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Sugars: Seductive, Sweet, Secret and Deadly

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Sugars: Seductive, Sweet, Secret and Deadly

By

Kaitlyn Gross

A thesis submitted in partial fulfillment
of the requirements of the
University Honors Program
University of South Florida, St. Petersburg

May 1, 2013

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University Honors Program
University of South Florida
St. Petersburg, Florida

CERTIFICATE OF APPROVAL

Honors Thesis

This is to certify that the Honors Thesis of

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Introduction

In America today, obesity has become commonplace and health-related costs are rising. Therefore, it is imperative that Americans start eating healthier foods. To start, Americans need to ingest less sugar. This may be complicated by the fact that food companies might be deceiving consumers with confusing, incomplete or misleading information on food labels that include nutrition facts and the list of ingredients. Certain practices, such as not distinguishing between added sugar and total sugar, although legal, can mislead the consumer into thinking the food is healthier than it is. Currently, such labeling is not required (U.S. Department of Health and Human Services, 2005). The objective of this paper is to determine whether these companies are purposely employing deceptive techniques such as using multiple types of sugar in their products to make the ingredients list appear more healthful. Our first null hypothesis is that there will be no difference in the type of sugar used by the four food groups sampled. The second null hypothesis is that there will be no difference in the order of sugar used by the four food groups. The third null hypothesis is that there will be no difference in the diversity of sweeteners by food type.

Ingredients are listed in decreasing order by weight, so the farther down the list an ingredient is, the less of that ingredient the consumer is eating (U.S. Department of Health and Human Services, 2005). Because the average buyer is not well-versed on the many different types of sugar, it is easy to fool these people by including two or three unfamiliar types of sugar in the ingredients list. In this way, people might make certain assumptions which may include: (a) there is no added sugar in the product so the total sugar is all natural; (b) if they do happen to recognize one of the sweeteners, it may appear farther down in the list of ingredients, making it seem like there is less total sugar than there really is. These two assumptions could be

influencing the products that consumers buy, thus adversely affecting their health without their knowledge.

Literature Review

“Over the past 50 years, consumption of sugar has tripled worldwide” (Lustig et al. 2012, p.28). This shocking statistic explains why obesity is at an all-time high. Most people believe that fatty foods are to blame for the global obesity epidemic, and though these foods may contribute to the problem, an increase in sugar consumption may be an even greater cause. Sugar occurs naturally in certain foods such as fruits and vegetables, but added processed sugar from cane, beet, and corn may be causing adverse health effects (Pomeranz, 2012). Unfortunately, because sugar costs are low and consumers love to eat sugar-enhanced products, there is little incentive for companies to change their profitable formula by reducing sugar (Bower and Whitten, 2000; Lustig et al., 2012). This also causes problems in the regulation of sugar-enhanced foods by governmental agencies who are easily persuaded by powerful political players who are heavily invested in the sweetener industry. If companies add different forms of sweeteners, thus distributing the amount of sweeteners throughout the ingredients list, they could potentially add more while still making a cheap product. Because many people are not familiar with some of the less common sugar types, they may think they are consuming less added sugar than they are, which could lead to health problems.

Background on Sugar

Sugars of any form are typically added to food products to enhance their flavor, but can serve other purposes (Fitch & Keim, 2012). Even though sugar has a bad reputation, it provides

many useful functions when added to food such as inhibiting microbial growth, contributing volume, and balancing acidity (Fitch & Keim, 2012). However, these processes benefit the producer, not the consumer who is endangered by the added empty calories that sugar contributes.

When people think of sugar, it is usually in the form of sucrose. Sucrose is a combination of fructose and glucose and makes up the ubiquitous and familiar white granulated sugar, powdered sugar, and brown sugar (Roth, 2010). The other common sugar is fructose, a naturally occurring sugar found in fruits; fructose is significantly sweeter than sucrose (Roth, 2010). Another common form of sugar, that might not be obvious to consumers, is syrup. Whether it is high fructose corn syrup, cane syrup, or brown rice syrup, this hydrated form of sugar is utilized most often in sweetened beverages because of its liquid state (Mitchell, 1990). There are many other types of sugar that can be found in foods and, subsequently, ingredients lists (Fig. 1).

Forms of Sugar Found on Food Labels

Brown Rice Syrup	Lactose
Brown Sugar	Levulose
Concentrated fruit juice sweetener	Maltose
Confectioner's sugar	Mannitol
Corn syrup	Maple Sugar
Dextrose	Molasses
Fructose	Natural Sweeteners
Galactose	Raw sugar
Glucose	Sorbitol
Granulated Sugar	Turbinado sugar
High-fructose corn syrup	White sugar
	Xylitol

Figure 1: Some types of sugar commonly used in food (Insel, Turner, & Ross, 2010).

According to The Journal of the Academy of Nutrition and Dietetics (May 2012), there are still some sugars currently found in foods that are not recognized as ingredients by the FDA

such as cane juice, evaporated corn sweetener, crystal dextrose, liquid fructose, fruit juice concentrate, sugar cane juice, and fruit nectar (Fitch & Keim, 2012). Food producers are not being honest and transparent with consumers. Distributing different types of sugars among the list of ingredients and not listing all sugar types smacks of intentional deception that could lead consumers to purchase products that they believe do not contain any added sugar. The next logical step is for the consumer to think that the product is healthier than it is. A number of groups have fought and are continuing to fight for nutrition labels to become more detailed and honest by introducing the amount of added sugar in a product (Weaver & Finke, 2003).

A study conducted by Ng et al. (2012) examined the purchases by consumers of packaged foods in the United States from 2005 to 2009. The results easily explain America's sugar addiction and the high prevalence of obesity. Seventy-five percent (75%) of all products studied contained sweeteners, and more than 95% of cakes/cookies/pies, granola/protein/energy bars, cereals, sweet snacks, and sweetened beverages contained caloric sweeteners. Finding the 25% of products that do not contain added sweeteners is the burden placed on the health-conscious consumer, while the majority of buyers go on obliviously consuming more sweeteners than is healthy. In this same study, it was also found that four out of five of the most common sweeteners found in the surveyed products did not contain the word "sugar". This subtle deception makes it difficult for buyers to identify the added sugar in these items.

