DuWop Diabetic Smoothie

Tamara Martinez,
Liz Williams, Allison LaVelle,
& Carrie Caporale
NFSC 320
12.7.11

Abstract

The objective of our smoothie was to create a diabetic friendly, meal replacement shake. Over a period of seven weeks we conducted a series of panelist testing, including Jar Scales, Acceptance tests, and Benchtop Evaluations. Through a process of elimination and addition of key ingredients preferred by consumers, we were able to narrow down smoothie components to yield our ideal flavor, color and texture while staying in conjunction with our proposed health claims. These claims included low calorie, low simple carbohydrate, low saturated fat, nutrient dense, high protein, high fiber and high monounsaturated fats.

We evaluated viscosity with a consistometer test for appropriate thickness. We concluded that our smoothie was an appropriate thickness for the feeling of satiety and to provide consumers with a fulfilling meal replacement shake. Through an objective qualitative assessment during week five of panelist testing, we received feedback that our smoothie was considered too bitter/sour. To reach the appropriate sweetness level without elevating the carbohydrate load we included Stevia, given that Stevia does not raise blood glucose levels in diabetics. In our final testing 20 consumers rated the sweetness of our smoothie at a mean of 4.55 and a standard deviation of 1.262.

Ultimately we created a delicious smoothie that is compliant with maintaining appropriate A1C blood glucose levels for Diabetics. In a comparative consumer test our smoothie was preferred 65% more than the current leading diabetic smoothie on the market.

In conclusion we substituted high fiber fruits with a palatable flavor to reduce bitterness, and decrease glycemic index. We added avocado and soy protein powder to increase nutrient dense calories without adding unhealthy fats in order to reach our diabetic friendly, meal replacement identity statement.

Introduction

The concept of our smoothie is to create a fulfilling and delicious smoothie that is acceptable for those with diabetes, as well as people looking for a healthy meal replacement shake. We created a low calorie, low carbohydrate, low saturated fat and high protein smoothie. Maintenance of blood glucose levels is the most important factor diabetics have to consider. Our research supports that our product will help maintain diabetics blood sugar levels.

Literature Review

Twenty five million children and adults in the United States (8.3% of the population) have diabetes. In 2007, diabetes was listed as the underlying cause on 71,382 death certificates and was listed as a contributing factor on an additional 160,022 death certificates. This means that diabetes contributed to a total of 231,404 deaths (www.diabetes.org). Uncontrolled diabetes has many negative and life threatening complications that include high blood pressure, blindness, kidney disease, neuropathy, limb amputation, and death. Diabetics have to be very cautious when eating certain foods that contain sucrose or have a high glycemic index because it will raise their blood glucose concentrations to unhealthy levels. Glycemic index is the measure of dietary glycemic carbohydrates, representing their ability to raise blood sugar concentrations (Guerreiro, et al). To help control blood sugar, diabetics can base their choices on how high the glycemic index score is for a particular food. The journal of Diabetics and its Complications states that "nutritional management is the cornerstone of successful diabetes treatment and should be based upon their usual exercise and eating patterns." Because nutritional management is the most important way to control diabetes, we have decided to try and create a new smoothie that is easy and safe for the busy diabetic to make regularly that also

provides plenty of other major macronutrients. In a study done by Food and Nutrition Research they found that if diabetics replaced sucrose for artificial sweeteners it would not cause significant elevations in blood glucose concentrations (Raben, et al.). The first issue that we addressed when brainstorming for ingredients was to replace sucrose based products with artificial sweeteners, but decided to go with a natural sweetener (Stevia) that reacts similar with postprandial blood glucose as artificial sweeteners.

Materials and Methods

We changed our smoothie many times during this process. We originally started with a fat-free vanilla yogurt, but we switched it to reduce the amount of sugar. We also decided to freeze some of our fruit so that we could use less ice, which helped to make our flavor more pronounced and less watered down. We switched the type of fruit several times as well to enhance the flavors and add more fiber and nutrients to our smoothie. Our smoothie at the end consisted of blackberries, strawberries, blueberries, mango, kiwi, lemon and avocado. We added the blackberries and blueberries at the end to make the color more appealing.

