.8501	<.0001	<.0001	<.0001	0.7248	0.0135
26	<.0001	<.0001	0.0548	<.0001	<.0001	<.0001	<.0001
27	0.0100	<.0001	0.0434	0.0009	<.0001	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	0.0152	<.0001	<.0001
29	<.0001	0.6238	<.0001	<.0001	<.0001	0.7433	0.0018
30	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1867
31	<.0001	<.0001	0.0093	<.0001	<.0001	<.0001	0.0004
32	0.0167	<.0001	<.0001	0.1016	<.0001	<.0001	<.0001
33	<.0001	0.2821	<.0001	<.0001	<.0001	0.2158	0.1103
34	0.0053	<.0001	0.0709	0.0004	<.0001	<.0001	<.0001
35	0.0012	<.0001	<.0001	0.0122	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	0.4960	<.0001	<.0001
37	<.0001	0.3083	<.0001	<.0001	<.0001	0.2376	0.0983
38	<.0001	<.0001	0.2337	<.0001	<.0001	<.0001	<.0001
39	0.0006	<.0001	0.2507	<.0001	<.0001	<.0001	<.0001
40	0.7855	<.0001	<.0001	0.6192	<.0001	<.0001	<.0001
41	<.0001	0.8667	<.0001	<.0001	<.0001	0.9961	0.0048
42	<.0001	<.0001	0.6730	<.0001	<.0001	<.0001	<.0001
43	0.1761	<.0001	0.0012	0.0346	<.0001	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	0.3766	<.0001	<.0001
45	<.0001	0.6089	<.0001	<.0001	<.0001	0.7273	0.0016
46	<.0001	0.0006	<.0001	<.0001	<.0001	0.0003	0.4221

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	71	72	73	74	75	76	77
1	<.0001	<.0001	0.3385	<.0001	<.0001	<.0001	0.5976
2	0.0249	<.0001	0.0234	<.0001	<.0001	<.0001	0.0072
3	0.7334	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	<.0001	0.1043	<.0001	<.0001	<.0001	0.2312
6	0.0070	<.0001	0.0706	<.0001	<.0001	<.0001	0.0257
7	0.2629	<.0001	0.0008	<.0001	<.0001	<.0001	0.0002
8	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001	0.2976	<.0001	<.0001	<.0001	0.5402
10	<.0001	0.0121	<.0001	0.1777	0.1110	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	0.6945	<.0001
13	<.0001	<.0001	0.1374	<.0001	<.0001	<.0001	0.2901
14	0.3810	<.0001	<.0001	0.0016	<.0001	<.0001	<.0001
15	<.0001	0.0072	<.0001	0.2441	0.0758	<.0001	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
17	<.0001	<.0001	0.9428	<.0001	<.0001	<.0001	0.7200
18	0.6192	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
19	0.0037	<.0001	<.0001	0.2554	<.0001	<.0001	<.0001
20	<.0001	<.0001	<.0001	<.0001	<.0001	0.0057	<.0001
21	<.0001	<.0001	0.1043	<.0001	<.0001	<.0001	0.2312
22	0.0009	<.0001	<.0001	0.4817	0.0003	<.0001	<.0001
23	<.0001	0.1192	<.0001	<.0001	0.0133	<.0001	<.0001
24	<.0001	<.0001	<.0001	<.0001	<.0001	0.4538	<.0001
25	<.0001	<.0001	0.8872	<.0001	<.0001	<.0001	0.7730
26	0.0382	<.0001	<.0001	0.0474	<.0001	<.0001	<.0001
27	<.0001	0.0567	<.0001	0.0503	0.3263	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	0.1507	<.0001
29	<.0001	<.0001	0.4118	<.0001	<.0001	<.0001	0.6957
30	0.3864	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001
31	0.1660	<.0001	<.0001	0.0077	<.0001	<.0001	<.0001
32	<.0001	0.0022	<.0001	<.0001	<.0001	<.0001	<.0001
33	0.0002	<.0001	0.4557	<.0001	<.0001	<.0001	0.2401
34	<.0001	0.0341	<.0001	0.0812	0.2312	<.0001	<.0001
35	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	0.7457	<.0001
37	0.0002	<.0001	0.4908	<.0001	<.0001	<.0001	0.2636
38	0.0052	<.0001	<.0001	0.2098	<.0001	<.0001	<.0001
39	<.0001	0.0057	<.0001	0.2777	0.0637	<.0001	<.0001
40	<.0001	0.3401	<.0001	<.0001	0.0603	<.0001	<.0001
41	<.0001	<.0001	0.6181	<.0001	<.0001	<.0001	0.9454
42	0.0004	<.0001	<.0001	0.6273	0.0007	<.0001	<.0001
43	<.0001	0.5011	<.0001	0.0015	0.7955	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	0.9040	<.0001
45	<.0001	<.0001	0.3999	<.0001	<.0001	<.0001	0.6802
46	0.1665	<.0001	0.0019	<.0001	<.0001	<.0001	0.0004

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	78	79	80	81	82	83	84
1	<.0001	<.0001	<.0001	0.3451	<.0001	<.0001	<.0001
2	0.1263	0.0006	<.0001	0.0227	<.0001	<.0001	<.0001
3	0.7018	0.1140	<.0001	<.0001	<.0001	<.0001	<.0001
4	<.0001	<.0001	0.0029	<.0001	<.0001	0.1118	<.0001
5	<.0001	<.0001	<.0001	0.1071	<.0001	<.0001	<.0001
6	0.0466	0.0001	<.0001	0.0686	<.0001	<.0001	<.0001
7	0.6909	0.0188	<.0001	0.0007	<.0001	<.0001	<.0001
8	<.0001	<.0001	<.0001	<.0001	<.0001	0.5521	<.0001
9	<.0001	<.0001	<.0001	0.3037	<.0001	<.0001	<.0001
10	<.0001	<.0001	0.0017	<.0001	0.3917	<.0001	<.0001
11	<.0001	<.0001	<.0001	<.0001	<.0001	0.4035	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0019
13	<.0001	<.0001	<.0001	0.1409	<.0001	<.0001	<.0001
14	0.1107	0.7127	<.0001	<.0001	<.0001	<.0001	<.0001
15	<.0001	<.0001	0.0009	<.0001	0.2983	<.0001	<.0001
16	<.0001	<.0001	<.0001	<.0001	<.0001	0.9325	<.0001
17	0.0001	<.0001	<.0001	0.9532	<.0001	<.0001	<.0001
18	0.8208	0.0827	<.0001	<.0001	<.0001	<.0001	<.0001
19	0.0003	0.0916	<.0001	<.0001	0.0010	<.0001	<.0001
20	<.0001	<.0001	<.0001	<.0001	<.0001	0.0554	<.0001
21	<.0001	<.0001	<.0001	0.1071	<.0001	<.0001	<.0001
22	<.0001	0.0343	<.0001	<.0001	0.0040	<.0001	<.0001
23	<.0001	<.0001	0.3654	<.0001	0.0014	0.0003	<.0001
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0459
25	0.0001	<.0001	<.0001	0.8976	<.0001	<.0001	<.0001
26	0.0054	0.4017	<.0001	<.0001	<.0001	<.0001	<.0001
27	<.0001	<.0001	0.0108	<.0001	0.8094	<.0001	<.0001
28	<.0001	<.0001	<.0001	<.0001	<.0001	0.0012	<.0001
29	<.0001	<.0001	<.0001	0.4193	<.0001	<.0001	<.0001
30	0.8860	0.0357	<.0001	0.0003	<.0001	<.0001	<.0001
31	0.0357	0.8860	<.0001	<.0001	<.0001	<.0001	<.0001
32	<.0001	<.0001	0.0155	<.0001	<.0001	0.0306	<.0001
33	0.0024	<.0001	<.0001	0.4479	<.0001	<.0001	<.0001
34	<.0001	<.0001	0.0058	<.0001	0.6471	<.0001	<.0001
35	<.0001	<.0001	0.0011	<.0001	<.0001	0.1972	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0158
37	0.0020	<.0001	<.0001	0.4827	<.0001	<.0001	<.0001
38	0.0005	0.1162	<.0001	<.0001	0.0006	<.0001	<.0001
39	<.0001	0.0001	0.0007	<.0001	0.2629	<.0001	<.0001
40	<.0001	<.0001	0.7655	<.0001	0.0092	<.0001	<.0001
41	<.0001	<.0001	<.0001	0.6273	<.0001	<.0001	<.0001
42	<.0001	0.0198	<.0001	<.0001	0.0076	<.0001	<.0001
43	<.0001	<.0001	0.1845	<.0001	0.3176	<.0001	<.0001
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0090
45	<.0001	<.0001	<.0001	0.4072	<.0001	<.0001	<.0001
46	0.5074	0.0091	<.0001	0.0018	<.0001	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	85	86	87	88	89	90	91
1	0.2337	<.0001	<.0001	<.0001	0.4008	<.0001	<.0001
2	0.0417	0.2231	<.0001	<.0001	0.0172	<.0001	<.0001
3	0.0001	0.4867	0.0002	<.0001	<.0001	0.0033	<.0001
4	<.0001	<.0001	<.0001	0.0785	<.0001	<.0001	<.0001
5	0.0634	<.0001	<.0001	<.0001	0.1316	<.0001	<.0001
6	0.1151	0.0928	<.0001	<.0001	0.0544	<.0001	<.0001
7	0.0017	0.9325	<.0001	<.0001	0.0005	0.0002	<.0001
8	<.0001	<.0001	<.0001	0.0061	<.0001	<.0001	<.0001
9	0.2023	<.0001	<.0001	<.0001	0.3551	<.0001	<.0001
10	<.0001	<.0001	0.0514	<.0001	<.0001	0.0056	0.0627
11	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
12	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
13	0.0858	<.0001	<.0001	<.0001	0.1710	<.0001	<.0001
14	<.0001	0.0569	0.0101	<.0001	<.0001	0.0804	<.0001
15	<.0001	<.0001	0.0774	<.0001	<.0001	0.0096	0.0411
16	<.0001	<.0001	<.0001	0.0007	<.0001	<.0001	<.0001
17	0.7593	0.0004	<.0001	<.0001	0.9636	<.0001	<.0001
18	0.0002	0.5897	0.0001	<.0001	<.0001	0.0020	<.0001
19	<.0001	<.0001	0.5942	<.0001	<.0001	0.7593	<.0001
20	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
21	0.0634	<.0001	<.0001	<.0001	0.1316	<.0001	<.0001
22	<.0001	<.0001	0.9221	<.0001	<.0001	0.4587	0.0001
23	<.0001	<.0001	<.0001	0.7297	<.0001	<.0001	0.0271
24	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
25	0.7066	0.0003	<.0001	<.0001	0.9805	<.0001	<.0001
26	<.0001	0.0021	0.1665	<.0001	<.0001	0.5841	<.0001
27	<.0001	<.0001	0.0107	0.0002	<.0001	0.0008	0.2110
28	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
29	0.2916	<.0001	<.0001	<.0001	0.4817	<.0001	<.0001
30	0.0007	0.8654	<.0001	<.0001	0.0002	0.0006	<.0001
31	<.0001	0.0161	0.0383	<.0001	<.0001	0.2146	<.0001
32	<.0001	<.0001	<.0001	0.2363	<.0001	<.0001	0.0002
33	0.6089	0.0063	<.0001	<.0001	0.3882	<.0001	<.0001
34	<.0001	<.0001	0.0193	<.0001	<.0001	0.0016	0.1427
35	<.0001	<.0001	<.0001	0.0395	<.0001	<.0001	<.0001
36	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
37	0.6494	0.0054	<.0001	<.0001	0.4202	<.0001	<.0001
38	<.0001	0.0002	0.5157	<.0001	<.0001	0.8501	<.0001
39	<.0001	<.0001	0.0916	<.0001	<.0001	0.0120	0.0339
40	<.0001	<.0001	<.0001	0.3409	<.0001	<.0001	0.1071
41	0.4636	<.0001	<.0001	<.0001	0.7030	<.0001	<.0001
42	<.0001	<.0001	0.9040	<.0001	<.0001	0.3377	0.0003
43	<.0001	<.0001	0.0002	0.0105	<.0001	<.0001	0.9909
44	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
45	0.2821	<.0001	<.0001	<.0001	0.4686	<.0001	<.0001
46	0.0039	0.7261	<.0001	<.0001	0.0013	<.0001	<.0001