Health Concerns of Added Sugar (With Emphasis on Added Fructose)

Determining the health effects that added sugars such as high fructose corn syrup have on human health can be problematic when research is not completed by an independent agency as opposed to those connected to the food industry. The results obtained by these two groups are

strikingly different, so consumers must be careful when they attempt to do their own investigation. It is well-known that obesity is not caused by a single factor; rather, it can be a product of genetics, poor diet, disease, or any combination of the three (Bray, 2008). Diet is the only one of these three components that can be controlled by the individual, therefore it is important for people to understand how added sugar can adversely affect their health. Sugar has been shown to trigger the diseases associated with metabolic syndrome and accelerated aging which include hypertension, high triglycerides, diabetes, and insulin resistance (Lustig et al., 2012). These diseases, in turn, lead to obesity in the affected individual (Lustig et al., 2012).

For this reason, Lustig et al. (2012) demand that producers of sugar-enhanced products must incur higher taxes, place limits on the distribution, and limit the age at which customers can buy such products. It is also recommended that the US Food and Drug Administration remove fructose from the Generally Regarded as Safe list, since occupying a spot on the list allows manufacturers to put an unlimited amount of fructose into any food. The reasoning behind these demands is that sugar, much like alcohol and tobacco, threatens public health and therefore requires regulation for the public's benefit. There are four criteria that Lustig et al. (2012) lists for justifying their recommendation. The first is unavoidability. Unless people are buying unprocessed, organic food and beverages, it is difficult to avoid added sugar in today's world. The second factor is toxicity. Sugar can induce numerous diseases. The third component is potential for abuse. While it may not seem as addictive or self-destructive as alcohol or tobacco, science has proven that sugar does induce a feeling of dependence that is difficult to overcome. Finally Lustig et al. (2012) asserts that sugar has a negative impact on society. They argue that long-term medical support of individuals with metabolic syndrome has cost the United States \$65 billion in lost productivity and \$150 billion in health-care resources.

A number of studies on the dangers of sugar and the obesity epidemic have focused on sugar-sweetened beverages that have become a normal part not only of the American diet but also of the global diet. The main form of sugar that has been used in these drinks since the 1970s is high fructose corn syrup, which has garnered much attention in recent years (Lustig et al., 2012; Bray, 2008). This liquid form of sugar is sweeter than normal sugar and does not satisfy any energy requirements of a normal diet (Bray, 2008). These drinks only add calories while doing nothing to reduce the amount of energy needed on a daily basis (Bray, 2008). The 1970s

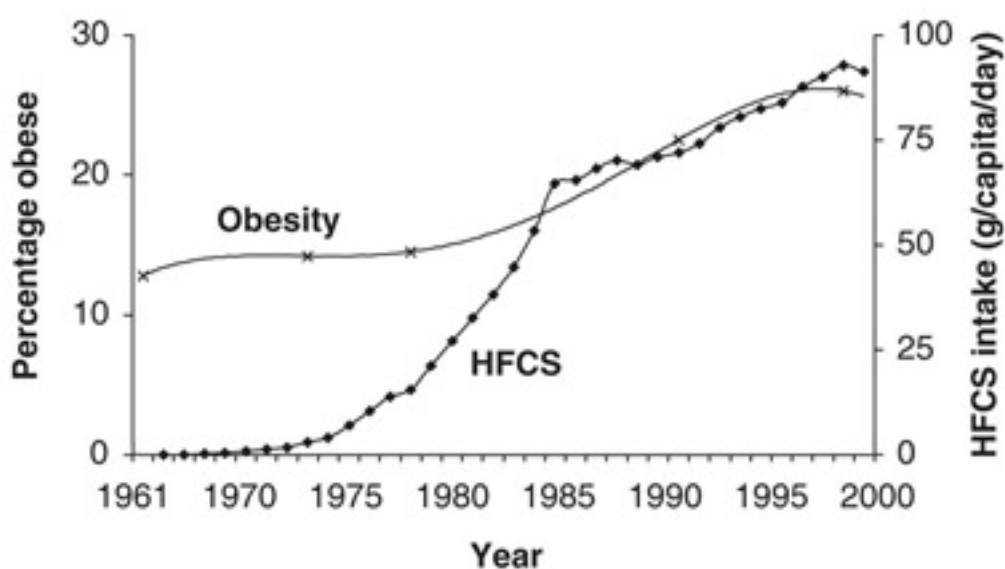


Figure 2 Changing intake of fructose and high-fructose corn syrup intake plotted against the increasing prevalence of obesity. Adapted from Bray *et al.*⁹

saw a decrease in the price of corn that fostered the conversion of corn starch into fructose; glucose was then combined with this fructose to create high fructose corn syrup (Bray, 2008). Within a decade the prevalence of obesity started to rise as high fructose corn syrup steadily replaced sugar in sweetened beverages (Fig. 2). It is the fructose in high fructose corn syrup that

gives researchers the most cause for concern. Unlike glucose, fructose does not need insulin to enter muscle and other cells, and once there it can “enter the pathways that provide the triglyceride backbone (glycerol) more efficiently than glucose” (Bray, 2008, p.129) thus acting as a type of fat-equivalent. Fructose also causes an increase in serum uric acid levels which leads to hypertension, increased risk for cardiovascular disease, and gout (Lustig et al. 2012; Stephan, Wells, Brayne, Albanese, & Siervo, 2010).

These studies illuminate the negative effects of fructose and directly contradict what most of us have been told. Fructose is a sugar that naturally occurs in fruits and vegetables (Gaby, 2005). It is this fact that makes it seem as though fructose is a healthy alternative to other types of sugar. What consumers do not realize is that the fructose content in fruit is much lower than what is currently used in products containing fructose or high fructose corn syrup (Gaby, 2005). Comparing naturally occurring sugar in fruits and vegetables to highly processed foods containing manufactured sugar products is not a reasonable parallel to make. It was thought that fructose should be recommended for people who suffer from diabetes because it does not have the same effect on blood glucose levels as other forms of sugar (Gaby, 2005). While this may be acceptable for moderate consumption in the short-term, the long-term impact of increased fructose consumption can lead to more problems than it solves.