We asked panelists to describe the appearance and found that this was strongly associated with how much they liked the smoothie. Panelists claimed to like the flavor and other characteristics of the dark colored smoothie. They preferred this better than the light smoothie that had a green/brown tint due to the avocado. We tested this out by adding red food dye to the smoothie for one week and discovered that our panelists liked the one that was dyed and actually thought they noticed a difference in the taste. All of the fruits that we chose had a low glycemic index, which is ideal for a diabetic. We decided to exclude the milk and replace it with an apple juice sweetened with Splenda to decrease the

carbohydrate count. This also got rid of the milky/chalky texture as well. We had our panelists and consumers rate and describe the texture of the smoothie. We added avocado for the addition of calories and heart healthy monounsaturated fat to make our smoothie an adequate meal replacement and not raise LDL cholesterol. We added extra Stevia to make our product sweeter and less bitter. We then asked panelists and consumers to rate the sweetness using a JAR (Just About Right) scale and found that this made our smoothie very close to "Just About Right"

Prototype Modifications		
Original Product	**Modifications During Process**	**Final Product**
Fat Free Vanilla Yogurt	Greek Plain Yogurt	Fat Free Plain Yogurt
Skim Milk	Reduced Sugar Apple Juice	Reduced Sugar Apple Juice
Mango and Orange	Mango, Strawberries, Lemon, Kiwi, Avocado	Mango, Strawberries, Kiwi, Avocado, Blackberries, Blueberries
Ice and room temperature mango and orange	Frozen mango, strawberries, kiwi and less ice	Frozen strawberries, blueberries and blackberries; room temperature mango and kiwi; ice

For our instrumental measurements, we ran a consistometer test to test the viscosity of our product. We were pleased with the results of the viscosity of our smoothie. We also ran a pH meter test and discovered that our pH was 4.4 because of the citrus fruits that we added to our smoothie. We ran both of these tests twice on different days with the same smoothie recipe. We found that the results were very similar; therefore the consistency did not change much between different days.

Descriptive Analysis defined

Sensory tests, both chemical and physical (appearance, aroma, flavor, taste, retro nasal, texture, aftertaste & texture), are used in order to measure, analyze, and evaluate a food product. Panelists who are trained in attribute scales, lexicon, and sensory studies are very valuable in developing successful products. Upon an overwhelming consensus, our group decided on a smoothie for a health issue that plagues a large amount of our population. We wanted to create a smoothie for diabetics, with fresh fruits that could be used as a meal replacement or snack. In order to benefit diabetics, we had to consider all of the diet requirements and increased health risks that diabetics have including heart disease and obesity.

Panelists were untrained, agreeable and able to follow both written and verbal instructions. No known medical or lifestyle preferences were an issue. Some partners were more visually influenced, so we added food coloring to one of the sample smoothies to address this issue.

We developed a lexicon for product development with words such as tart, smooth, thick, mellow, creamy, chalky, milky, sour, citrusy and thick.

Samples were poured into sample cups and given in various ways. We started out with a triangle test, but found that over time using 2 samples in comparison of one another was less complicated and best

received by our panelists. We used Just About Right tests, Subjective/Quantitative Acceptability Tests with a 0-9 (dislike to like extremely), and Objective/Qualitative Defined Attribute Prototype Comparison Tests. Several of these tests were followed by a subjective / qualitative comment section.

We labeled our two samples with symbols such as a square and a circle so as not to influence panelists with numbers. We had panelists sit at partitioned sampling tables and placed evaluation sheets with verbal and written instructions on the evaluations. Samples were served in 4 ounce plastic cups and placed side by side. When we felt other stimuli may be influencing our panelists we added food coloring to our smoothies to assess panelist evaluations.