Least Squares Means for effect Hour*Enz*Prep*Load
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: Glucose

i/j	92	93	94	95	96
1	<.0001	0.6055	0.0013	<.0001	<.0001
2	<.0001	0.0070	0.9896	0.0123	<.0001
3	<.0001	<.0001	0.0581	0.5434	<.0001
4	<.0001	<.0001	<.0001	<.0001	<.0001
5	<.0001	0.2356	0.0001	<.0001	<.0001
6	<.0001	0.0249	0.6319	0.0031	<.0001
7	<.0001	0.0002	0.2622	0.1660	<.0001
8	0.0002	<.0001	<.0001	<.0001	<.0001
9	<.0001	0.5478	0.0010	<.0001	<.0001
10	<.0001	<.0001	<.0001	<.0001	0.1636
11	0.0160	<.0001	<.0001	<.0001	<.0001
12	0.2894	<.0001	<.0001	<.0001	<.0001
13	<.0001	0.2953	0.0002	<.0001	<.0001
14	<.0001	<.0001	0.0021	0.5424	<.0001
15	<.0001	<.0001	<.0001	<.0001	0.1151
16	0.0017	<.0001	<.0001	<.0001	<.0001
17	<.0001	0.7115	0.0188	<.0001	<.0001
18	<.0001	<.0001	0.0818	0.4450	<.0001
19	<.0001	<.0001	<.0001	0.0081	0.0001
20	0.1819	<.0001	<.0001	<.0001	<.0001
21	<.0001	0.2356	0.0001	<.0001	<.0001
22	<.0001	<.0001	<.0001	0.0022	0.0007
23	<.0001	<.0001	<.0001	<.0001	0.0075
24	0.0285	<.0001	<.0001	<.0001	<.0001
25	<.0001	0.7643	0.0156	<.0001	<.0001
26	<.0001	<.0001	<.0001	0.0704	<.0001
27	<.0001	<.0001	<.0001	<.0001	0.4354
28	0.9896	<.0001	<.0001	<.0001	<.0001
29	<.0001	0.7042	0.0021	<.0001	<.0001
30	<.0001	<.0001	0.1695	0.2574	<.0001
31	<.0001	<.0001	0.0004	0.2629	<.0001
32	<.0001	<.0001	<.0001	<.0001	<.0001
33	<.0001	0.2356	0.1227	<.0001	<.0001
34	<.0001	<.0001	<.0001	<.0001	0.3192
35	<.0001	<.0001	<.0001	<.0001	<.0001
36	0.0766	<.0001	<.0001	<.0001	<.0001
37	<.0001	0.2588	0.1096	<.0001	<.0001
38	<.0001	<.0001	<.0001	0.0113	<.0001
39	<.0001	<.0001	<.0001	<.0001	0.0980
40	<.0001	<.0001	<.0001	<.0001	0.0377
41	<.0001	0.9545	0.0057	<.0001	<.0001
42	<.0001	<.0001	<.0001	0.0010	0.0014
43	<.0001	<.0001	<.0001	<.0001	0.6447
44	0.1166	<.0001	<.0001	<.0001	<.0001
45	<.0001	0.6885	0.0019	<.0001	<.0001
46	<.0001	0.0004	0.3917	0.0993	<.0001

Dependent Variable: Glucose

i/j	1	2	3	4	5	6	7
47	<.0001	0.0020	0.2274	<.0001	<.0001	0.0004	0.0477
48	<.0001	<.0001	<.0001	0.0223	<.0001	<.0001	<.0001
49	0.4656	0.0128	<.0001	<.0001	0.1621	0.0421	0.0003
50	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
51	<.0001	<.0001	<.0001	0.0196	<.0001	<.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
53	0.6435	0.0060	<.0001	<.0001	0.2574	0.0217	0.0001
54	<.0001	0.0554	0.9935	<.0001	<.0001	0.0176	0.4306
55	<.0001	0.0804	0.8718	<.0001	<.0001	0.0273	0.5359
56	<.0001	<.0001	<.0001	0.5543	<.0001	<.0001	<.0001
57	0.4460	0.0140	<.0001	<.0001	0.1526	0.0454	0.0004
58	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
59	<.0001	<.0001	<.0001	1.0000	<.0001	<.0001	<.0001
60	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
61	0.1621	0.0672	0.0002	<.0001	0.0392	0.1710	0.0033
62	<.0001	<.0001	0.0031	<.0001	<.0001	<.0001	0.0002
63	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001
64	<.0001	<.0001	<.0001	0.0031	<.0001	<.0001	<.0001
65	0.5306	0.0096	<.0001	<.0001	0.1949	0.0329	0.0002
66	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
67	<.0001	<.0001	<.0001	0.0272	<.0001	<.0001	<.0001
68	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
69	0.6424	0.0060	<.0001	<.0001	0.2568	0.0218	0.0001
70	0.0011	0.9467	0.0655	<.0001	<.0001	0.5942	0.2857
71	<.0001	0.0249	0.7334	<.0001	<.0001	0.0070	0.2629
72	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001
73	0.3385	0.0234	<.0001	<.0001	0.1043	0.0706	0.0008
74	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
75	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
76	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
77	0.5976	0.0072	<.0001	<.0001	0.2312	0.0257	0.0002
78	<.0001	0.1263	0.7018	<.0001	<.0001	0.0466	0.6909
79	<.0001	0.0006	0.1140	<.0001	<.0001	0.0001	0.0188
80	<.0001	<.0001	<.0001	0.0029	<.0001	<.0001	<.0001
81	0.3451	0.0227	<.0001	<.0001	0.1071	0.0686	0.0007
82	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
83	<.0001	<.0001	<.0001	0.1118	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
85	0.2337	0.0417	0.0001	<.0001	0.0634	0.1151	0.0017
86	<.0001	0.2231	0.4867	<.0001	<.0001	0.0928	0.9325
87	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001
88	<.0001	<.0001	<.0001	0.0785	<.0001	<.0001	<.0001
89	0.4008	0.0172	<.0001	<.0001	0.1316	0.0544	0.0005
90	<.0001	<.0001	0.0033	<.0001	<.0001	<.0001	0.0002
91	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
92	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
93	0.6055	0.0070	<.0001	<.0001	0.2356	0.0249	0.0002
94	0.0013	0.9896	0.0581	<.0001	0.0001	0.6319	0.2622
95	<.0001	0.0123	0.5434	<.0001	<.0001	0.0031	0.1660
96	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	8	9	10	11	12	13	14
47	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.9935
48	0.0011	<.0001	0.0001	<.0001	<.0001	<.0001	<.0001
49	<.0001	0.4155	<.0001	<.0001	<.0001	0.2081	<.0001
50	<.0001	<.0001	0.1185	<.0001	<.0001	<.0001	0.0032
51	0.0010	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	0.1597	<.0001	<.0001
53	<.0001	0.5841	<.0001	<.0001	<.0001	0.3207	<.0001
54	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.2274
55	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1690
56	0.6825	<.0001	<.0001	0.0669	<.0001	<.0001	<.0001
57	<.0001	0.3972	<.0001	<.0001	<.0001	0.1966	<.0001
58	<.0001	<.0001	0.2152	<.0001	<.0001	<.0001	<.0001
59	0.3176	<.0001	<.0001	0.0158	<.0001	<.0001	<.0001
60	<.0001	<.0001	<.0001	<.0001	0.3247	<.0001	<.0001
61	<.0001	0.1383	<.0001	<.0001	<.0001	0.0544	<.0001
62	<.0001	<.0001	0.0059	<.0001	<.0001	<.0001	0.0774
63	<.0001	<.0001	0.0182	<.0001	<.0001	<.0001	<.0001
64	<.0001	<.0001	0.0015	<.0001	<.0001	<.0001	<.0001
65	<.0001	0.4766	<.0001	<.0001	<.0001	0.2474	<.0001
66	<.0001	<.0001	0.1582	<.0001	<.0001	<.0001	0.0019
67	0.0015	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
68	<.0001	<.0001	<.0001	<.0001	0.1631	<.0001	<.0001
69	<.0001	0.5830	<.0001	<.0001	<.0001	0.3200	<.0001
70	<.0001	0.0008	<.0001	<.0001	<.0001	0.0002	0.0024
71	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.3810
72	<.0001	<.0001	0.0121	<.0001	<.0001	<.0001	<.0001
73	<.0001	0.2976	<.0001	<.0001	<.0001	0.1374	<.0001
74	<.0001	<.0001	0.1777	<.0001	<.0001	<.0001	0.0016
75	<.0001	<.0001	0.1110	<.0001	<.0001	<.0001	<.0001
76	<.0001	<.0001	<.0001	0.0001	0.6945	<.0001	<.0001
77	<.0001	0.5402	<.0001	<.0001	<.0001	0.2901	<.0001
78	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1107
79	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.7127
80	<.0001	<.0001	0.0017	<.0001	<.0001	<.0001	<.0001
81	<.0001	0.3037	<.0001	<.0001	<.0001	0.1409	<.0001
82	<.0001	<.0001	0.3917	<.0001	<.0001	<.0001	<.0001
83	0.5521	<.0001	<.0001	0.4035	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	0.0019	<.0001	<.0001
85	<.0001	0.2023	<.0001	<.0001	<.0001	0.0858	<.0001
86	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0569
87	<.0001	<.0001	0.0514	<.0001	<.0001	<.0001	0.0101
88	0.0061	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
89	<.0001	0.3551	<.0001	<.0001	<.0001	0.1710	<.0001
90	<.0001	<.0001	0.0056	<.0001	<.0001	<.0001	0.0804
91	<.0001	<.0001	0.0627	<.0001	<.0001	<.0001	<.0001
92	0.0002	<.0001	<.0001	0.0160	0.2894	<.0001	<.0001
93	<.0001	0.5478	<.0001	<.0001	<.0001	0.2953	<.0001
94	<.0001	0.0010	<.0001	<.0001	<.0001	0.0002	0.0021
95	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.5424
96	<.0001	<.0001	0.1636	<.0001	<.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	15	16	17	18	19	20	21
47	<.0001	<.0001	<.0001	0.1730	0.0395	<.0001	<.0001
48	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
49	<.0001	<.0001	0.8757	<.0001	<.0001	<.0001	0.1621
50	0.1680	<.0001	<.0001	<.0001	0.3560	<.0001	<.0001
51	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	<.0001
53	<.0001	<.0001	0.6718	<.0001	<.0001	<.0001	0.2574
54	<.0001	<.0001	<.0001	0.8693	0.0013	<.0001	<.0001
55	<.0001	<.0001	<.0001	0.9961	0.0007	<.0001	<.0001
56	<.0001	0.2770	<.0001	<.0001	<.0001	0.0038	<.0001
57	<.0001	<.0001	0.9014	<.0001	<.0001	<.0001	0.1526
58	0.1549	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001
59	<.0001	0.0941	<.0001	<.0001	<.0001	0.0005	<.0001
60	<.0001	<.0001	<.0001	<.0001	<.0001	0.0008	<.0001
61	<.0001	<.0001	0.6067	0.0004	<.0001	<.0001	0.0392
62	0.0101	<.0001	<.0001	0.0019	0.7730	<.0001	<.0001
63	0.0110	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
64	0.0008	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
65	<.0001	<.0001	0.7955	<.0001	<.0001	<.0001	0.1949
66	0.2194	<.0001	<.0001	<.0001	0.2828	<.0001	<.0001
67	<.0001	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001
68	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	<.0001
69	<.0001	<.0001	0.6730	<.0001	<.0001	<.0001	0.2568
70	<.0001	<.0001	0.0163	0.0916	<.0001	<.0001	<.0001
71	<.0001	<.0001	<.0001	0.6192	0.0037	<.0001	<.0001
72	0.0072	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
73	<.0001	<.0001	0.9428	<.0001	<.0001	<.0001	0.1043
74	0.2441	<.0001	<.0001	<.0001	0.2554	<.0001	<.0001
75	0.0758	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
76	<.0001	<.0001	<.0001	<.0001	<.0001	0.0057	<.0001
77	<.0001	<.0001	0.7200	<.0001	<.0001	<.0001	0.2312
78	<.0001	<.0001	0.0001	0.8208	0.0003	<.0001	<.0001
79	<.0001	<.0001	<.0001	0.0827	0.0916	<.0001	<.0001
80	0.0009	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
81	<.0001	<.0001	0.9532	<.0001	<.0001	<.0001	0.1071
82	0.2983	<.0001	<.0001	<.0001	0.0010	<.0001	<.0001
83	<.0001	0.9325	<.0001	<.0001	<.0001	0.0554	<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
85	<.0001	<.0001	0.7593	0.0002	<.0001	<.0001	0.0634
86	<.0001	<.0001	0.0004	0.5897	<.0001	<.0001	<.0001
87	0.0774	<.0001	<.0001	0.0001	0.5942	<.0001	<.0001
88	<.0001	0.0007	<.0001	<.0001	<.0001	<.0001	<.0001
89	<.0001	<.0001	0.9636	<.0001	<.0001	<.0001	0.1316
90	0.0096	<.0001	<.0001	0.0020	0.7593	<.0001	<.0001
91	0.0411	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
92	<.0001	0.0017	<.0001	<.0001	<.0001	0.1819	<.0001
93	<.0001	<.0001	0.7115	<.0001	<.0001	<.0001	0.2356
94	<.0001	<.0001	0.0188	0.0818	<.0001	<.0001	0.0001
95	<.0001	<.0001	<.0001	0.4450	0.0081	<.0001	<.0001
96	0.1151	<.0001	<.0001	<.0001	0.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	22	23	24	25	26	27	28
47	0.0130	<.0001	<.0001	<.0001	0.2249	<.0001	<.0001
48	<.0001	0.8501	<.0001	<.0001	<.0001	0.0012	<.0001
49	<.0001	<.0001	<.0001	0.9312	<.0001	<.0001	<.0001
50	0.6250	<.0001	<.0001	<.0001	0.0766	0.0301	<.0001
51	<.0001	0.8119	<.0001	<.0001	<.0001	0.0014	<.0001
52	<.0001	<.0001	0.7893	<.0001	<.0001	<.0001	0.0147
53	<.0001	<.0001	<.0001	0.7236	<.0001	<.0001	<.0001
54	0.0003	<.0001	<.0001	<.0001	0.0164	<.0001	<.0001
55	0.0001	<.0001	<.0001	<.0001	0.0103	<.0001	<.0001
56	<.0001	0.0074	<.0001	<.0001	<.0001	<.0001	<.0001
57	<.0001	<.0001	<.0001	0.9571	<.0001	<.0001	<.0001
58	0.0011	0.0048	<.0001	<.0001	<.0001	0.5316	<.0001
59	<.0001	0.0357	<.0001	<.0001	<.0001	<.0001	<.0001
60	<.0001	<.0001	0.8757	<.0001	<.0001	<.0001	0.0431
61	<.0001	<.0001	<.0001	0.5586	<.0001	<.0001	<.0001
62	0.4696	<.0001	<.0001	<.0001	0.5719	0.0008	<.0001
63	<.0001	0.0876	<.0001	<.0001	<.0001	0.0790	<.0001
64	<.0001	0.3793	<.0001	<.0001	<.0001	0.0100	<.0001
65	<.0001	<.0001	<.0001	0.8501	<.0001	<.0001	<.0001
66	0.5221	<.0001	<.0001	<.0001	0.0548	0.0434	<.0001
67	<.0001	0.9118	<.0001	<.0001	<.0001	0.0009	<.0001
68	<.0001	<.0001	0.7981	<.0001	<.0001	<.0001	0.0152
69	<.0001	<.0001	<.0001	0.7248	<.0001	<.0001	<.0001
70	<.0001	<.0001	<.0001	0.0135	<.0001	<.0001	<.0001
71	0.0009	<.0001	<.0001	<.0001	0.0382	<.0001	<.0001
72	<.0001	0.1192	<.0001	<.0001	<.0001	0.0567	<.0001
73	<.0001	<.0001	<.0001	0.8872	<.0001	<.0001	<.0001
74	0.4817	<.0001	<.0001	<.0001	0.0474	0.0503	<.0001
75	0.0003	0.0133	<.0001	<.0001	<.0001	0.3263	<.0001
76	<.0001	<.0001	0.4538	<.0001	<.0001	<.0001	0.1507
77	<.0001	<.0001	<.0001	0.7730	<.0001	<.0001	<.0001
78	<.0001	<.0001	<.0001	0.0001	0.0054	<.0001	<.0001
79	0.0343	<.0001	<.0001	<.0001	0.4017	<.0001	<.0001
80	<.0001	0.3654	<.0001	<.0001	<.0001	0.0108	<.0001
81	<.0001	<.0001	<.0001	0.8976	<.0001	<.0001	<.0001
82	0.0040	0.0014	<.0001	<.0001	<.0001	0.8094	<.0001
83	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001	0.0012
84	<.0001	<.0001	0.0459	<.0001	<.0001	<.0001	<.0001
85	<.0001	<.0001	<.0001	0.7066	<.0001	<.0001	<.0001
86	<.0001	<.0001	<.0001	0.0003	0.0021	<.0001	<.0001
87	0.9221	<.0001	<.0001	<.0001	0.1665	0.0107	<.0001
88	<.0001	0.7297	<.0001	<.0001	<.0001	0.0002	<.0001
89	<.0001	<.0001	<.0001	0.9805	<.0001	<.0001	<.0001
90	0.4587	<.0001	<.0001	<.0001	0.5841	0.0008	<.0001
91	0.0001	0.0271	<.0001	<.0001	<.0001	0.2110	<.0001
92	<.0001	<.0001	0.0285	<.0001	<.0001	<.0001	0.9896
93	<.0001	<.0001	<.0001	0.7643	<.0001	<.0001	<.0001
94	<.0001	<.0001	<.0001	0.0156	<.0001	<.0001	<.0001
95	0.0022	<.0001	<.0001	<.0001	0.0704	<.0001	<.0001
96	0.0007	0.0075	<.0001	<.0001	<.0001	0.4354	<.0001