Gaby (2005) wrote a comprehensive review of studies regarding the effects of fructose on health. Fructose is a highly reactive reducing sugar, which means that it “[reacts] with proteins and amino acids to form substituted amino sugars” (p.297). This reaction goes one step further and is converted into advanced glycation end-products (AGEs); this whole reaction is magnified when there is heat involved, as in cooking. These products do many things, including advancing the aging process, contributing to certain diabetes complications, and playing a part in

atherosclerotic development. In regards to diabetes, fructose has been shown to help diabetics lower their blood glucose levels in the short-term since it is not fully converted to glucose. Therefore, insulin levels are not as high. However, high fructose consumption in the long-term can either cause the development of diabetes or hasten diabetic complications as a result of the AGEs. Excessive fructose ingestion can also lead to liver problems due to an inability of this organ to metabolize all the fructose. According to Gaby's (2005) review, other effects of fructose include irritation of the bowel, increased triglyceride levels, increased uric acid levels, and obesity.

Sugar is not the only unhealthy substance that is consumed in extreme quantities. Increased salt consumption has also become a problem in recent years. Salt is known to negatively affect blood pressure, but these effects are worsened by a high fructose diet. Fructose is being investigated for causing an increase in salt uptake, which can worsen the effect that both fructose and salt already produce on blood pressure. Since hypertension is not caused by a single factor, Soleimani (2011) performed multiple experiments on animals to test whether diets high in fructose plus salt or diets with fructose by itself could hasten the onset of hypertension. The study was conducted on mice that had been genetically altered to not produce certain chemical exchangers or transporters thought to be essential to sodium and fructose absorption. The study showed that fructose alone can accelerate the start of hypertension due to the increased salt uptake associated with it, but a diet high in both fructose and salt will lead to an even faster onset of hypertension. These results could significantly improve the health of people with hypertension.

Despite the progress made on understanding the role of sugar consumption and obesity, not much research has been conducted on the neurological effects of fructose. Stephan et al.

(2010) studied the effects that fructose may have on the brain, specifically dementia. It may be that while excessive fructose consumption does not directly cause degeneration of neurons, the effects it has on other body systems may be causing dementia. Rats that were fed diets high in sucrose or high fructose corn syrup showed cognitive decline as well as neuronal degeneration. The increased quantity of sugar in the diet induced insulin resistance which caused a subsequent increase in amyloid deposition which is one of the factors associated with Alzheimer's disease. Stephan et al. (2010) also hypothesized that the increased uric acid levels seen in those who consume excessive amounts of fructose could reduce the synthesis of nitric oxide. Nitric oxide has many different functions, but its ability to decrease the risk of atherosclerotic plaque and its role as a neurotransmitter in the formation of memories is important. A decrease in nitric oxide could not only hinder memory formation but also induce the plaque formation in the brain that results in dementia. This research is only in the beginning stages, though some positive associations have been found between insulin resistance and changes in brain structure.

Other important developments have been made regarding sweeteners that function as alternatives to high fructose corn syrup. Specifically, a study performed by Jackson et al. (2012) investigated whether organic brown rice syrup is as healthy as it claims to be. The study focused on foods consumed by infants and toddlers that contain organic brown rice syrup such as formula and cereal but also examined energy bars. Infants and young children were the focus since this age group's "dietary [arsenic] exposure per kilogram of body weight is 2-3 times higher than that of adults" (Jackson et al. 2012, p.623). Because of the recent concern about high fructose corn syrup and its contribution to childhood obesity, the sugar in these items has been replaced with organic brown rice syrup. This study found that consumers may have to worry about high levels of arsenic, a known carcinogen! Rice can be a significant source of arsenic, and products

containing rice are no different. The results showed that rice products can contribute significantly to arsenic exposure per individual. Unfortunately, no definitive conclusions can be drawn from this evidence as there are currently no regulations in the United States regarding arsenic in food. This is important research and more studies must be done, especially since it concerns the health of young children.

Regulatory Issues

Sugar regulation and government intervention in the United States has a long history that dates back to the late eighteenth century (Alvarez, 2005). It was at this time that the newly formed American government decided to establish a tariff on imported sugar with the goal of bringing in more revenue (Alvarez, 2005). Eventually, this tariff came to protect the blossoming domestic sugar industry (Alvarez, 2005). It was not until the 1920s that government protection and assistance started to become a staple of American sugar production. Production of many items, including sugar, had increased during World War I to accommodate the increased demand, thus the government provided agricultural subsidies—a first for our country (Fields, 2004). After the war, farmers still maintained their increased production, while demand and prices plummeted with the arrival of the Great Depression (Fields, 2004). This led to the management of domestic sugar supplies to coincide with the tariff restrictions on sugar imports, which is the situation that sugar-producers find themselves in today (Fields, 2004). The control methods used by the government have varied over the years depending on their success. These methods include: buying the excess product when demand is low, paying farmers not to plant, fixing quotas for certain products, and removing excess sugar from the marketplace (Fields,

2004). Some of these methods have had more success than others in controlling sugar production.

Fields (2004) examined the impact of agricultural subsidies that support the growth of corn, and therefore high fructose corn syrup, on the health of people in the United States. As reported in the previous section, high fructose corn syrup can cause a number of health problems including those that lead to obesity. According to Fields (2004), these negative health effects are most pronounced on two main groups: children and the poor. Neither of these groups has much control over their food choices; children are at the mercy of their provider, and those who are poor cannot afford the non-subsidized fruits and vegetables that they should be eating. The low prices associated with the sugar-laden foods make the decision to sacrifice nutrition for savings fairly easy. It is easy to blame the agricultural industry that grows the corn, wheat, and soybeans that have seemingly taken over grocery stores. Unfortunately, the subsidies that fuel these farmers may not be making as large an impact as previously thought. While it is true that subsidies drive down the price of corn, certain studies have shown that even if the price of the high-fat, sugar-laden foods increases, people will still buy them (Fields, 2004). Sugary foods are “addictive”. Consumers love the taste, therefore the slight increase in price seems worth it since buyers have already been conditioned to crave these types of foods. The point remains, however, if the government can afford to subsidize the less healthy crops, why not the healthy fruits and vegetables? Healthy foods should be approximately the same price as the unhealthy foods so that financially burdened consumers can have equitable options (Fields, 2004).

