The Relationship Between High Fructose Corn Syrup and Alzheimer's Disease

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Abstract

High Fructose Corn Syrup (HFCS) is a common low-cost sweetener made from corn that is often found in processed foods and soft drinks. HFCS contains both fructose and glucose monomers, just like regular sugar. In the 1980s, HFCS was created because while sugarcane and beet sugar were the preferred sweeteners, they became financially unaffordable. Research studies have illustrated that ingesting HFCS over a longer period of time can increase oxidative stress and inflammation in the brain which are associated characteristics of Alzheimer's Disease (AD). Although there may not be a cure for AD, which is a progressive brain disease caused by the accumulation of tau tangles and Aβ amyloid plaques, there is a way to reduce the risk of developing AD. For instance, eliminating HFCS from a balanced diet of whole foods and exercising regularly is beneficial for a decrease in the development of AD. The purpose of this research poster is to create awareness of the detrimental effects of HFCS and its link to an increase in AD in the United States. Although dietary fructose is by itself dangerous, in the brain, about 20% of the brain glucose is converted endogenously to additional fructose via the sorbitol pathway which also contributes to Alzheimer's neuropathy, diabetic peripheral neuropathy, and retinal degeneration. Continued research in identifying the time frame it takes for HFCS to establish AD is crucial as AD is responsible for 60-80% of all diagnosed dementia cases in the United States.

Introduction

Currently, there are over 6 million Americans that are affected by AD (2). It is estimated that 12.7 million individuals over the age of 65 will be diagnosed with Alzheimer's by 2050 (2). With the ever-increasing AD population, it is imperative that we find better preventative measures that ultimately lead to a cure. AD pathogenesis can be characterized as the neurodegeneration of the Aβ amyloid plaques along with an overproduction of reactive oxygen species (ROS) and oxidative stress levels. Reactive oxygen species are generated via normal cellular metabolism and are important in cell signaling, cell survival, cell death, and inflammatory response (1). The organelle responsible to produce ROS is the Mitochondria (3). The mitochondria have several mechanisms to regulate ROS via certain enzymes, one of them being glutathione. Mitochondrial dysfunction is one of the primary characteristics of AD but is also a characteristic of diabetic neuropathy, obesity, and insulin resistance. Overproduction of ROS leads to an increase in oxidative stress (OS) which is detrimental to neuronal and synapse function (3). The increase in oxidative stress is responsible for the fabrication of increased Aβ amyloid plaques which leads to neuroinflammation.

High Fructose Corn Syrup is comprised of either 45% (HFCS 45) or 55% (HFCS 55) fructose the rest being glucose. Common table sugar is a dimer consisting of 50% glucose and 50% fructose. Consumption of HFCS per capita in 2019 was 36.7 pounds, a decrease compared to 62.5 pounds per capita in 2000 (4). This decrease may have been due to people using alternative sweeteners including free fructose or fluctuations in the price of HFCS. However, while there is a decrease in the consumption of HFCS, the overall consumption of added sugars remains high.

References

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Results

Figure 1. Pathways Glucose Takes When Upregulated

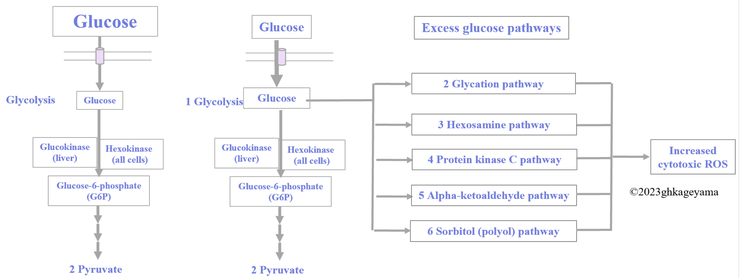


Figure 2. Sorbitol Pathway Between Normoglycemia & Hyperglycemia

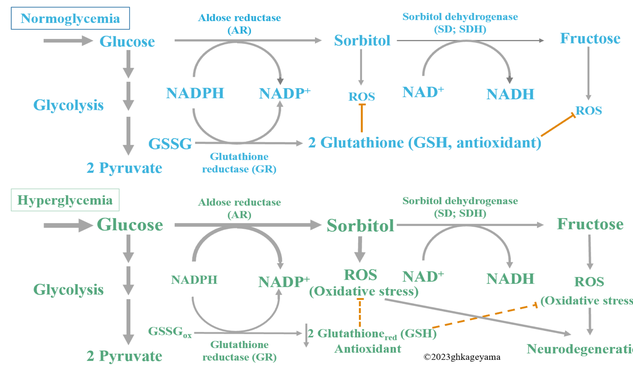


Figure 3. Sorbitol Pathway of Hyperglycemia

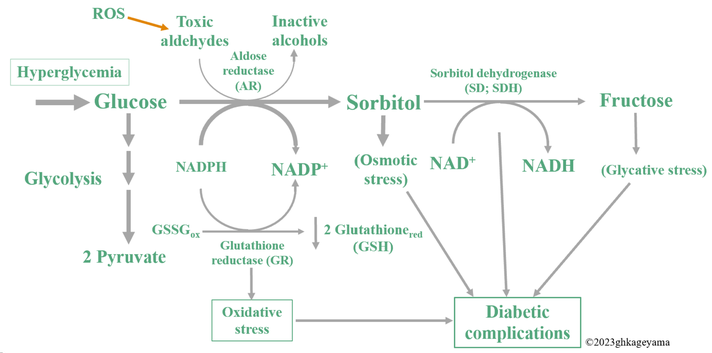
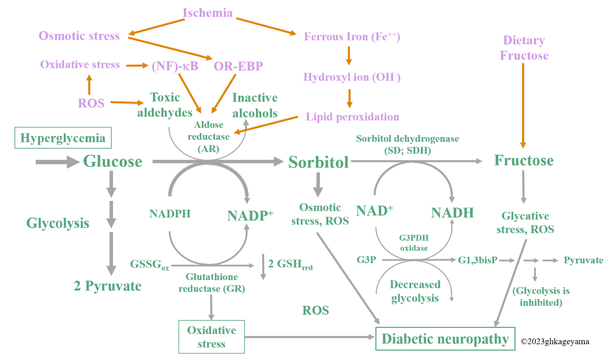


Figure 4. Effects of Hyperglycemia



Discussion

The essential link between HFCS and AD is the increased production of reactive oxygen species created by the sorbitol pathway or polyol pathway which leads to oxidative stress. Figure 2 shows the normoglycemia and hyperglycemia of the sorbitol pathway in relation to oxidative stress and Aldose reductase. ATP is generated via oxidative phosphorylation of the mitochondria. About 20% of the glucose gets converted endogenously to fructose via the sorbitol pathway utilizing Aldose reductase. Within the sorbitol pathway or polyol pathway, this is converted to fructose by an enzyme called sorbitol dehydrogenase which consumes NAD+. When there is an abundance of NADH, the result is inhibited production of glycolysis. Inhibition of glycolysis causes glucose to undergo metabolism through the sorbitol pathway. As glucose continues to metabolize, it will also cause oxidative stress to increase, resulting in more reactive oxygen species produced from sorbitol and fructose. Due to this, decreasing the antioxidant glutathione reduces its neuroprotective functions against oxidative stress.

Future Research

Further research is needed to investigate the effects of the underlying mechanism involved with HFCS within the development of neurodegenerative diseases such as frontotemporal dementia (FTD), Lou Gehrig's (Amyotrophic Lateral Sclerosis, ALS), Alzheimer's disease (AD), and Parkinson's disease (PD).

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