Dependent Variable: Glucose

i/j	29	30	31	32	33	34	35
47	<.0001	0.0838	0.6032	<.0001	<.0001	<.0001	<.0001
48	<.0001	<.0001	<.0001	0.0864	<.0001	0.0006	0.0098
49	0.5532	0.0001	<.0001	<.0001	0.3303	<.0001	<.0001
50	<.0001	<.0001	0.0141	<.0001	<.0001	0.0505	<.0001
51	<.0001	<.0001	<.0001	0.0779	<.0001	0.0007	0.0086
52	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
53	0.7445	<.0001	<.0001	<.0001	0.2152	<.0001	<.0001
54	<.0001	0.5931	0.0864	<.0001	0.0007	<.0001	<.0001
55	<.0001	0.7151	0.0599	<.0001	0.0012	<.0001	<.0001
56	<.0001	<.0001	<.0001	0.2421	<.0001	<.0001	0.7730
57	0.5316	0.0001	<.0001	<.0001	0.3467	<.0001	<.0001
58	<.0001	<.0001	<.0001	<.0001	<.0001	0.3999	<.0001
59	<.0001	<.0001	<.0001	0.5619	<.0001	<.0001	0.7618
60	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
61	0.2069	0.0014	<.0001	<.0001	0.7618	<.0001	<.0001
62	<.0001	0.0005	0.2081	<.0001	<.0001	0.0017	<.0001
63	<.0001	<.0001	<.0001	0.0014	<.0001	0.0488	<.0001
64	<.0001	<.0001	<.0001	0.0167	<.0001	0.0053	0.0012
65	0.6238	<.0001	<.0001	<.0001	0.2821	<.0001	<.0001
66	<.0001	<.0001	0.0093	<.0001	<.0001	0.0709	<.0001
67	<.0001	<.0001	<.0001	0.1016	<.0001	0.0004	0.0122
68	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
69	0.7433	<.0001	<.0001	<.0001	0.2158	<.0001	<.0001
70	0.0018	0.1867	0.0004	<.0001	0.1103	<.0001	<.0001
71	<.0001	0.3864	0.1660	<.0001	0.0002	<.0001	<.0001
72	<.0001	<.0001	<.0001	0.0022	<.0001	0.0341	<.0001
73	0.4118	0.0003	<.0001	<.0001	0.4557	<.0001	<.0001
74	<.0001	<.0001	0.0077	<.0001	<.0001	0.0812	<.0001
75	<.0001	<.0001	<.0001	<.0001	<.0001	0.2312	<.0001
76	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
77	0.6957	<.0001	<.0001	<.0001	0.2401	<.0001	<.0001
78	<.0001	0.8860	0.0357	<.0001	0.0024	<.0001	<.0001
79	<.0001	0.0357	0.8860	<.0001	<.0001	<.0001	<.0001
80	<.0001	<.0001	<.0001	0.0155	<.0001	0.0058	0.0011
81	0.4193	0.0003	<.0001	<.0001	0.4479	<.0001	<.0001
82	<.0001	<.0001	<.0001	<.0001	<.0001	0.6471	<.0001
83	<.0001	<.0001	<.0001	0.0306	<.0001	<.0001	0.1972
84	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
85	0.2916	0.0007	<.0001	<.0001	0.6089	<.0001	<.0001
86	<.0001	0.8654	0.0161	<.0001	0.0063	<.0001	<.0001
87	<.0001	<.0001	0.0383	<.0001	<.0001	0.0193	<.0001
88	<.0001	<.0001	<.0001	0.2363	<.0001	<.0001	0.0395
89	0.4817	0.0002	<.0001	<.0001	0.3882	<.0001	<.0001
90	<.0001	0.0006	0.2146	<.0001	<.0001	0.0016	<.0001
91	<.0001	<.0001	<.0001	0.0002	<.0001	0.1427	<.0001
92	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
93	0.7042	<.0001	<.0001	<.0001	0.2356	<.0001	<.0001
94	0.0021	0.1695	0.0004	<.0001	0.1227	<.0001	<.0001
95	<.0001	0.2574	0.2629	<.0001	<.0001	<.0001	<.0001
96	<.0001	<.0001	<.0001	<.0001	<.0001	0.3192	<.0001

Dependent Variable: Glucose

i/j	36	37	38	39	40	41	42
47	<.0001	<.0001	0.0520	<.0001	<.0001	<.0001	0.0070
48	<.0001	<.0001	<.0001	<.0001	0.6754	<.0001	<.0001
49	<.0001	0.3594	<.0001	<.0001	<.0001	0.7868	<.0001
50	<.0001	<.0001	0.2983	0.1938	<.0001	<.0001	0.7868
51	<.0001	<.0001	<.0001	<.0001	0.7115	<.0001	<.0001
52	0.4888	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
53	<.0001	0.2369	<.0001	<.0001	<.0001	0.9974	<.0001
54	<.0001	0.0005	0.0018	<.0001	<.0001	<.0001	0.0001
55	<.0001	0.0010	0.0011	<.0001	<.0001	<.0001	<.0001
56	<.0001	<.0001	<.0001	<.0001	0.0011	<.0001	<.0001
57	<.0001	0.3766	<.0001	<.0001	<.0001	0.7618	<.0001
58	<.0001	<.0001	0.0002	0.1332	0.0258	<.0001	0.0024
59	<.0001	<.0001	<.0001	<.0001	0.0071	<.0001	<.0001
60	0.7880	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
61	<.0001	0.8056	<.0001	<.0001	<.0001	0.3467	<.0001
62	<.0001	<.0001	0.8641	0.0126	<.0001	<.0001	0.3467
63	<.0001	<.0001	<.0001	0.0088	0.2692	<.0001	<.0001
64	<.0001	<.0001	<.0001	0.0006	0.7855	<.0001	<.0001
65	<.0001	0.3083	<.0001	<.0001	<.0001	0.8667	<.0001
66	<.0001	<.0001	0.2337	0.2507	<.0001	<.0001	0.6730
67	<.0001	<.0001	<.0001	<.0001	0.6192	<.0001	<.0001
68	0.4960	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
69	<.0001	0.2376	<.0001	<.0001	<.0001	0.9961	<.0001
70	<.0001	0.0983	<.0001	<.0001	<.0001	0.0048	<.0001
71	<.0001	0.0002	0.0052	<.0001	<.0001	<.0001	0.0004
72	<.0001	<.0001	<.0001	0.0057	0.3401	<.0001	<.0001
73	<.0001	0.4908	<.0001	<.0001	<.0001	0.6181	<.0001
74	<.0001	<.0001	0.2098	0.2777	<.0001	<.0001	0.6273
75	<.0001	<.0001	<.0001	0.0637	0.0603	<.0001	0.0007
76	0.7457	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
77	<.0001	0.2636	<.0001	<.0001	<.0001	0.9454	<.0001
78	<.0001	0.0020	0.0005	<.0001	<.0001	<.0001	<.0001
79	<.0001	<.0001	0.1162	0.0001	<.0001	<.0001	0.0198
80	<.0001	<.0001	<.0001	0.0007	0.7655	<.0001	<.0001
81	<.0001	0.4827	<.0001	<.0001	<.0001	0.6273	<.0001
82	<.0001	<.0001	0.0006	0.2629	0.0092	<.0001	0.0076
83	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
84	0.0158	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
85	<.0001	0.6494	<.0001	<.0001	<.0001	0.4636	<.0001
86	<.0001	0.0054	0.0002	<.0001	<.0001	<.0001	<.0001
87	<.0001	<.0001	0.5157	0.0916	<.0001	<.0001	0.9040
88	<.0001	<.0001	<.0001	<.0001	0.3409	<.0001	<.0001
89	<.0001	0.4202	<.0001	<.0001	<.0001	0.7030	<.0001
90	<.0001	<.0001	0.8501	0.0120	<.0001	<.0001	0.3377
91	<.0001	<.0001	<.0001	0.0339	0.1071	<.0001	0.0003
92	0.0766	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
93	<.0001	0.2588	<.0001	<.0001	<.0001	0.9545	<.0001
94	<.0001	0.1096	<.0001	<.0001	<.0001	0.0057	<.0001
95	<.0001	<.0001	0.0113	<.0001	<.0001	<.0001	0.0010
96	<.0001	<.0001	<.0001	0.0980	0.0377	<.0001	0.0014

Dependent Variable: Glucose

i/j	43	44	45	46	47	48	49
47	<.0001	<.0001	<.0001	0.0250		<.0001	<.0001
48	0.0417	<.0001	<.0001	<.0001	<.0001		<.0001
49	<.0001	<.0001	0.5391	0.0009	<.0001	<.0001	
50	0.0007	<.0001	<.0001	<.0001	0.0031	<.0001	<.0001
51	0.0468	<.0001	<.0001	<.0001	<.0001	0.9610	<.0001
52	<.0001	0.3705	<.0001	<.0001	<.0001	<.0001	<.0001
53	<.0001	<.0001	0.7285	0.0003	<.0001	<.0001	0.7893
54	<.0001	<.0001	<.0001	0.2924	0.2306	<.0001	<.0001
55	<.0001	<.0001	<.0001	0.3766	0.1715	<.0001	<.0001
56	<.0001	<.0001	<.0001	<.0001	<.0001	0.0042	<.0001
57	<.0001	<.0001	0.5178	0.0010	<.0001	<.0001	0.9740
58	0.5380	<.0001	<.0001	<.0001	<.0001	0.0083	<.0001
59	<.0001	<.0001	<.0001	<.0001	<.0001	0.0223	<.0001
60	<.0001	0.6366	<.0001	<.0001	<.0001	<.0001	<.0001
61	<.0001	<.0001	0.1994	0.0073	<.0001	<.0001	0.5022
62	<.0001	<.0001	<.0001	<.0001	0.0760	<.0001	<.0001
63	0.6021	<.0001	<.0001	<.0001	<.0001	0.1283	<.0001
64	0.1761	<.0001	<.0001	<.0001	<.0001	0.4898	<.0001
65	<.0001	<.0001	0.6089	0.0006	<.0001	<.0001	0.9182
66	0.0012	<.0001	<.0001	<.0001	0.0019	<.0001	<.0001
67	0.0346	<.0001	<.0001	<.0001	<.0001	0.9376	<.0001
68	<.0001	0.3766	<.0001	<.0001	<.0001	<.0001	<.0001
69	<.0001	<.0001	0.7273	0.0003	<.0001	<.0001	0.7905
70	<.0001	<.0001	0.0016	0.4221	0.0025	<.0001	0.0106
71	<.0001	<.0001	<.0001	0.1665	0.3855	<.0001	<.0001
72	0.5011	<.0001	<.0001	<.0001	<.0001	0.1705	<.0001
73	<.0001	<.0001	0.3999	0.0019	<.0001	<.0001	0.8195
74	0.0015	<.0001	<.0001	<.0001	0.0015	<.0001	<.0001
75	0.7955	<.0001	<.0001	<.0001	<.0001	0.0220	<.0001
76	<.0001	0.9040	<.0001	<.0001	<.0001	<.0001	<.0001
77	<.0001	<.0001	0.6802	0.0004	<.0001	<.0001	0.8398
78	<.0001	<.0001	<.0001	0.5074	0.1125	<.0001	<.0001
79	<.0001	<.0001	<.0001	0.0091	0.7066	<.0001	<.0001
80	0.1845	<.0001	<.0001	<.0001	<.0001	0.4736	<.0001
81	<.0001	<.0001	0.4072	0.0018	<.0001	<.0001	0.8297
82	0.3176	<.0001	<.0001	<.0001	<.0001	0.0026	<.0001
83	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001	<.0001
84	<.0001	0.0090	<.0001	<.0001	<.0001	<.0001	<.0001
85	<.0001	<.0001	0.2821	0.0039	<.0001	<.0001	0.6435
86	<.0001	<.0001	<.0001	0.7261	0.0579	<.0001	0.0002
87	0.0002	<.0001	<.0001	<.0001	0.0099	<.0001	<.0001
88	0.0105	<.0001	<.0001	<.0001	<.0001	0.5931	<.0001
89	<.0001	<.0001	0.4686	0.0013	<.0001	<.0001	0.9118
90	<.0001	<.0001	<.0001	<.0001	0.0790	<.0001	<.0001
91	0.9909	<.0001	<.0001	<.0001	<.0001	0.0429	<.0001
92	<.0001	0.1166	<.0001	<.0001	<.0001	<.0001	<.0001
93	<.0001	<.0001	0.6885	0.0004	<.0001	<.0001	0.8309
94	<.0001	<.0001	0.0019	0.3917	0.0021	<.0001	0.0123
95	<.0001	<.0001	<.0001	0.0993	0.5478	<.0001	<.0001
96	0.6447	<.0001	<.0001	<.0001	<.0001	0.0128	<.0001