In addition to the flawed interests of the public by the sweetener industries, these same industries which produce corn, sugar cane, and sugar beet, have influential supporters in the government. Alvarez (2005) observes that the United States has a large stake in the sweetener

market since it creates substantial revenue and creates many jobs. Through the Food and Agriculture Act of 1977, the United States government has retained control over domestic sugarcane and, now, corn production (Alvarez, 2005). The government controls supply in a few ways. First, they control the amount of sugar imported and exported; it is adjusted depending on how much sweetener is produced domestically; 1.5 million tons must be imported every year (Alvarez, 2005). Secondly, they control sweetener production domestically through a loan program worked out with the producers, which keeps prices for both the farmers and consumers low (Alvarez, 2005). The prices and profit involved in the loan program depend on the regulation of sugar import and export. The program does not work without it. The sweetener industry is also supported through the US Congress. Forty-two out of the fifty states are involved in the sweetener industry in some way, which means the majority of states are heavily invested in the future of sweeteners (Alvarez, 2005). The committees and sub-committees in the House of Representatives and the Senate are dominated by representatives from sweetener-producing states and are therefore able to keep sweeteners well protected from any legislation that may harm the interests of the industry (Alvarez, 2005).

The fact that sweeteners generate considerable revenue for the government makes regulation of these products even more difficult. When the Nutrition Labeling and Education Act of 1990 gave the US Food and Drug Administration (FDA) the authority to require nutrition labels on food, it did not originally include sugar until there were complaints about the omission (Pomeranz, 2012). The FDA also does not have a recommended limit for sugar, either added or natural, and does not list a disqualifying nutrient level for sugar (Pomeranz, 2012). This allows manufacturers to claim that their product is healthy regardless of the amount of total sugar, as long as it meets the requirements for other nutrient levels such as sodium, total fat, saturated fat,

and cholesterol (Pomeranz, 2012). At the time, their justification for these decisions was that there was insufficient evidence to support the claim that sugar and other sweeteners pose a threat to public health (Pomeranz, 2012). They also claimed that it would give consumers the false idea that it is acceptable to ingest a certain amount of sugar or that buyers would be misled into thinking that healthy foods labeled as having a moderate amount of naturally occurring sugar were unhealthy (Pomeranz, 2012). Furthermore, in 2009 the FDA decided not to include sugar or added sugar in its new front-of-package labeling system because of the same lack of scientific information regarding health effects due to insufficient testing methods (Pomeranz, 2012). No further progress on revising sugar regulations has been made.

Pomeranz (2012) is calling for a much needed revision of these outdated regulations by invalidating the FDA's reasons for not regulating sugar more strictly. She uses the example of the Food Allergen Labeling and Consumer Protection Act of 2004. This act made food manufacturers disclose the eight most common food allergens on the nutrition labels even though there are currently no methods to detect such substances. It is argued that the same courtesy be applied to added sugar since there are no commercially available detection methods for this substance either. The proposed solution to this problem is to have the FDA require manufacturers to confidentially submit their recipes to verify the added sugar content. In this way, the recipe remains secret, but the FDA is able to place added sugar on the nutrition label without having to go through any expensive testing of the food substances. Pomeranz (2012) also suggests that a daily recommended value for sugar be formulated, whether it be for total, natural, or added sugar. If the total sugar was used, this could validate the concern that people would not be able to discriminate between healthy foods with naturally occurring sugar and less healthy foods that have added sugar. Generally speaking, however, if the FDA required labeling

of added sugar to differentiate it from the natural sugar, this should not be a problem.

Sweeteners have been proven to cause undesirable health effects and it is time the FDA took the necessary steps to protect and inform the public of the potential harm added sugars and sweeteners can cause.

Methods

In this study, we chose four food types that are perceived as healthy by most people to show how distorted their understanding of sweetener labeling is, as well as their lack of knowledge of the risks involved in consuming high amounts of sweeteners. The four food categories selected were salad dressings, spaghetti sauces, nutrition bars, and cereals. For each of the four food types, we sampled five brands with five flavors per brand (4 food types x 5 brands x 5 flavors = 100). The flavors within each food type were selected at random from grocery store shelves. For each sample, we recorded the price per ounce, total grams of sugar, type and number of sugars in the list of ingredients, and the numerical position of those sugars (1st, 2nd etc). These data were then analyzed using JMP Statistics software. Descriptive histograms were used to describe single factors. Comparative data were analyzed using regression, ANOVA when the response variable was normally distributed and a non-parametric Wilcoxon test if the response variable was skewed. The items that were analyzed as non-sugar included syrups and other forms of sugar that were not explicitly labeled as sugar in the list of ingredients.

Results

The majority (62%) of sampled foods had sweeteners as the 1st, 2nd, 3rd, 4th or 5th ingredient (Fig. 3a). A third (36%) of sweeteners were among the 3rd or 4th ingredient in sampled foods. Only 7 out of the 100 sampled foods listed sugar as the first ingredient. Of those, 5 were nutrition bars (Clif bars) and 2 were salad dressings (Kraft Creamy Poppyseed and Ken's Steakhouse Lite Sweet Vidalia) (Fig. 3b).

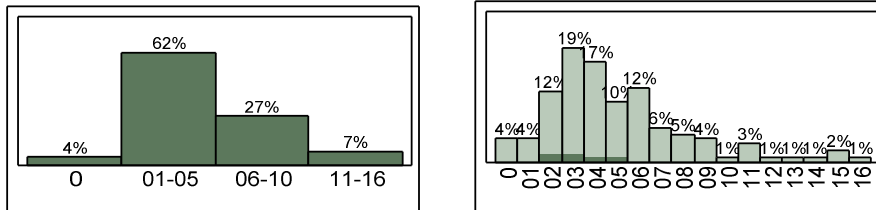


Figure 3: Distribution of all sweeteners by order of ingredient for all sampled food types (n = 100 food items).

Sugar sweeteners tended to be the 2nd, 3rd or 4th ingredient in the sampled food items (Fig. 4a) whereas non-sugar sweeteners tended to be the 3rd through the 6th ingredient.

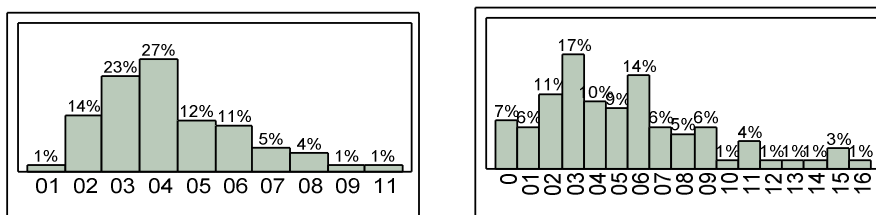


Figure 4: Distribution of sugar sweeteners and non-sugar sweeteners by order of ingredient for all sampled food types (n = 100).