For our consumer testing we had consumers test our smoothie and evaluate it. Afterwards, we had consumers taste our smoothie again and compare it to a diabetic friendly smoothie that we got from Jamba Juice. We had consumers taste 4-ounce samples instead of 2-ounce cups so that they could get more of a taste of the smoothies. We chose our consumers by telling our friends to come by and also by hanging flyers. All of our consumers were college age and most were current Chico State students, but from various majors. We had consumers first read the concept of our smoothie and then ask how interested they were in tasting our product and why. We had our consumers fill out questions about our smoothie regarding the sweetness, overall taste, appearance, suggestions to improve the taste, what flavors stood out the most, the texture, and finally which smoothie they liked better between our smoothie and the one from Jamba Juice.

We had our consumers fill out an evaluation regarding our smoothie and then we pulled all of the results for a comparison. On the consumer test we asked consumers to rate the sweetness of our smoothie (JAR

scale), rate the overall taste of the smoothie (JAR scale), describe the appearance, suggestions to improve the taste, what flavors stood out the most, describe the texture of the smoothie, and then finally which smoothie they liked better between ours and the one from Jamba Juice and why. We then typed up all of the results together to find the overall opinion of our smoothie.

Results and Discussion

		Rate sweetness of smoothie 1-10	Rate overall taste of smoothie 1-10	Rate interest in trying smoothie 1-5
N	Valid	22	22	22
	Missing	0	0	0
Mean		4.55	5.36	3.68
Median		4.00	5.00	4.00
Mode		4	5	4
Std. Deviation		1.262	1.329	1.129
Variance		1.593	1.766	1.275
Range		5	5	4

Above: statistics from our three quantitative measures

We were pleased to see little deviation from the mean, indicating consistent consumer likability and the potential success of our product. The overall rate for interest in trying our smoothie was a 3.68 out of 5 on a likability scale. This was the mean response from consumers based on our concept before tasting the smoothie. This shows that the consumer market is interested in our product and also the potential success.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	4.5	4.5	4.5
	3	2	9.1	9.1	13.6
	4	10	45.5	45.5	59.1
	5	4	18.2	18.2	77.3
	6	3	13.6	13.6	90.9
	7	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

Above: Sweetness of our Smoothie on a JAR 1-10 scale

During panelist testing, our smoothie was considered to be to bitter/sour. At final consumer testing, our smoothie was rated with a mean of 4.55 on a JAR 1-10 Scale, only 0.45 below a perfect 5 rating. This indicates the majority of consumers found our smoothie to be sweetened to an acceptable level.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	9.1	9.1	9.1
	4	2	9.1	9.1	18.2
	5	10	45.5	45.5	63.6
	6	4	18.2	18.2	81.8
	7	2	9.1	9.1	90.9
	8	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

Above: Rating the Overall Taste of our Smoothie on a JAR 1-10 Scale

At final consumer testing, our smoothie was rated with a mean of 5.36 on a JAR 1-10 Scale in regards to overall smoothie taste. Almost half of the participating consumers rated our smoothie to be a perfect 5 on the JAR scale. This gave us evidence to believe our smoothie would be a successful product if it were to be sold in grocery stores and outlets.

The DuWop Diabetic Smoothie is sweetened with Stevia. Stevia is categorized as a "food additive" and it has a "Healthy and Reduced Sugar" nutritional claim that is also low in carbohydrate. Individuals with Diabetes Mellitus have to maintain a level A1C blood sugar in order to maintain health. Studies suggest that Stevia may enhance glucose tolerance and metabolism. This smoothie also contains avocado, high fiber fruits, and protein. (Goyal, et al.)

Diabetics are more prone to heart disease and may benefit from a rich monounsaturated fat diet. Avocado adds heart healthy monounsaturated fats. Monounsaturated fat is beneficial in reducing LDL-cholesterol concentration and increasing HDL. Monounsaturated fats are

not linked to weight gain in Diabetes Mellitus 1 and 2 individuals with controlled calorie intake. (Garg, et al.)