Dependent Variable: Glucose

i/j	50	51	52	53	54	55	56
47	0.0031	<.0001	<.0001	<.0001	0.2306	0.1715	<.0001
48	<.0001	0.9610	<.0001	<.0001	<.0001	<.0001	0.0042
49	<.0001	<.0001	<.0001	0.7893	<.0001	<.0001	<.0001
50		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
51	<.0001		<.0001	<.0001	<.0001	<.0001	0.0036
52	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
53	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
54	<.0001	<.0001	<.0001	<.0001		0.8654	<.0001
55	<.0001	<.0001	<.0001	<.0001	0.8654		<.0001
56	<.0001	0.0036	<.0001	<.0001	<.0001	<.0001	
57	<.0001	<.0001	<.0001	0.7643	<.0001	<.0001	<.0001
58	0.0054	0.0096	<.0001	<.0001	<.0001	<.0001	<.0001
59	<.0001	0.0196	<.0001	<.0001	<.0001	<.0001	0.5543
60	<.0001	<.0001	0.6718	<.0001	<.0001	<.0001	<.0001
61	<.0001	<.0001	<.0001	0.3484	0.0002	0.0004	<.0001
62	0.2262	<.0001	<.0001	<.0001	0.0032	0.0019	<.0001
63	0.0001	0.1409	<.0001	<.0001	<.0001	<.0001	<.0001
64	<.0001	0.5210	<.0001	<.0001	<.0001	<.0001	0.0004
65	<.0001	<.0001	<.0001	0.8693	<.0001	<.0001	<.0001
66	0.8795	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
67	<.0001	0.8988	<.0001	<.0001	<.0001	<.0001	0.0053
68	<.0001	<.0001	0.9909	<.0001	<.0001	<.0001	<.0001
69	<.0001	<.0001	<.0001	0.9987	<.0001	<.0001	<.0001
70	<.0001	<.0001	<.0001	0.0049	0.0644	0.0925	<.0001
71	0.0002	<.0001	<.0001	<.0001	0.7396	0.6158	<.0001
72	<.0001	0.1862	<.0001	<.0001	<.0001	<.0001	<.0001
73	<.0001	<.0001	<.0001	0.6204	<.0001	<.0001	<.0001
74	0.8297	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
75	0.0018	0.0249	<.0001	<.0001	<.0001	<.0001	<.0001
76	<.0001	<.0001	0.3098	<.0001	<.0001	<.0001	<.0001
77	<.0001	<.0001	<.0001	0.9480	<.0001	<.0001	<.0001
78	<.0001	<.0001	<.0001	<.0001	0.6957	0.8246	<.0001
79	0.0095	<.0001	<.0001	<.0001	0.1158	0.0818	<.0001
80	<.0001	0.5042	<.0001	<.0001	<.0001	<.0001	0.0004
81	<.0001	<.0001	<.0001	0.6296	<.0001	<.0001	<.0001
82	0.0162	0.0030	<.0001	<.0001	<.0001	<.0001	<.0001
83	<.0001	0.0001	<.0001	<.0001	<.0001	<.0001	0.3160
84	<.0001	<.0001	0.0832	<.0001	<.0001	<.0001	<.0001
85	<.0001	<.0001	<.0001	0.4656	<.0001	0.0002	<.0001
86	<.0001	<.0001	<.0001	<.0001	0.4817	0.5931	<.0001
87	0.6957	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001
88	<.0001	0.5597	<.0001	<.0001	<.0001	<.0001	0.0192
89	<.0001	<.0001	<.0001	0.7054	<.0001	<.0001	<.0001
90	0.2194	<.0001	<.0001	<.0001	0.0034	0.0020	<.0001
91	0.0007	0.0481	<.0001	<.0001	<.0001	<.0001	<.0001
92	<.0001	<.0001	0.0142	<.0001	<.0001	<.0001	<.0001
93	<.0001	<.0001	<.0001	0.9571	<.0001	<.0001	<.0001
94	<.0001	<.0001	<.0001	0.0057	0.0571	0.0827	<.0001
95	0.0004	<.0001	<.0001	<.0001	0.5488	0.4421	<.0001
96	0.0034	0.0147	<.0001	<.0001	<.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	57	58	59	60	61	62	63
47	<.0001	<.0001	<.0001	<.0001	<.0001	0.0760	<.0001
48	<.0001	0.0083	0.0223	<.0001	<.0001	<.0001	0.1283
49	0.9740	<.0001	<.0001	<.0001	0.5022	<.0001	<.0001
50	<.0001	0.0054	<.0001	<.0001	<.0001	0.2262	0.0001
51	<.0001	0.0096	0.0196	<.0001	<.0001	<.0001	0.1409
52	<.0001	<.0001	<.0001	0.6718	<.0001	<.0001	<.0001
53	0.7643	<.0001	<.0001	<.0001	0.3484	<.0001	<.0001
54	<.0001	<.0001	<.0001	<.0001	0.0002	0.0032	<.0001
55	<.0001	<.0001	<.0001	<.0001	0.0004	0.0019	<.0001
56	<.0001	<.0001	0.5543	<.0001	<.0001	<.0001	<.0001
57		<.0001	<.0001	<.0001	0.5231	<.0001	<.0001
58	<.0001		<.0001	<.0001	<.0001	<.0001	0.2561
59	<.0001	<.0001		<.0001	<.0001	<.0001	0.0002
60	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
61	0.5231	<.0001	<.0001	<.0001		<.0001	<.0001
62	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
63	<.0001	0.2561	0.0002	<.0001	<.0001	<.0001	
64	<.0001	0.0497	0.0031	<.0001	<.0001	<.0001	0.4044
65	0.8924	<.0001	<.0001	<.0001	0.4392	<.0001	<.0001
66	<.0001	0.0085	<.0001	<.0001	<.0001	0.1736	0.0002
67	<.0001	0.0066	0.0272	<.0001	<.0001	<.0001	0.1100
68	<.0001	<.0001	<.0001	0.6802	<.0001	<.0001	<.0001
69	0.7655	<.0001	<.0001	<.0001	0.3492	<.0001	<.0001
70	0.0116	<.0001	<.0001	<.0001	0.0579	<.0001	<.0001
71	<.0001	<.0001	<.0001	<.0001	<.0001	0.0086	<.0001
72	<.0001	0.1983	0.0003	<.0001	<.0001	<.0001	0.8795
73	0.8449	<.0001	<.0001	<.0001	0.6576	<.0001	<.0001
74	<.0001	0.0101	<.0001	<.0001	<.0001	0.1545	0.0002
75	<.0001	0.7212	<.0001	<.0001	<.0001	<.0001	0.4354
76	<.0001	<.0001	<.0001	0.5532	<.0001	<.0001	<.0001
77	0.8145	<.0001	<.0001	<.0001	0.3828	<.0001	<.0001
78	<.0001	<.0001	<.0001	<.0001	0.0009	0.0009	<.0001
79	<.0001	<.0001	<.0001	<.0001	<.0001	0.1611	<.0001
80	<.0001	0.0528	0.0029	<.0001	<.0001	<.0001	0.4193
81	0.8552	<.0001	<.0001	<.0001	0.6482	<.0001	<.0001
82	<.0001	0.7006	<.0001	<.0001	<.0001	0.0003	0.1291
83	<.0001	<.0001	0.1118	<.0001	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	0.0316	<.0001	<.0001	<.0001
85	0.6671	<.0001	<.0001	<.0001	0.8348	<.0001	<.0001
86	0.0003	<.0001	<.0001	<.0001	0.0025	0.0003	<.0001
87	<.0001	0.0016	<.0001	<.0001	<.0001	0.4118	<.0001
88	<.0001	0.0016	0.0785	<.0001	<.0001	<.0001	0.0405
89	0.9376	<.0001	<.0001	<.0001	0.5752	<.0001	<.0001
90	<.0001	<.0001	<.0001	<.0001	<.0001	0.9857	<.0001
91	<.0001	0.5306	<.0001	<.0001	<.0001	<.0001	0.6101
92	<.0001	<.0001	<.0001	0.0417	<.0001	<.0001	<.0001
93	0.8056	<.0001	<.0001	<.0001	0.3766	<.0001	<.0001
94	0.0135	<.0001	<.0001	<.0001	0.0653	<.0001	<.0001
95	<.0001	<.0001	<.0001	<.0001	<.0001	0.0180	<.0001
96	<.0001	0.8770	<.0001	<.0001	<.0001	<.0001	0.3263

Dependent Variable: Glucose

i/j	64	65	66	67	68	69	70
47	<.0001	<.0001	0.0019	<.0001	<.0001	<.0001	0.0025
48	0.4898	<.0001	<.0001	0.9376	<.0001	<.0001	<.0001
49	<.0001	0.9182	<.0001	<.0001	<.0001	0.7905	0.0106
50	<.0001	<.0001	0.8795	<.0001	<.0001	<.0001	<.0001
51	0.5210	<.0001	<.0001	0.8988	<.0001	<.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	0.9909	<.0001	<.0001
53	<.0001	0.8693	<.0001	<.0001	<.0001	0.9987	0.0049
54	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0644
55	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0925
56	0.0004	<.0001	<.0001	0.0053	<.0001	<.0001	<.0001
57	<.0001	0.8924	<.0001	<.0001	<.0001	0.7655	0.0116
58	0.0497	<.0001	0.0085	0.0066	<.0001	<.0001	<.0001
59	0.0031	<.0001	<.0001	0.0272	<.0001	<.0001	<.0001
60	<.0001	<.0001	<.0001	<.0001	0.6802	<.0001	<.0001
61	<.0001	0.4392	<.0001	<.0001	<.0001	0.3492	0.0579
62	<.0001	<.0001	0.1736	<.0001	<.0001	<.0001	<.0001
63	0.4044	<.0001	0.0002	0.1100	<.0001	<.0001	<.0001
64		<.0001	<.0001	0.4421	<.0001	<.0001	<.0001
65	<.0001		<.0001	<.0001	<.0001	0.8705	0.0079
66	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
67	0.4421	<.0001	<.0001		<.0001	<.0001	<.0001
68	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
69	<.0001	0.8705	<.0001	<.0001	<.0001		0.0049
70	<.0001	0.0079	<.0001	<.0001	<.0001	0.0049	
71	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0295
72	0.4949	<.0001	0.0001	0.1476	<.0001	<.0001	<.0001
73	<.0001	0.7408	<.0001	<.0001	<.0001	0.6215	0.0197
74	<.0001	<.0001	0.9493	<.0001	<.0001	<.0001	<.0001
75	0.1075	<.0001	0.0029	0.0179	<.0001	<.0001	<.0001
76	<.0001	<.0001	<.0001	<.0001	0.3152	<.0001	<.0001
77	<.0001	0.9208	<.0001	<.0001	<.0001	0.9493	0.0059
78	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1435
79	<.0001	<.0001	0.0061	<.0001	<.0001	<.0001	0.0007
80	0.9792	<.0001	<.0001	0.4268	<.0001	<.0001	<.0001
81	<.0001	0.7507	<.0001	<.0001	<.0001	0.6308	0.0190
82	0.0193	<.0001	0.0240	0.0020	<.0001	<.0001	<.0001
83	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	0.0812	<.0001	<.0001
85	<.0001	0.5719	<.0001	<.0001	<.0001	0.4666	0.0356
86	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001	0.2494
87	<.0001	<.0001	0.5875	<.0001	<.0001	<.0001	<.0001
88	0.2212	<.0001	<.0001	0.6482	<.0001	<.0001	<.0001
89	<.0001	0.8309	<.0001	<.0001	<.0001	0.7066	0.0144
90	<.0001	<.0001	0.1680	<.0001	<.0001	<.0001	<.0001
91	0.1798	<.0001	0.0012	0.0356	<.0001	<.0001	<.0001
92	<.0001	<.0001	<.0001	<.0001	0.0147	<.0001	<.0001
93	<.0001	0.9118	<.0001	<.0001	<.0001	0.9584	0.0057
94	<.0001	0.0093	<.0001	<.0001	<.0001	0.0058	0.9571
95	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001	0.0147
96	0.0704	<.0001	0.0054	0.0103	<.0001	<.0001	<.0001