The majority (40%) of the 100 food items listed sugar as the primary sweetener (Fig. 5).

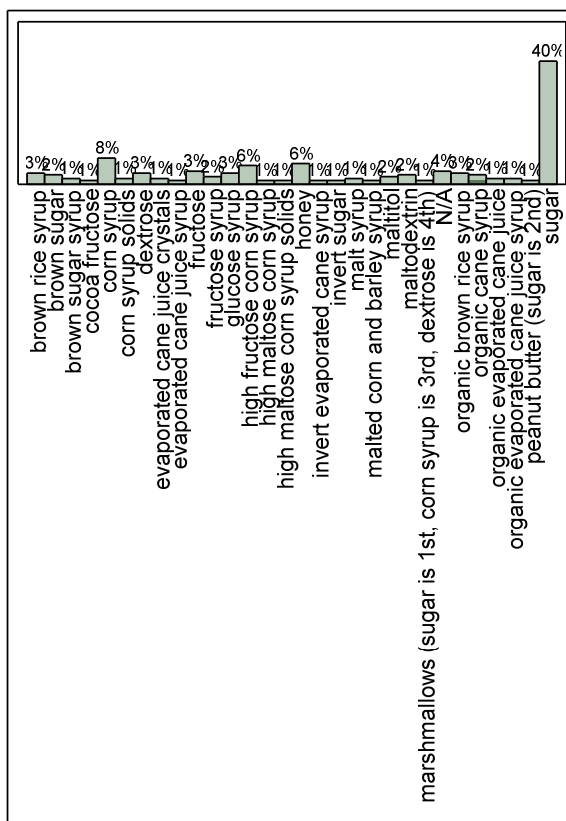


Figure 5: Frequency of sweeteners for all sampled food types (n = 177).

Sugar sweeteners comprised 44% of the ingredients; non-sugar sweeteners comprised 57% of the ingredients (Fig. 6).

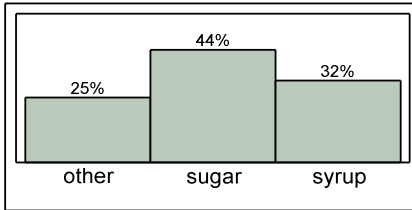


Figure 6: Frequency of sweeteners for all sampled food types (n = 100).

The majority (67%) of food items had only one sweetener and it was sugar sweetener; in contrast, only 20% of food items had only one non-sugar sweetener (Fig. 7).

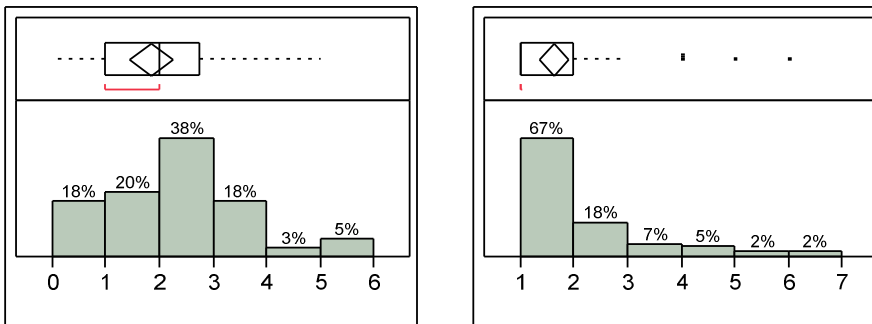


Figure 7: Distribution of non-sugar sweeteners and sugar sweeteners by the number of sweeteners in the list of ingredients for all sampled food types (n = 40).

In cereals, the majority (63%) of sweeteners were listed as the 1st through the 5th ingredient (Fig. 8). Sugar was the most frequent sweetener ingredient, topping 2nd place in 43% of food items. Non-sugar sweeteners are relatively evenly distributed throughout from the 1st to the 16th ingredient. The majority of cereals contained two sugar sweeteners and three non-sugar sweeteners.

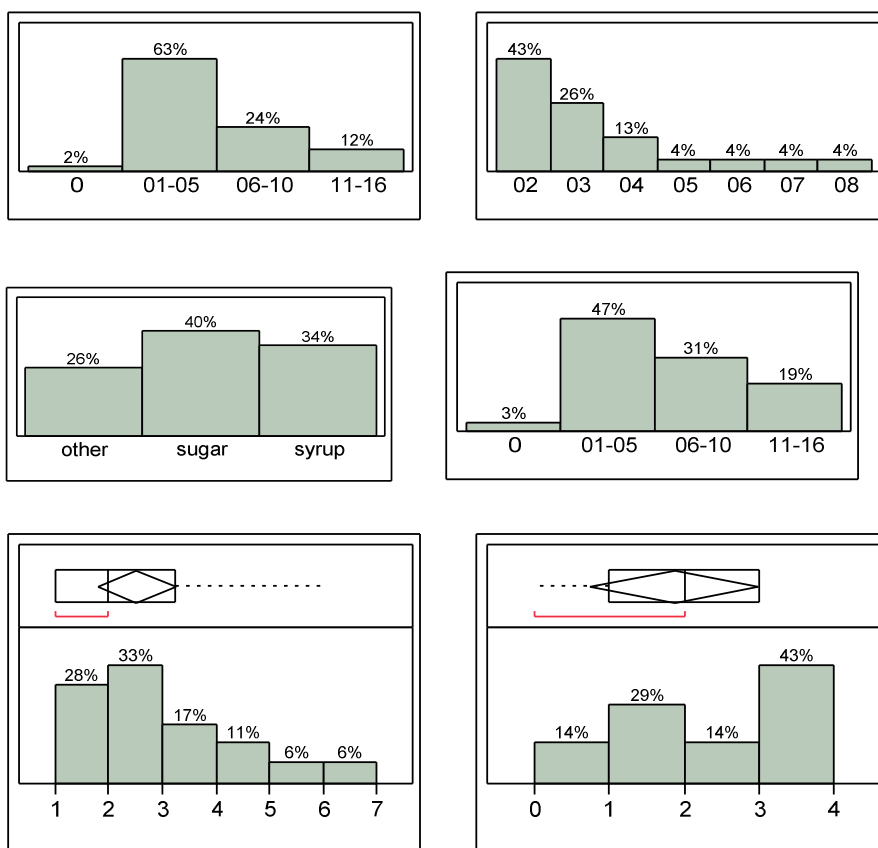


Figure 8: Cereals: (a) Order of all sweeteners (n = 59). (b) Order of sugar sweeteners (n = 23). (c) Frequency of sweeteners by type (n = 58). (d) Order of non-sugar sweeteners (n = 35). (e) Number of sugar sweeteners among ingredients (n = 18). (f) Number of non-sugar sweeteners among ingredients (n = 7).