The higher the amount of fiber in a fruit, the lower the overall carbohydrate count of the smoothie. This is because the amount of fiber in a fruit (food) can be subtracted from the overall carbohydrate count therefore reducing the carbohydrates. We carefully chose fruits for our smoothie, specifically for their high fiber count and bold taste.

A soy (plant based) protein was added in order to boost protein and to keep saturated fat to a minimum. This is in consideration to the increased risk of heart disease in diabetic individuals.

Past studies have had concerns with the safety of Stevia and it's derivatives suggesting that Stevia acts as a mutagenic substance causing reproductive toxicity. In 2008 studies were reviewed and results suggest no mutagenic response, no evidence for cancer or birth defects from any stevia constituents. (Sutajit, et al.).

The health claim for the DuWop Diabetic smoothie is that it supports and maintains a balanced A1C blood glucose without add extra calories. Several studies suggest that Stevia aides in glucose metabolism and decreases postprandial blood glucose levels in Diabetes Mellitus 2 patients. By decreasing postprandial blood glucose levels these results over time would support the balanced A1C health claim. (Curi, et al.)

Confounding Factors

Our original sample cups were paper and the taste of the paper leached into the smoothie, adding an unpleasant taste. We overcame this by switching to plastic. Fruits varied in ripeness from week to week changing the taste from sweet to sour depending on fruit. Occasionally the yogurt brand would change, which also changed the overall taste of the smoothie. Size of fruit changed from week to week making it difficult to order the correct quantity of fruit.

Conclusions and Recommendations

In a comparative consumer test our smoothie was preferred 65% more than the current leading diabetic smoothie on the market. In conclusion, we substituted certain high fiber fruits to reduce bitterness and decrease glycemic index. We added avocado and soy protein powder to increase nutrient dense calories without adding unhealthy fats in order to reach our diabetic friendly, meal replacement identity statement.

The DuWop Diabetic Smoothie could easily be sold at any large grocery store or outlet. We know our product would produce successful sales because during our final consumer testing panelists rated their interest in our product at 3.68 out of 5 after reading our product statement and before trying our smoothie. After trying our smoothie, our product was rated at a 5.36 for likability, only 0.36 away from a perfect 5 on the JAR scale.

Further research on our topic could include the effects of fiber and decreasing the glycemic index and fibers effect on blood glucose levels. We are interested in research regarding combinations of higher "healthy" (mono/poly unsaturated) fats and low carbohydrate versus low fat and high carbohydrate in regards to weight loss and blood sugar. This is of interest to us because we have heard of research showing positive correlations between weight loss and better diabetes management.

If this project were to be repeated we would focus on using in season fruits, which are high in fiber, in order to avoid using added sweeteners. In accordance with using in season fruits, we would also be interested in trying to make our smoothie more sustainable by shopping at local farmers markets. Another area of interest could be the potential use of gums in our smoothie; to increase fiber and mouth feel without raising blood glucose levels, calorie count or altering the taste.

References

Curi, R. "Effect of Stevia Rebaudiana on Glucose Tolerance in Normal Adult Humans." *Braz J Med Biol Res* 6th ser. 19 (1986): 771-4. Print.

Garg, A. "High-monounsaturated-fat Diets for Patients with Diabetes Mellitus: A Meta-analysis." The American Society for Clinical Nutrition, Inc. Web.

Goyal, SK. ""Stevia (Stevia Rebaudiana) a Bio-sweetener: A Review"." *Int J Food Sci Nutr*: 61 (1): 1-10. Print.

Guerreiro, SK. "Sugary Drinks and Glycemia." *Acta Med Port* (2010): 567-78. Print.

Raben, Anne. "Increased Postprandial Glycemia, Insulinemia, and Lipidemia after 10 Weeks Sucrose-rich Diet Compared to an Artificially Sweetened Diet: A Randomized Controlled Trial." *Food & Nutrition Research* (2011): 5961-969. Print.

Sutajit, M. "Mutagenicity and Human Chromosomal Effect of Stevioside, a Sweetener

www.diabetes.org