Dependent Variable: Glucose

i/j	71	72	73	74	75	76	77
47	0.3855	<.0001	<.0001	0.0015	<.0001	<.0001	<.0001
48	<.0001	0.1705	<.0001	<.0001	0.0220	<.0001	<.0001
49	<.0001	<.0001	0.8195	<.0001	<.0001	<.0001	0.8398
50	0.0002	<.0001	<.0001	0.8297	0.0018	<.0001	<.0001
51	<.0001	0.1862	<.0001	<.0001	0.0249	<.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	<.0001	0.3098	<.0001
53	<.0001	<.0001	0.6204	<.0001	<.0001	<.0001	0.9480
54	0.7396	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
55	0.6158	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
56	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
57	<.0001	<.0001	0.8449	<.0001	<.0001	<.0001	0.8145
58	<.0001	0.1983	<.0001	0.0101	0.7212	<.0001	<.0001
59	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001
60	<.0001	<.0001	<.0001	<.0001	<.0001	0.5532	<.0001
61	<.0001	<.0001	0.6576	<.0001	<.0001	<.0001	0.3828
62	0.0086	<.0001	<.0001	0.1545	<.0001	<.0001	<.0001
63	<.0001	0.8795	<.0001	0.0002	0.4354	<.0001	<.0001
64	<.0001	0.4949	<.0001	<.0001	0.1075	<.0001	<.0001
65	<.0001	<.0001	0.7408	<.0001	<.0001	<.0001	0.9208
66	<.0001	0.0001	<.0001	0.9493	0.0029	<.0001	<.0001
67	<.0001	0.1476	<.0001	<.0001	0.0179	<.0001	<.0001
68	<.0001	<.0001	<.0001	<.0001	<.0001	0.3152	<.0001
69	<.0001	<.0001	0.6215	<.0001	<.0001	<.0001	0.9493
70	0.0295	<.0001	0.0197	<.0001	<.0001	<.0001	0.0059
71		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
72	<.0001		<.0001	0.0001	0.3517	<.0001	<.0001
73	<.0001	<.0001		<.0001	<.0001	<.0001	0.6671
74	<.0001	0.0001	<.0001		0.0035	<.0001	<.0001
75	<.0001	0.3517	<.0001	0.0035		<.0001	<.0001
76	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
77	<.0001	<.0001	0.6671	<.0001	<.0001	<.0001	
78	0.4696	<.0001	0.0002	<.0001	<.0001	<.0001	<.0001
79	0.2140	<.0001	<.0001	0.0051	<.0001	<.0001	<.0001
80	<.0001	0.5115	<.0001	<.0001	0.1132	<.0001	<.0001
81	<.0001	<.0001	0.9896	<.0001	<.0001	<.0001	0.6766
82	<.0001	0.0954	<.0001	0.0282	0.4587	<.0001	<.0001
83	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001	0.0063	<.0001
85	<.0001	<.0001	0.8145	<.0001	<.0001	<.0001	0.5063
86	0.3006	<.0001	0.0006	<.0001	<.0001	<.0001	0.0001
87	0.0006	<.0001	<.0001	0.5445	0.0005	<.0001	<.0001
88	<.0001	0.0575	<.0001	<.0001	0.0049	<.0001	<.0001
89	<.0001	<.0001	0.9066	<.0001	<.0001	<.0001	0.7544
90	0.0091	<.0001	<.0001	0.1494	<.0001	<.0001	<.0001
91	<.0001	0.5084	<.0001	0.0015	0.7868	<.0001	<.0001
92	<.0001	<.0001	<.0001	<.0001	<.0001	0.1471	<.0001
93	<.0001	<.0001	0.6588	<.0001	<.0001	<.0001	0.9909
94	0.0258	<.0001	0.0227	<.0001	<.0001	<.0001	0.0070
95	0.7893	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001
96	<.0001	0.2574	<.0001	0.0065	0.8398	<.0001	<.0001

Dependent Variable: Glucose

i/j	78	79	80	81	82	83	84
47	0.1125	0.7066	<.0001	<.0001	<.0001	<.0001	<.0001
48	<.0001	<.0001	0.4736	<.0001	0.0026	0.0001	<.0001
49	<.0001	<.0001	<.0001	0.8297	<.0001	<.0001	<.0001
50	<.0001	0.0095	<.0001	<.0001	0.0162	<.0001	<.0001
51	<.0001	<.0001	0.5042	<.0001	0.0030	0.0001	<.0001
52	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0832
53	<.0001	<.0001	<.0001	0.6296	<.0001	<.0001	<.0001
54	0.6957	0.1158	<.0001	<.0001	<.0001	<.0001	<.0001
55	0.8246	0.0818	<.0001	<.0001	<.0001	<.0001	<.0001
56	<.0001	<.0001	0.0004	<.0001	<.0001	0.3160	<.0001
57	<.0001	<.0001	<.0001	0.8552	<.0001	<.0001	<.0001
58	<.0001	<.0001	0.0528	<.0001	0.7006	<.0001	<.0001
59	<.0001	<.0001	0.0029	<.0001	<.0001	0.1118	<.0001
60	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0316
61	0.0009	<.0001	<.0001	0.6482	<.0001	<.0001	<.0001
62	0.0009	0.1611	<.0001	<.0001	0.0003	<.0001	<.0001
63	<.0001	<.0001	0.4193	<.0001	0.1291	<.0001	<.0001
64	<.0001	<.0001	0.9792	<.0001	0.0193	<.0001	<.0001
65	<.0001	<.0001	<.0001	0.7507	<.0001	<.0001	<.0001
66	<.0001	0.0061	<.0001	<.0001	0.0240	<.0001	<.0001
67	<.0001	<.0001	0.4268	<.0001	0.0020	0.0002	<.0001
68	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0812
69	<.0001	<.0001	<.0001	0.6308	<.0001	<.0001	<.0001
70	0.1435	0.0007	<.0001	0.0190	<.0001	<.0001	<.0001
71	0.4696	0.2140	<.0001	<.0001	<.0001	<.0001	<.0001
72	<.0001	<.0001	0.5115	<.0001	0.0954	<.0001	<.0001
73	0.0002	<.0001	<.0001	0.9896	<.0001	<.0001	<.0001
74	<.0001	0.0051	<.0001	<.0001	0.0282	<.0001	<.0001
75	<.0001	<.0001	0.1132	<.0001	0.4587	<.0001	<.0001
76	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0063
77	<.0001	<.0001	<.0001	0.6766	<.0001	<.0001	<.0001
78		0.0501	<.0001	0.0002	<.0001	<.0001	<.0001
79	0.0501		<.0001	<.0001	<.0001	<.0001	<.0001
80	<.0001	<.0001		<.0001	0.0206	<.0001	<.0001
81	0.0002	<.0001	<.0001		<.0001	<.0001	<.0001
82	<.0001	<.0001	0.0206	<.0001		<.0001	<.0001
83	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	
85	0.0004	<.0001	<.0001	0.8044	<.0001	<.0001	<.0001
86	0.7544	0.0234	<.0001	0.0005	<.0001	<.0001	<.0001
87	<.0001	0.0270	<.0001	<.0001	0.0053	<.0001	<.0001
88	<.0001	<.0001	0.2116	<.0001	0.0004	0.0009	<.0001
89	0.0001	<.0001	<.0001	0.9169	<.0001	<.0001	<.0001
90	0.0009	0.1665	<.0001	<.0001	0.0003	<.0001	<.0001
91	<.0001	<.0001	0.1883	<.0001	0.3121	<.0001	<.0001
92	<.0001	<.0001	<.0001	<.0001	<.0001	0.0013	<.0001
93	<.0001	<.0001	<.0001	0.6683	<.0001	<.0001	<.0001
94	0.1295	0.0006	<.0001	0.0219	<.0001	<.0001	<.0001
95	0.3223	0.3287	<.0001	<.0001	<.0001	<.0001	<.0001
96	<.0001	<.0001	0.0745	<.0001	0.5897	<.0001	<.0001

Dependent Variable: Glucose

i/j	85	86	87	88	89	90	91
47	<.0001	0.0579	0.0099	<.0001	<.0001	0.0790	<.0001
48	<.0001	<.0001	<.0001	0.5931	<.0001	<.0001	0.0429
49	0.6435	0.0002	<.0001	<.0001	0.9118	<.0001	<.0001
50	<.0001	<.0001	0.6957	<.0001	<.0001	0.2194	0.0007
51	<.0001	<.0001	<.0001	0.5597	<.0001	<.0001	0.0481
52	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
53	0.4656	<.0001	<.0001	<.0001	0.7054	<.0001	<.0001
54	<.0001	0.4817	0.0002	<.0001	<.0001	0.0034	<.0001
55	0.0002	0.5931	<.0001	<.0001	<.0001	0.0020	<.0001
56	<.0001	<.0001	<.0001	0.0192	<.0001	<.0001	<.0001
57	0.6671	0.0003	<.0001	<.0001	0.9376	<.0001	<.0001
58	<.0001	<.0001	0.0016	0.0016	<.0001	<.0001	0.5306
59	<.0001	<.0001	<.0001	0.0785	<.0001	<.0001	<.0001
60	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
61	0.8348	0.0025	<.0001	<.0001	0.5752	<.0001	<.0001
62	<.0001	0.0003	0.4118	<.0001	<.0001	0.9857	<.0001
63	<.0001	<.0001	<.0001	0.0405	<.0001	<.0001	0.6101
64	<.0001	<.0001	<.0001	0.2212	<.0001	<.0001	0.1798
65	0.5719	0.0002	<.0001	<.0001	0.8309	<.0001	<.0001
66	<.0001	<.0001	0.5875	<.0001	<.0001	0.1680	0.0012
67	<.0001	<.0001	<.0001	0.6482	<.0001	<.0001	0.0356
68	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
69	0.4666	<.0001	<.0001	<.0001	0.7066	<.0001	<.0001
70	0.0356	0.2494	<.0001	<.0001	0.0144	<.0001	<.0001
71	<.0001	0.3006	0.0006	<.0001	<.0001	0.0091	<.0001
72	<.0001	<.0001	<.0001	0.0575	<.0001	<.0001	0.5084
73	0.8145	0.0006	<.0001	<.0001	0.9066	<.0001	<.0001
74	<.0001	<.0001	0.5445	<.0001	<.0001	0.1494	0.0015
75	<.0001	<.0001	0.0005	0.0049	<.0001	<.0001	0.7868
76	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
77	0.5063	0.0001	<.0001	<.0001	0.7544	<.0001	<.0001
78	0.0004	0.7544	<.0001	<.0001	0.0001	0.0009	<.0001
79	<.0001	0.0234	0.0270	<.0001	<.0001	0.1665	<.0001
80	<.0001	<.0001	<.0001	0.2116	<.0001	<.0001	0.1883
81	0.8044	0.0005	<.0001	<.0001	0.9169	<.0001	<.0001
82	<.0001	<.0001	0.0053	0.0004	<.0001	0.0003	0.3121
83	<.0001	<.0001	<.0001	0.0009	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
85		0.0013	<.0001	<.0001	0.7248	<.0001	<.0001
86	0.0013		<.0001	<.0001	0.0004	0.0003	<.0001
87	<.0001	<.0001		<.0001	<.0001	0.4017	0.0002
88	<.0001	<.0001	<.0001		<.0001	<.0001	0.0108
89	0.7248	0.0004	<.0001	<.0001		<.0001	<.0001
90	<.0001	0.0003	0.4017	<.0001	<.0001		<.0001
91	<.0001	<.0001	0.0002	0.0108	<.0001	<.0001	
92	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
93	0.4991	0.0001	<.0001	<.0001	0.7457	<.0001	<.0001
94	0.0405	0.2280	<.0001	<.0001	0.0167	<.0001	<.0001
95	<.0001	0.1933	0.0016	<.0001	<.0001	0.0189	<.0001
96	<.0001	<.0001	0.0009	0.0026	<.0001	<.0001	0.6366

Dependent Variable: Glucose

i/j	92	93	94	95	96
47	<.0001	<.0001	0.0021	0.5478	<.0001
48	<.0001	<.0001	<.0001	<.0001	0.0128
49	<.0001	0.8309	0.0123	<.0001	<.0001
50	<.0001	<.0001	<.0001	0.0004	0.0034
51	<.0001	<.0001	<.0001	<.0001	0.0147
52	0.0142	<.0001	<.0001	<.0001	<.0001
53	<.0001	0.9571	0.0057	<.0001	<.0001
54	<.0001	<.0001	0.0571	0.5488	<.0001
55	<.0001	<.0001	0.0827	0.4421	<.0001
56	<.0001	<.0001	<.0001	<.0001	<.0001
57	<.0001	0.8056	0.0135	<.0001	<.0001
58	<.0001	<.0001	<.0001	<.0001	0.8770
59	<.0001	<.0001	<.0001	<.0001	<.0001
60	0.0417	<.0001	<.0001	<.0001	<.0001
61	<.0001	0.3766	0.0653	<.0001	<.0001
62	<.0001	<.0001	<.0001	0.0180	<.0001
63	<.0001	<.0001	<.0001	<.0001	0.3263
64	<.0001	<.0001	<.0001	<.0001	0.0704
65	<.0001	0.9118	0.0093	<.0001	<.0001
66	<.0001	<.0001	<.0001	0.0002	0.0054
67	<.0001	<.0001	<.0001	<.0001	0.0103
68	0.0147	<.0001	<.0001	<.0001	<.0001
69	<.0001	0.9584	0.0058	<.0001	<.0001
70	<.0001	0.0057	0.9571	0.0147	<.0001
71	<.0001	<.0001	0.0258	0.7893	<.0001
72	<.0001	<.0001	<.0001	<.0001	0.2574
73	<.0001	0.6588	0.0227	<.0001	<.0001
74	<.0001	<.0001	<.0001	0.0002	0.0065
75	<.0001	<.0001	<.0001	<.0001	0.8398
76	0.1471	<.0001	<.0001	<.0001	<.0001
77	<.0001	0.9909	0.0070	<.0001	<.0001
78	<.0001	<.0001	0.1295	0.3223	<.0001
79	<.0001	<.0001	0.0006	0.3287	<.0001
80	<.0001	<.0001	<.0001	<.0001	0.0745
81	<.0001	0.6683	0.0219	<.0001	<.0001
82	<.0001	<.0001	<.0001	<.0001	0.5897
83	0.0013	<.0001	<.0001	<.0001	<.0001
84	<.0001	<.0001	<.0001	<.0001	<.0001
85	<.0001	0.4991	0.0405	<.0001	<.0001
86	<.0001	0.0001	0.2280	0.1933	<.0001
87	<.0001	<.0001	<.0001	0.0016	0.0009
88	<.0001	<.0001	<.0001	<.0001	0.0026
89	<.0001	0.7457	0.0167	<.0001	<.0001
90	<.0001	<.0001	<.0001	0.0189	<.0001
91	<.0001	<.0001	<.0001	<.0001	0.6366
92		<.0001	<.0001	<.0001	<.0001
93	<.0001		0.0067	<.0001	<.0001
94	<.0001	0.0067		0.0127	<.0001
95	<.0001	<.0001	0.0127		<.0001
96	<.0001	<.0001	<.0001	<.0001	