Salad dressings: The majority (70%) of sweeteners were listed as the 1st through the 5th ingredient (Fig. 9). Most sweeteners were in the 3rd through the 5th ingredient. Sugars were the dominant sweetener used.

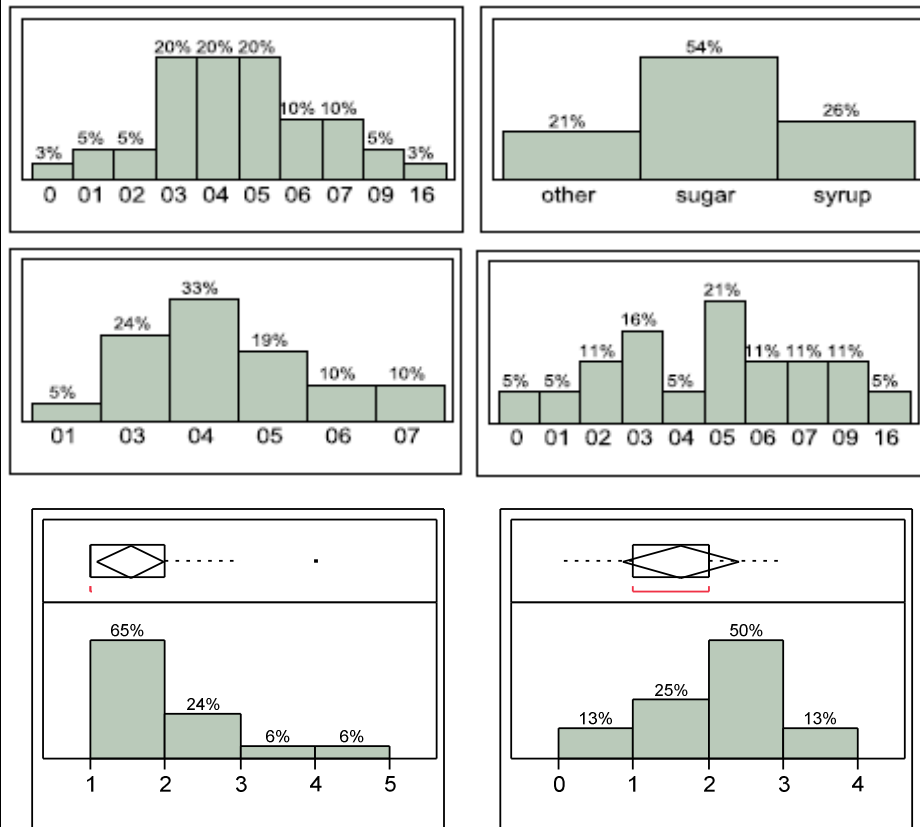


Figure 9: (a) All sweeteners by order of ingredient in salad dressings (n = 40). (b) Frequency of sweeteners by type. (c) Sugar sweeteners were usually the 4th ingredient (n = 21). (d) Non-sugar sweeteners were usually the 5th ingredient (n = 19). (e) The majority of salad dressings contained only one sugar sweetener (n = 17). (f) The majority of salad dressings contained two types of non-sugar sweeteners (n = 8).

Sauces: The majority (62%) of all sweeteners were the 3rd, 4th, and 5th ingredients (Fig. 10). Sugar was the dominant sweetener used.

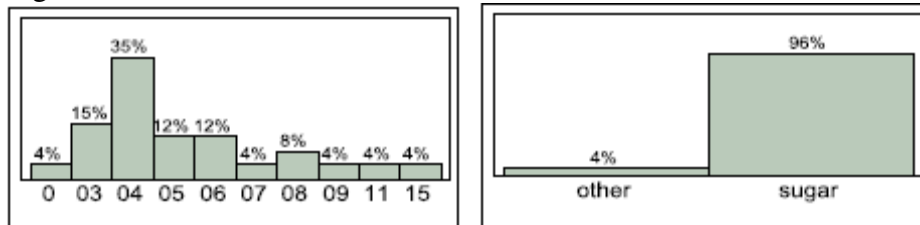


Figure 10: (a) Distribution of sweeteners by the order ingredients for sauces (n = 26). (b) Frequency of sweetener by type (n = 25).

Nutrition bars: The majority (56%) of sweeteners were listed in the 1st through the 5th position on the list of ingredients for nutrition bars (Fig. 11).