Appendix C: SAS® Analyses for Saccharification of FTA-94 ISP with Promozyme

Appendix C.1 Flour ISP

```
title 'Sacch. with Pullulanase on FTA-94 ISP: Glucose and Change in
Starch';
data Saccharification032008;
input Temp Load Rep DeltaAIS Glucose;
datalines;
55     0      1      53.00  788.5
55     0      2      52.67  780.6
55     0      3      53.00  869.8
55     0.1    1      53.33  808.2
55     0.1    2      53.67  802.3
55     0.1    3      54.00  790.4
55     0.5    1      53.00  794.4
55     0.5    2      53.33  883.6
55     0.5    3      54.00  808.2
55     1      1      53.67  738.6
55     1      2      52.67  771.4
55     1      3      54.00  795.0
65     0      1      54.17  827.1
65     0      2      52.83  745.3
65     0      3      54.50  814.7
65     0.1    1      54.50  774.1
65     0.1    2      54.50  827.8
65     0.1    3      53.50  762.4
65     0.5    1      53.17  858.6
65     0.5    2      52.83  905.0
65     0.5    3      52.50  874.3
65     1      1      52.83  799.0
65     1      2      53.83  686.4
65     1      3      53.50  878.2
45     0      1      53.67  771.5
45     0      2      53.33  825.7
45     0      3      52.33  804.8
45     0.1    1      53.33  797.0
45     0.1    2      52.00  808.1
45     0.1    3      54.33  844.6
45     0.5    1      53.33  804.1
45     0.5    2      53.67  823.1
45     0.5    3      53.67  823.1
45     1      1      53.00  781.3
45     1      2      52.00  790.4
45     1      3      52.67  778.7
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
      class Temp Load;
      model DeltaAIS Glucose = Temp Load Temp*Load;
      lsmeans Temp Load Temp*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Sacch. with Pullulanase on Flour FTA-94 ISP: Glucose and Change in Starch

Obs	Temp	Load	Rep	Delta AIS	Glucose
1	55	0.0	1	53.00	788.5
2	55	0.0	2	52.67	780.6
3	55	0.0	3	53.00	869.8
4	55	0.1	1	53.33	808.2
5	55	0.1	2	53.67	802.3
6	55	0.1	3	54.00	790.4
7	55	0.5	1	53.00	794.4
8	55	0.5	2	53.33	883.6
9	55	0.5	3	54.00	808.2
10	55	1.0	1	53.67	738.6
11	55	1.0	2	52.67	771.4
12	55	1.0	3	54.00	795.0
13	65	0.0	1	54.17	827.1
14	65	0.0	2	52.83	745.3
15	65	0.0	3	54.50	814.7
16	65	0.1	1	54.50	774.1
17	65	0.1	2	54.50	827.8
18	65	0.1	3	53.50	762.4
19	65	0.5	1	53.17	858.6
20	65	0.5	2	52.83	905.0
21	65	0.5	3	52.50	874.3
22	65	1.0	1	52.83	799.0
23	65	1.0	2	53.83	686.4
24	65	1.0	3	53.50	878.2
25	45	0.0	1	53.67	771.5
26	45	0.0	2	53.33	825.7
27	45	0.0	3	52.33	804.8
28	45	0.1	1	53.33	797.0
29	45	0.1	2	52.00	808.1
30	45	0.1	3	54.33	844.6
31	45	0.5	1	53.33	804.1
32	45	0.5	2	53.67	823.1
33	45	0.5	3	53.67	823.1
34	45	1.0	1	53.00	781.3
35	45	1.0	2	52.00	790.4
36	45	1.0	3	52.67	778.7

Sacch. with Pullulanase on Flour FTA-94 ISP: Glucose and Change in Starch
Interaction and Main Effects of Treatments

The GLM Procedure
Class Level Information

Class	Levels	Values
Temp	3	45 55 65
Load	4	0 0.1 0.5 1

Number of Observations Read 36
Number of Observations Used 36

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	6.73407500	0.61218864	1.62	0.1550
Error	24	9.04980000	0.37707500		
Corrected Total	35	15.78387500			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.426643	1.151173	0.614064	53.34250

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Temp	2	1.19031667	0.59515833	1.58	0.2270
Load	3	1.53414167	0.51138056	1.36	0.2799
Temp*Load	6	4.00961667	0.66826944	1.77	0.1476

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Temp	2	1.19031667	0.59515833	1.58	0.2270
Load	3	1.53414167	0.51138056	1.36	0.2799
Temp*Load	6	4.00961667	0.66826944	1.77	0.1476

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	26714.30972	2428.57361	1.45	0.2166
Error	24	40320.23333	1680.00972		
Corrected Total	35	67034.54306			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.398516	5.081795	40.98792	806.5639

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Temp	2	706.05056	353.02528	0.21	0.8120
Load	3	17775.88306	5925.29435	3.53	0.0301
Temp*Load	6	8232.37611	1372.06269	0.82	0.5677

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Temp	2	706.05056	353.02528	0.21	0.8120
Load	3	17775.88306	5925.29435	3.53	0.0301
Temp*Load	6	8232.37611	1372.06269	0.82	0.5677

Load	Glucose LSMEAN	LSMEAN Number
0	803.111111	1
0.1	801.655556	2
0.5	841.600000	3
1	779.888889	4

Dependent Variable: Glucose

i/j	1	2	3	4
1		0.9406	0.0579	0.2411
2	0.9406		0.0497	0.2711
3	0.0579	0.0497		0.0039
4	0.2411	0.2711	0.0039	

Appendix C.2 Fresh ISP

```
title 'Sacch. with Pullulanase on FTA-94 ISP: Glucose and Change in
Starch';
data Saccharification032008;
input Temp Load Rep DeltaAIS Glucose;
datalines;
55    0     1     63.67 853.4
55    0     2     64.33 839.6
55    0     3     64.67 842.7
55    0.1   1     65.33 852.3
55    0.1   2     65.00 850.2
55    0.1   3     65.33 859.8
55    0.5   1     65.33 889.6
55    0.5   2     64.67 875.8
55    0.5   3     64.33 843.8
55    1     1     66.00 871.5
55    1     2     65.67 861.9
55    1     3     65.33 860.9
65    0     1     49.00 772.5
65    0     2     49.33 808.1
65    0     3     49.00 804.0
65    0.1   1     49.33 793.0
65    0.1   2     50.00 968.4
65    0.1   3     49.67 879.3
65    0.5   1     49.00 860.2
65    0.5   2     49.00 872.5
65    0.5   3     49.00 888.9
65    1     1     49.67 861.5
65    1     2     49.33 731.4
65    1     3     49.00 719.1
45    0     1     49.00 853.0
45    0     2     49.33 875.1
45    0     3     48.67 796.2
45    0.1   1     49.33 869.6
45    0.1   2     49.33 851.6
45    0.1   3     49.33 861.3
45    0.5   1     50.00 846.1
45    0.5   2     49.67 853.0
45    0.5   3     50.00 850.2
45    1     1     49.67 848.8
45    1     2     .     826.7
45    1     3     48.67 879.3
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
      class Temp Load;
      model DeltaAIS Glucose = Temp Load Temp*Load;
      lsmeans Temp Load Temp*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Obs	Temp	Load	Rep	Delta AIS	Glucose
1	55	0.0	1	63.67	853.4
2	55	0.0	2	64.33	839.6
3	55	0.0	3	64.67	842.7
4	55	0.1	1	65.33	852.3
5	55	0.1	2	65.00	850.2
6	55	0.1	3	65.33	859.8
7	55	0.5	1	65.33	889.6
8	55	0.5	2	64.67	875.8
9	55	0.5	3	64.33	843.8
10	55	1.0	1	66.00	871.5
11	55	1.0	2	65.67	861.9
12	55	1.0	3	65.33	860.9
13	65	0.0	1	49.00	772.5
14	65	0.0	2	49.33	808.1
15	65	0.0	3	49.00	804.0
16	65	0.1	1	49.33	793.0
17	65	0.1	2	50.00	968.4
18	65	0.1	3	49.67	879.3
19	65	0.5	1	49.00	860.2
20	65	0.5	2	49.00	872.5
21	65	0.5	3	49.00	888.9
22	65	1.0	1	49.67	861.5
23	65	1.0	2	49.33	731.4
24	65	1.0	3	49.00	719.1
25	45	0.0	1	49.00	853.0
26	45	0.0	2	49.33	875.1
27	45	0.0	3	48.67	796.2
28	45	0.1	1	49.33	869.6
29	45	0.1	2	49.33	851.6
30	45	0.1	3	49.33	861.3
31	45	0.5	1	50.00	846.1
32	45	0.5	2	49.67	853.0
33	45	0.5	3	50.00	850.2
34	45	1.0	1	49.67	848.8
35	45	1.0	2	.	826.7
36	45	1.0	3	48.67	879.3

The GLM Procedure

Class Level Information

Class	Levels	Values
Temp	3	45 55 65
Load	4	0 0.1 0.5 1

Data for Analysis of DeltaAIS

Number of Observations Read	36
Number of Observations Used	35

Data for Analysis of Glucose

Number of Observations Read	36
Number of Observations Used	36

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	1937.678135	176.152558	1532.84	<.0001
Error	23	2.643133	0.114919		
Corrected Total	34	1940.321269			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.998638	0.619903	0.338997	54.68543

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Temp	2	1932.164822	966.082411	8406.65	<.0001
Load	3	2.442701	0.814234	7.09	0.0015
Temp*Load	6	3.070612	0.511769	4.45	0.0039

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Temp	2	1924.485082	962.242541	8373.24	<.0001
Load	3	2.265324	0.755108	6.57	0.0023
Temp*Load	6	3.070612	0.511769	4.45	0.0039

The GLM Procedure
Least Squares Means

Temp	Load	DeltaAIS LSMEAN	LSMEAN Number
45	0	49.0000000	1
45	0.1	49.3300000	2
45	0.5	49.8900000	3
45	1	49.1700000	4
55	0	64.2233333	5
55	0.1	65.2200000	6
55	0.5	64.7766667	7
55	1	65.6666667	8
65	0	49.1100000	9
65	0.1	49.6666667	10
65	0.5	49.0000000	11
65	1	49.3333333	12

Least Squares Means for effect Temp*Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		0.2453	0.0038	0.5881	<.0001	<.0001
2	0.2453		0.0548	0.6101	<.0001	<.0001
3	0.0038	0.0548		0.0292	<.0001	<.0001
4	0.5881	0.6101	0.0292		<.0001	<.0001
5	<.0001	<.0001	<.0001	<.0001		0.0015
6	<.0001	<.0001	<.0001	<.0001	0.0015	
7	<.0001	<.0001	<.0001	<.0001	0.0575	0.1229
8	<.0001	<.0001	<.0001	<.0001	<.0001	0.1202
9	0.6947	0.4348	0.0098	0.8480	<.0001	<.0001
10	0.0244	0.2362	0.4280	0.1222	<.0001	<.0001
11	1.0000	0.2453	0.0038	0.5881	<.0001	<.0001
12	0.2407	0.9905	0.0562	0.6027	<.0001	<.0001

i/j	7	8	9	10	11	12
1	<.0001	<.0001	0.6947	0.0244	1.0000	0.2407
2	<.0001	<.0001	0.4348	0.2362	0.2453	0.9905
3	<.0001	<.0001	0.0098	0.4280	0.0038	0.0562
4	<.0001	<.0001	0.8480	0.1222	0.5881	0.6027
5	0.0575	<.0001	<.0001	<.0001	<.0001	<.0001
6	0.1229	0.1202	<.0001	<.0001	<.0001	<.0001
7		0.0038	<.0001	<.0001	<.0001	<.0001
8	0.0038		<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001		0.0562	0.6947	0.4280
10	<.0001	<.0001	0.0562		0.0244	0.2407
11	<.0001	<.0001	0.6947	0.0244		0.2407
12	<.0001	<.0001	0.4280	0.2407	0.2407	

The GLM Procedure

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	34512.36083	3137.48735	2.14	0.0581
Error	24	35232.18667	1468.00778		
Corrected Total	35	69744.54750			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.494840	4.526637	38.31459	846.4250

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Temp	2	5252.42000	2626.21000	1.79	0.1887
Load	3	12113.07861	4037.69287	2.75	0.0648
Temp*Load	6	17146.86222	2857.81037	1.95	0.1140

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Temp	2	5252.42000	2626.21000	1.79	0.1887
Load	3	12113.07861	4037.69287	2.75	0.0648
Temp*Load	6	17146.86222	2857.81037	1.95	0.1140

Appendix C.3 Comparison of Flour and Fresh ISP

```
title 'Sacch. with Pullulanase on FTA-94 ISP: Glucose and Change in
Starch';
data Saccharification032008;
input Prep$ Temp Load Rep DeltaAIS Glucose;
datalines;
Fresh 55    0     1     63.67 853.4
Fresh 55    0     2     64.33 839.6
Fresh 55    0     3     64.67 842.7
Fresh 55    0.1   1     65.33 852.3
Fresh 55    0.1   2     65.00 850.2
Fresh 55    0.1   3     65.33 859.8
Fresh 55    0.5   1     65.33 889.6
Fresh 55    0.5   2     64.67 875.8
Fresh 55    0.5   3     64.33 843.8
Fresh 55    1     1     66.00 871.5
Fresh 55    1     2     65.67 861.9
Fresh 55    1     3     65.33 860.9
Fresh 65    0     1     49.00 772.5
Fresh 65    0     2     49.33 808.1
Fresh 65    0     3     49.00 804.0
Fresh 65    0.1   1     49.33 793.0
Fresh 65    0.1   2     50.00 968.4
Fresh 65    0.1   3     49.67 879.3
Fresh 65    0.5   1     49.00 860.2
Fresh 65    0.5   2     49.00 872.5
Fresh 65    0.5   3     49.00 888.9
Fresh 65    1     1     49.67 861.5
Fresh 65    1     2     49.33 731.4
Fresh 65    1     3     49.00 719.1
Dry   55    0     1     53.00 788.5
Dry   55    0     2     52.67 780.6
Dry   55    0     3     53.00 869.8
Dry   55    0.1   1     53.33 808.2
Dry   55    0.1   2     53.67 802.3
Dry   55    0.1   3     54.00 790.4
Dry   55    0.5   1     53.00 794.4
Dry   55    0.5   2     53.33 883.6
Dry   55    0.5   3     54.00 808.2
Dry   55    1     1     53.67 738.6
Dry   55    1     2     52.67 771.4
Dry   55    1     3     54.00 795.0
Dry   65    0     1     54.17 827.1
Dry   65    0     2     52.83 745.3
Dry   65    0     3     54.50 814.7
Dry   65    0.1   1     54.50 774.1
Dry   65    0.1   2     54.50 827.8
Dry   65    0.1   3     53.50 762.4
Dry   65    0.5   1     53.17 858.6
Dry   65    0.5   2     52.83 905.0
Dry   65    0.5   3     52.50 874.3
```

```
Dry   65    1     1     52.83 799.0
Dry   65    1     2     53.83 686.4
Dry   65    1     3     53.50 878.2
Dry   45    0     1     53.67 771.5
Dry   45    0     2     53.33 825.7
Dry   45    0     3     52.33 804.8
Dry   45    0.1   1     53.33 797.0
Dry   45    0.1   2     52.00 808.1
Dry   45    0.1   3     54.33 844.6
Dry   45    0.5   1     53.33 804.1
Dry   45    0.5   2     53.67 823.1
Dry   45    0.5   3     53.67 823.1
Dry   45    1     1     53.00 781.3
Dry   45    1     2     52.00 790.4
Dry   45    1     3     52.67 778.7
Fresh 45    0     1     49.00 853.0
Fresh 45    0     2     49.33 875.1
Fresh 45    0     3     48.67 796.2
Fresh 45    0.1   1     49.33 869.6
Fresh 45    0.1   2     49.33 851.6
Fresh 45    0.1   3     49.33 861.3
Fresh 45    0.5   1     50.00 846.1
Fresh 45    0.5   2     49.67 853.0
Fresh 45    0.5   3     50.00 850.2
Fresh 45    1     1     49.67 848.8
Fresh 45    1     2     .     826.7
Fresh 45    1     3     48.67 879.3
;
proc print;
options LS=75 PS=55 nodate pageno = 1;
proc glm data = Saccharification032008;
      class Prep Temp Load;
      model DeltaAIS Glucose = Prep Temp Load Prep*Temp Prep*Load
Temp*Load Prep*Temp*Load;
      lsmeans Prep Temp Load Prep*Temp Prep*Load Temp*Load
Prep*Temp*Load/pdiff;
title2 'Interaction and Main Effects of Treatments';
run;
```

Sacch. with Pullulanase on FTA-94 ISP: Glucose and Change in Starch

Obs	Prep	Temp	Load	Rep	Delta AIS	Glucose
1	Fresh	55	0.0	1	63.67	853.4
2	Fresh	55	0.0	2	64.33	839.6
3	Fresh	55	0.0	3	64.67	842.7
4	Fresh	55	0.1	1	65.33	852.3
5	Fresh	55	0.1	2	65.00	850.2
6	Fresh	55	0.1	3	65.33	859.8
7	Fresh	55	0.5	1	65.33	889.6
8	Fresh	55	0.5	2	64.67	875.8
9	Fresh	55	0.5	3	64.33	843.8
10	Fresh	55	1.0	1	66.00	871.5
11	Fresh	55	1.0	2	65.67	861.9
12	Fresh	55	1.0	3	65.33	860.9
13	Fresh	65	0.0	1	49.00	772.5
14	Fresh	65	0.0	2	49.33	808.1
15	Fresh	65	0.0	3	49.00	804.0
16	Fresh	65	0.1	1	49.33	793.0
17	Fresh	65	0.1	2	50.00	968.4
18	Fresh	65	0.1	3	49.67	879.3
19	Fresh	65	0.5	1	49.00	860.2
20	Fresh	65	0.5	2	49.00	872.5
21	Fresh	65	0.5	3	49.00	888.9
22	Fresh	65	1.0	1	49.67	861.5
23	Fresh	65	1.0	2	49.33	731.4
24	Fresh	65	1.0	3	49.00	719.1
25	Dry	55	0.0	1	53.00	788.5
26	Dry	55	0.0	2	52.67	780.6
27	Dry	55	0.0	3	53.00	869.8
28	Dry	55	0.1	1	53.33	808.2
29	Dry	55	0.1	2	53.67	802.3
30	Dry	55	0.1	3	54.00	790.4
31	Dry	55	0.5	1	53.00	794.4
32	Dry	55	0.5	2	53.33	883.6
33	Dry	55	0.5	3	54.00	808.2
34	Dry	55	1.0	1	53.67	738.6
35	Dry	55	1.0	2	52.67	771.4
36	Dry	55	1.0	3	54.00	795.0
37	Dry	65	0.0	1	54.17	827.1
38	Dry	65	0.0	2	52.83	745.3
39	Dry	65	0.0	3	54.50	814.7
40	Dry	65	0.1	1	54.50	774.1
41	Dry	65	0.1	2	54.50	827.8
42	Dry	65	0.1	3	53.50	762.4
43	Dry	65	0.5	1	53.17	858.6
44	Dry	65	0.5	2	52.83	905.0
45	Dry	65	0.5	3	52.50	874.3
46	Dry	65	1.0	1	52.83	799.0
47	Dry	65	1.0	2	53.83	686.4
48	Dry	65	1.0	3	53.50	878.2
49	Dry	45	0.0	1	53.67	771.5
50	Dry	45	0.0	2	53.33	825.7

Obs	Prep	Temp	Load	Rep	Delta AIS	Glucose
51	Dry	45	0.0	3	52.33	804.8
52	Dry	45	0.1	1	53.33	797.0
53	Dry	45	0.1	2	52.00	808.1
54	Dry	45	0.1	3	54.33	844.6
55	Dry	45	0.5	1	53.33	804.1
56	Dry	45	0.5	2	53.67	823.1
57	Dry	45	0.5	3	53.67	823.1
58	Dry	45	1.0	1	53.00	781.3
59	Dry	45	1.0	2	52.00	790.4
60	Dry	45	1.0	3	52.67	778.7
61	Fresh	45	0.0	1	49.00	853.0
62	Fresh	45	0.0	2	49.33	875.1
63	Fresh	45	0.0	3	48.67	796.2
64	Fresh	45	0.1	1	49.33	869.6
65	Fresh	45	0.1	2	49.33	851.6
66	Fresh	45	0.1	3	49.33	861.3
67	Fresh	45	0.5	1	50.00	846.1
68	Fresh	45	0.5	2	49.67	853.0
69	Fresh	45	0.5	3	50.00	850.2
70	Fresh	45	1.0	1	49.67	848.8
71	Fresh	45	1.0	2	.	826.7
72	Fresh	45	1.0	3	48.67	879.3

The GLM Procedure
Class Level Information

Class	Levels	Values
Prep	2	Dry Fresh
Temp	3	45 55 65
Load	4	0 0.1 0.5 1

Data for Analysis of DeltaAIS

Number of Observations Read	72
Number of Observations Used	71

Data for Analysis of Glucose

Number of Observations Read	72
Number of Observations Used	72

The GLM Procedure

Dependent Variable: DeltaAIS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	1976.417224	85.931184	345.40	<.0001
Error	47	11.692933	0.248786		
Corrected Total	70	1988.110158			

R-Square	Coeff Var	Root MSE	DeltaAIS Mean
0.994119	0.923598	0.498784	54.00451

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Prep	1	32.0050142	32.0050142	128.64	<.0001
Temp	2	962.7461741	481.3730871	1934.89	<.0001
Load	3	2.7077758	0.9025919	3.63	0.0195
Prep*Temp	2	970.3249217	485.1624609	1950.12	<.0001
Prep*Load	3	1.5531097	0.5177032	2.08	0.1154
Temp*Load	6	6.5348514	1.0891419	4.38	0.0014
Prep*Temp*Load	6	0.5453774	0.0908962	0.37	0.8972

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prep	1	24.9579442	24.9579442	100.32	<.0001
Temp	2	974.3015028	487.1507514	1958.11	<.0001
Load	3	2.4261427	0.8087142	3.25	0.0299
Prep*Temp	2	969.2010094	484.6005047	1947.86	<.0001
Prep*Load	3	1.3643649	0.4547883	1.83	0.1550
Temp*Load	6	6.5294935	1.0882489	4.37	0.0014
Prep*Temp*Load	6	0.5453774	0.0908962	0.37	0.8972

The GLM Procedure
Least Squares Means

Prep	DeltaAIS LSMEAN	H0:LSMean1= LSMean2 Pr > |t|
Dry	53.3425000	<.0001
Fresh	54.5322222	

Load	DeltaAIS LSMEAN	LSMEAN Number
0	53.6944444	1
0.1	54.2116667	2
0.5	53.9166667	3
1	53.9266667	4

Least Squares Means for effect Load
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4
1		0.0032	0.1878	0.1777
2	0.0032		0.0825	0.0997
3	0.1878	0.0825		0.9533
4	0.1777	0.0997	0.9533	

Prep	Temp	DeltaAIS LSMEAN	LSMEAN Number
Dry	45	53.1108333	1
Dry	55	53.3616667	2
Dry	65	53.5550000	3
Fresh	45	49.3475000	4
Fresh	55	64.9716667	5
Fresh	65	49.2775000	6

Least Squares Means for effect Prep*Temp
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		0.2241	0.0342	<.0001	<.0001	<.0001
2	0.2241		0.3473	<.0001	<.0001	<.0001
3	0.0342	0.3473		<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001		<.0001	0.7402
5	<.0001	<.0001	<.0001	<.0001		<.0001
6	<.0001	<.0001	<.0001	0.7402	<.0001	

Temp	Load	DeltaAIS LSMEAN	LSMEAN Number
45	0	51.0550000	1
45	0.1	51.2750000	2
45	0.5	51.7233333	3
45	1	50.8633333	4
55	0	58.5566667	5
55	0.1	59.4433333	6
55	0.5	59.1100000	7
65	0	51.4716667	9
65	0.1	51.9166667	10
65	0.5	50.9166667	11
65	1	51.3600000	12

Least Squares Means for effect Temp*Load
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	1	2	3	4	5	6
1		0.4487	0.0247	0.5334	<.0001	<.0001
2	0.4487		0.1262	0.1842	<.0001	<.0001
3	0.0247	0.1262		0.0071	<.0001	<.0001
4	0.5334	0.1842	0.0071		<.0001	<.0001
5	<.0001	<.0001	<.0001	<.0001		0.0035
6	<.0001	<.0001	<.0001	<.0001	0.0035	
7	<.0001	<.0001	<.0001	<.0001	0.0607	0.2529
8	<.0001	<.0001	<.0001	<.0001	0.0011	0.6957
9	0.1546	0.4980	0.3866	0.0522	<.0001	<.0001
10	0.0044	0.0307	0.5053	0.0012	<.0001	<.0001
11	0.6332	0.2195	0.0074	0.8621	<.0001	<.0001
12	0.2950	0.7692	0.2133	0.1106	<.0001	<.0001

Least Squares Means for effect Temp*Load
Pr > |t| for HO: LSMean(i)=LSMean(j)

Dependent Variable: DeltaAIS

i/j	7	8	9	10	11	12
1	<.0001	<.0001	0.1546	0.0044	0.6332	0.2950
2	<.0001	<.0001	0.4980	0.0307	0.2195	0.7692
3	<.0001	<.0001	0.3866	0.5053	0.0074	0.2133
4	<.0001	<.0001	0.0522	0.0012	0.8621	0.1106
5	0.0607	0.0011	<.0001	<.0001	<.0001	<.0001
6	0.2529	0.6957	<.0001	<.0001	<.0001	<.0001
7		0.1276	<.0001	<.0001	<.0001	<.0001
8	0.1276		<.0001	<.0001	<.0001	<.0001
9	<.0001	<.0001		0.1290	0.0600	0.6999
10	<.0001	<.0001	0.1290		0.0011	0.0593
11	<.0001	<.0001	0.0600	0.0011		0.1304
12	<.0001	<.0001	0.6999	0.0593	0.1304	