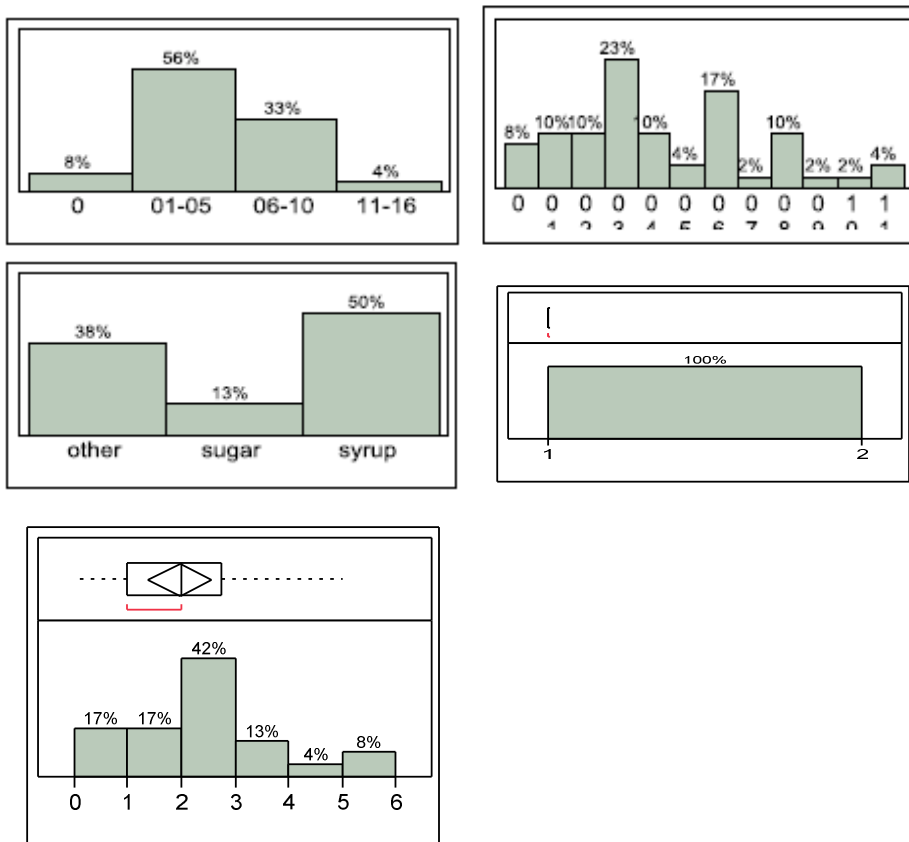


Figure 11: (a and b) Distribution of sweeteners by order of ingredient (n = 52). (c) Non-sugar sweeteners were the dominant sweeteners (88%; n = 48). (d) One nutrition bar contained only one sweetener and it was sugar (n = 1). (e) Almost half of nutrition bars had two non-sugar sweeteners (n = 24).

Grams of sweetener: The majority (75%) of sampled food items had between 5 and 15 grams of sugar (Fig. 12a); 85% had between 1 and 3 types of sugar (Fig. 12b). Only 3 products contained sugar alcohol instead of sugar (Fig. 12c).

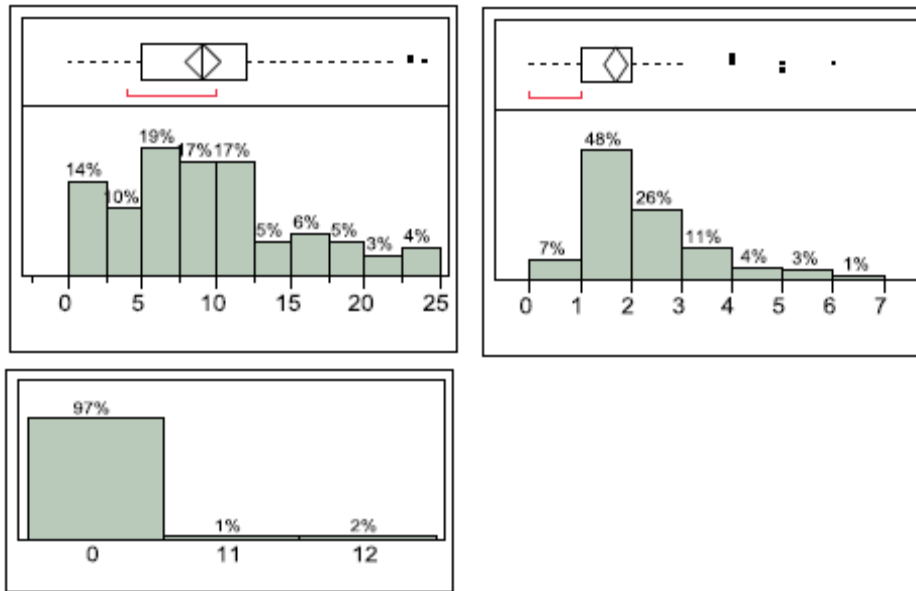


Figure 12: (a) Total sugar (g) for all food items (n = 100). (b) Number of sweeteners per food item (n = 100). (c) Type of sugar (n = 100).

Differences in the type of sugar used among the food types was significant (Pearson: $X^2 = 48.97$; $p < 0.0001$). As a sweetener, sugar dominated sauces. In contrast, syrups and other non-sugar sweeteners dominated nutrition bars. Salad dressings and cereals used equivalent amounts of sugar and non-sugar sweeteners. We suspect that using a large number of sweeteners allows food producers to spread the sugars among the ingredients so as to not alarm the buyer into thinking that they are purchasing products with too much sugar.

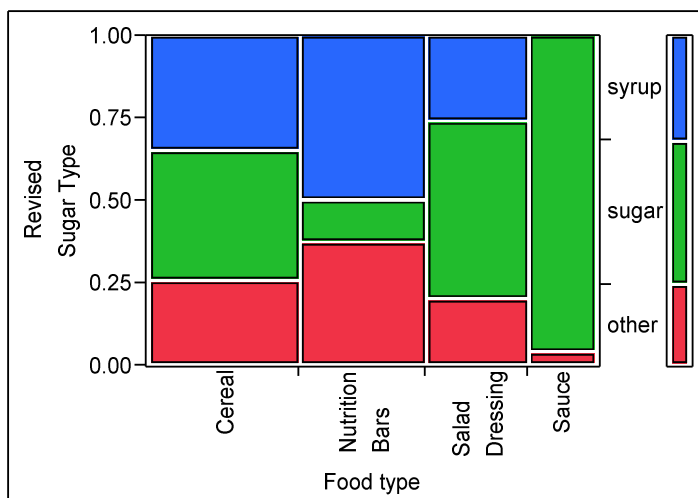


Figure 13: Sugar Type By Food type Mosaic Plot

Nutrition bars were significantly more expensive per ounce than cereal, salad dressing, and sauce (Fig. 14; ANOVA: $F = 144.90$; $p < 0.0001$), were significantly higher in total grams of sugar than cereal, salad dressing, and sauce (Fig. 15; ANOVA: $F = 22.466$; $p = .0001$), and had the highest number of sweeteners compared to sauce (Fig. 16; ANOVA: $F = 6.6460$; $p = .0004$).