The GLM Procedure

Dependent Variable: Glucose

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	89827.0178	3905.5225	2.48	0.0040
Error	48	75552.4200	1574.0088		
Corrected Total	71	165379.4378			

R-Square	Coeff Var	Root MSE	Glucose Mean
0.543157	4.800248	39.67378	826.4944

The GLM Procedure

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Prep	1	28600.34722	28600.34722	18.17	<.0001
Temp	2	1061.79694	530.89847	0.34	0.7154
Load	3	24585.70778	8195.23593	5.21	0.0034
Prep*Temp	2	4896.67361	2448.33681	1.56	0.2215
Prep*Load	3	5303.25389	1767.75130	1.12	0.3491
Temp*Load	6	14554.73972	2425.78995	1.54	0.1852
Prep*Temp*Load	6	10824.49861	1804.08310	1.15	0.3507

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prep	1	28600.34722	28600.34722	18.17	<.0001
Temp	2	1061.79694	530.89847	0.34	0.7154
Load	3	24585.70778	8195.23593	5.21	0.0034
Prep*Temp	2	4896.67361	2448.33681	1.56	0.2215
Prep*Load	3	5303.25389	1767.75130	1.12	0.3491
Temp*Load	6	14554.73972	2425.78995	1.54	0.1852
Prep*Temp*Load	6	10824.49861	1804.08310	1.15	0.3507

The GLM Procedure
Least Squares Means

Prep	Glucose LSMEAN	HO:LSMean1= LSMean2 Pr > |t|
Dry	806.563889	<.0001
Fresh	846.425000	

The GLM Procedure
Least Squares Means

Load	Glucose LSMEAN	LSMEAN Number
0	815.144444	1
0.1	833.355556	2
0.5	853.027778	3
1	804.450000	4

Least Squares Means for effect Load
Dependent Variable: Glucose

i/j	1	2	3	4
1		0.1749	0.0062	0.4227
2	0.1749		0.1434	0.0337
3	0.0062	0.1434		0.0006
4	0.4227	0.0337	0.0006	

Appendix D: Preliminary Saccharification of FTA-94 ISP using Spirizyme Plus Tech

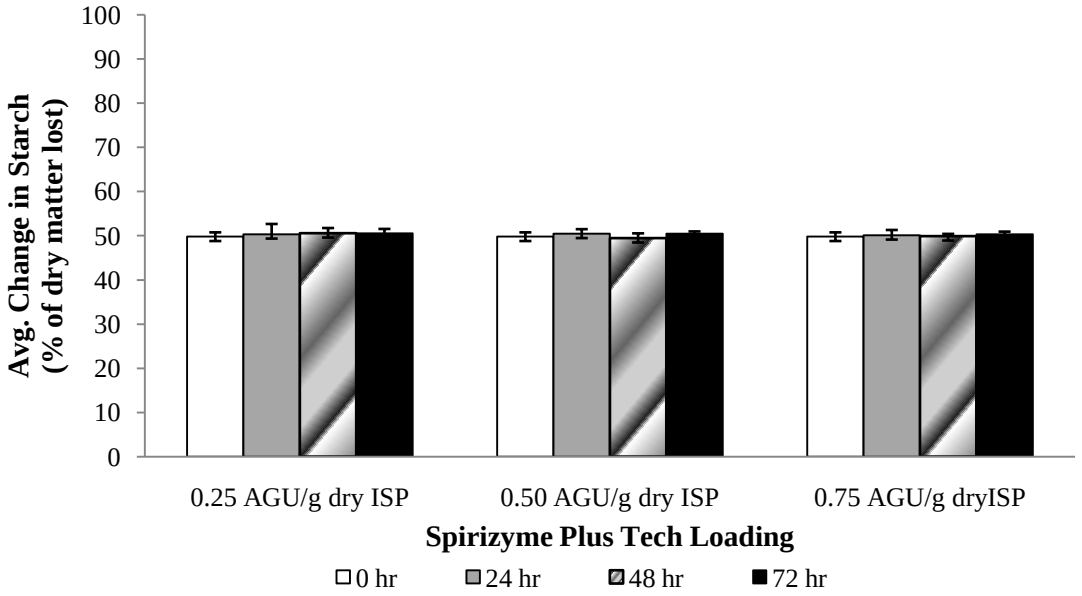

Figure D.1 Average change in starch content (% of dry matter lost) over time during saccharification of flour ISP using Spirizyme Plus Tech. Initial starch content: 65.4%

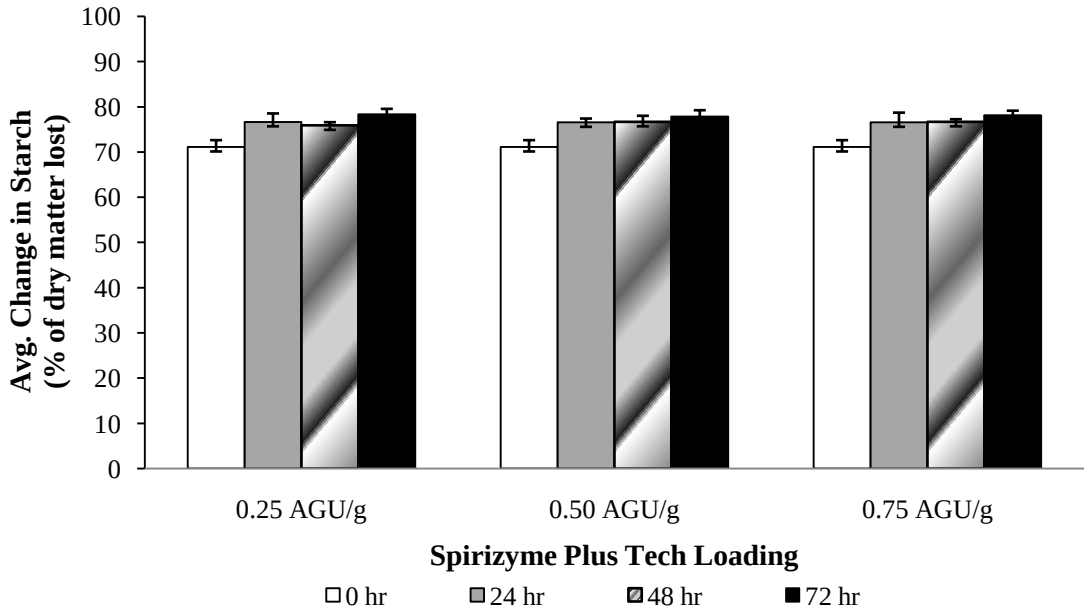

Figure D.2 Average change in starch content (% of dry matter lost) over time during saccharification of fresh ISP using Spirizyme Plus Tech. Initial starch content: 90.4%

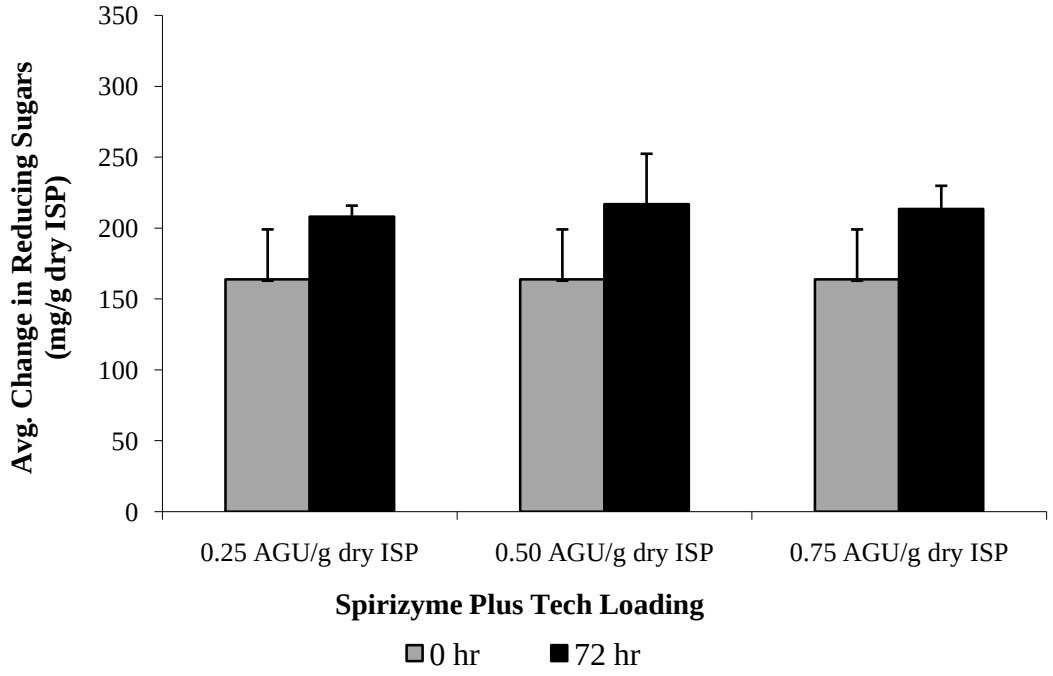

Figure D.3 Average change in reducing sugars over time during saccharification of flour industrial sweetpotato using Spirizyme Plus Tech.

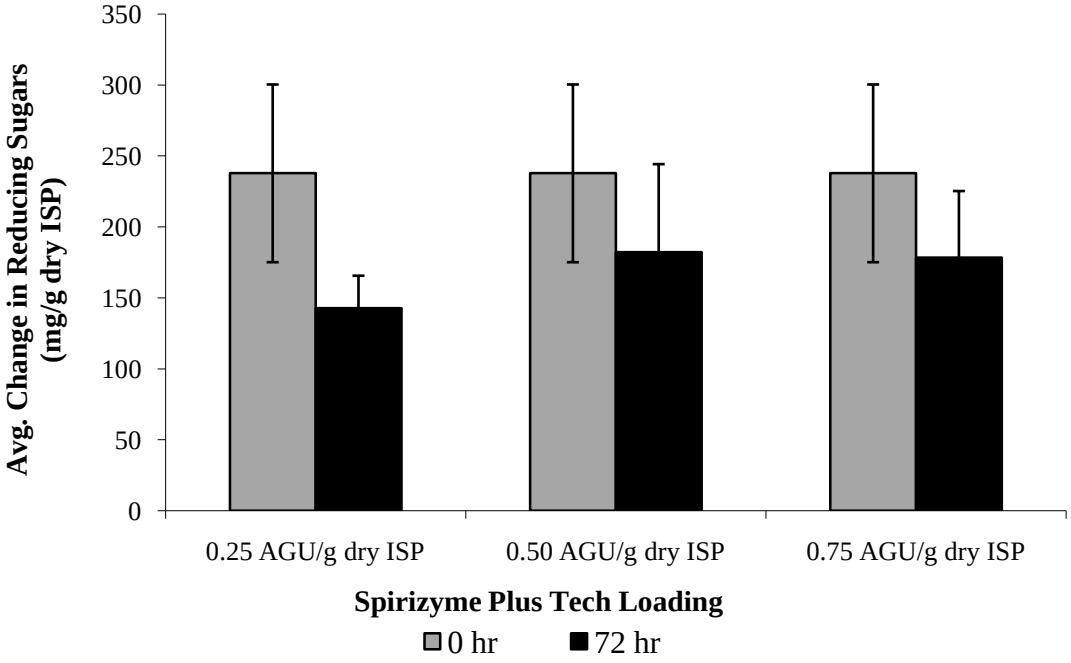

Figure D.4 Average change in reducing sugars over time during saccharification of fresh industrial sweetpotato using Spirizyme Plus Tech.

Appendix E: Preliminary Examination of Sodium Azide Significance during Saccharification

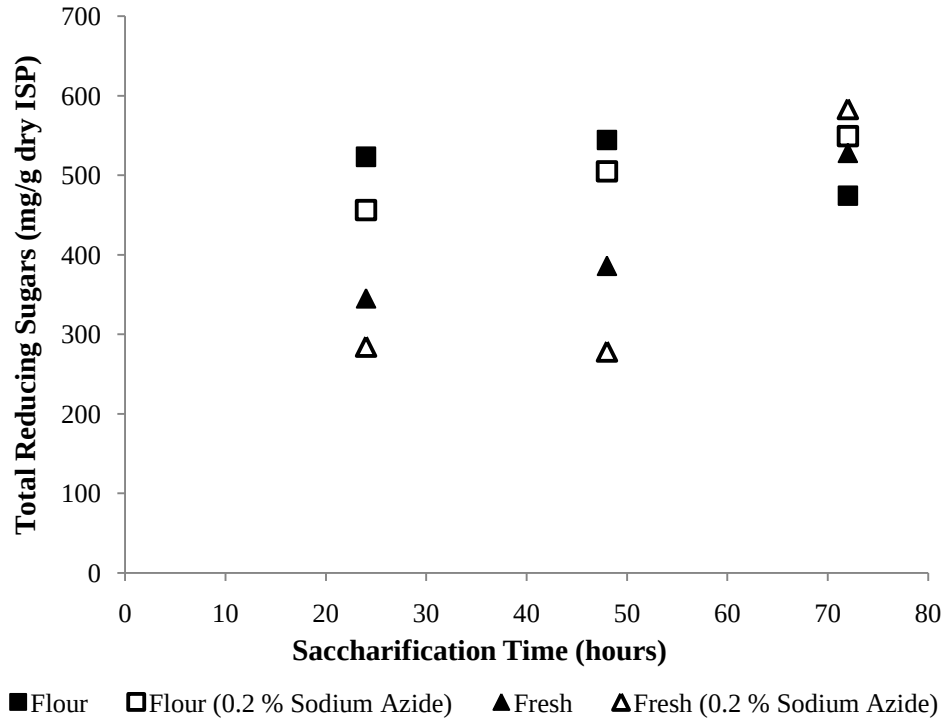

Figure E.1 Total reducing sugars over time during saccharification of flour and fresh ISP with and without the addition of Sodium Azide