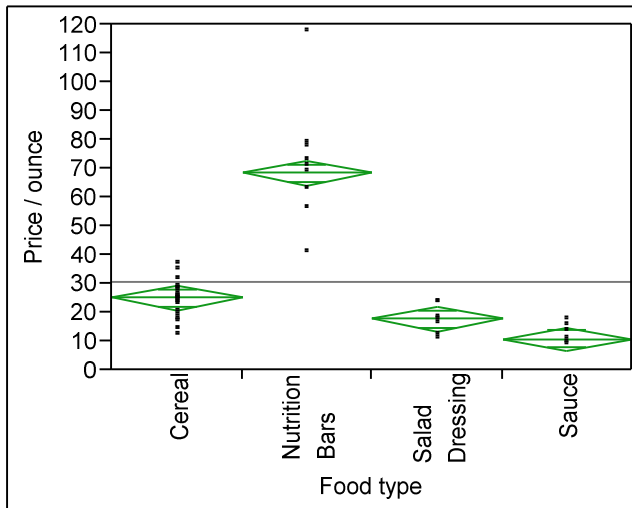


Figure 14: Price per ounce by food type (n = 100).

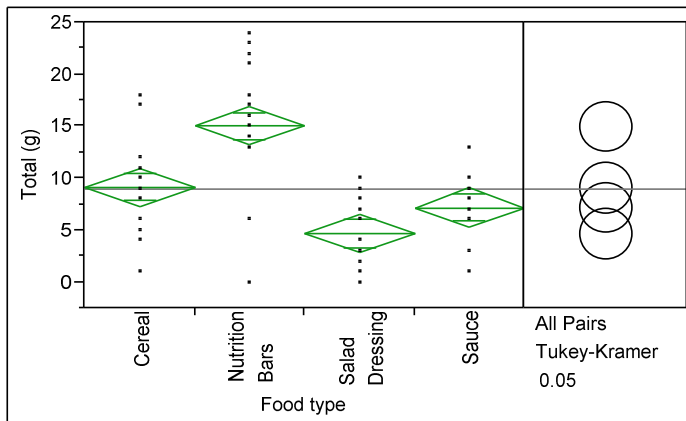


Figure 15: Total sugar (g) by food type (n = 100).

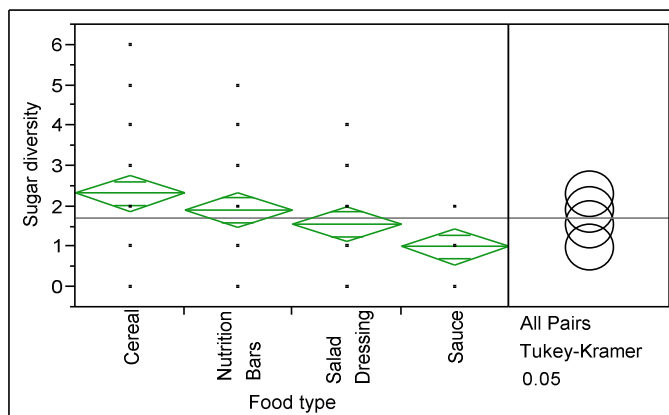


Figure 16: Number of sweeteners per food item (n = 100).

Discussion

Determining whether food companies are purposefully misleading consumers with their ingredients list is an idea that is only in the early stages of research. Other studies have focused on how some front-of-package nutrition labels and other deceptive advertising choices can cause consumer perceptions to be altered (Kim et al., 2012; Colby et al., 2010). The results of this study seek to further this research by speculating that the ingredients list is another place where food companies employ deceptive techniques. Excluding sauces, many food items that were sampled contained more than one type of sweetener; these products usually contained non-sugar sweeteners. If more sugar is added to food products this would make them more addictive and popular, while still being a cheap product (Pomeranz, 2012). However, our research suggests that companies attempt to disguise all of this added sugar by using forms that are not well known. This tactic could fool even health-conscious consumers since they might not be looking for non-sugar sweeteners when reading the label. This research can be combined with the work being done on the effectiveness of nutrition labels in combating obesity rates. It is currently

unclear what role reading the nutrition panel or the ingredients list has on the food choices of the individual. Factors such as current health status, age, race, or the knowledge that someone already has about nutrition may affect how the information is used, if it is used at all (Wojcicki & Heyman, 2012; Weaver & Finke, 2003).

Additionally, this study found that for all the sampled food types, sugar and non-sugar sweeteners occupied the 1st through the 5th position in the list of ingredients the majority of the time. These products were chosen for this study specifically because of their perceived healthfulness, yet all of them contained a fair amount of added sugar by weight. This analysis supports other research saying that, on average, Americans have been increasing the amount of added sugar in their diet to unhealthy levels, while companies continue to add more of it (Pomeranz, 2012). Most studies cite the individual's food choices regarding added sugar consumption, but our research may suggest that even if consumers are trying to be healthy by choosing items such as salad dressing, they are still getting unwanted added sugar. All the added sugar that is increasing the calories but not the nutrient content is quickly becoming a significant factor in today's climbing obesity rates (Lustig et al. 2012). If this holds true for other sugar-enhanced products this could be the beginning of very important research.

When examining the individual components of this study, nutrition bars were interesting. Even though they contain more cheap sugar (both in total grams and in number of sweeteners) they were still the most expensive product sampled. This study was limited in its scope therefore it cannot account for why this is so. Since nutrition bars are typically thought of as healthful choices, it could be that these companies have advertised well enough and put enough nutrients in them to make their product appear like a healthy snack as has happened with 100% fruit juices (Kim et al., 2012). According to Kim et al. (2012), people's perceptions of sugar-enhanced

beverages and 100% fruit juices were significantly altered simply due to a change in front-of-package labeling systems. Our research strengthens the case for more strict advertising rules so that foods which may contain important nutrients but have a considerable amount of added sugar are not promoted as healthy foods (Colby et al., 2010; Kim et al., 2012).

Though this study is a good start, it is important to examine its limitations. Since only four food types were analyzed, these results cannot be generalized to include the majority of food products. It is also restricted because we do not yet know how label-reading influences sugar consumption and obesity. Overweight and obese buyers may not care about the nutrition information. On the other hand, consumers looking to avoid consuming added sugar will know to look at the list of ingredients, and will therefore be at a more reasonable weight and health level than those who do not read labels. This research is important, however, because even if healthier people are checking the ingredients list, they may be unknowingly consuming added sugar that companies are hiding. To further this research, it would be beneficial to combine a study of the ingredients list with a survey to ascertain what kind of people care about the nutrition panel.

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