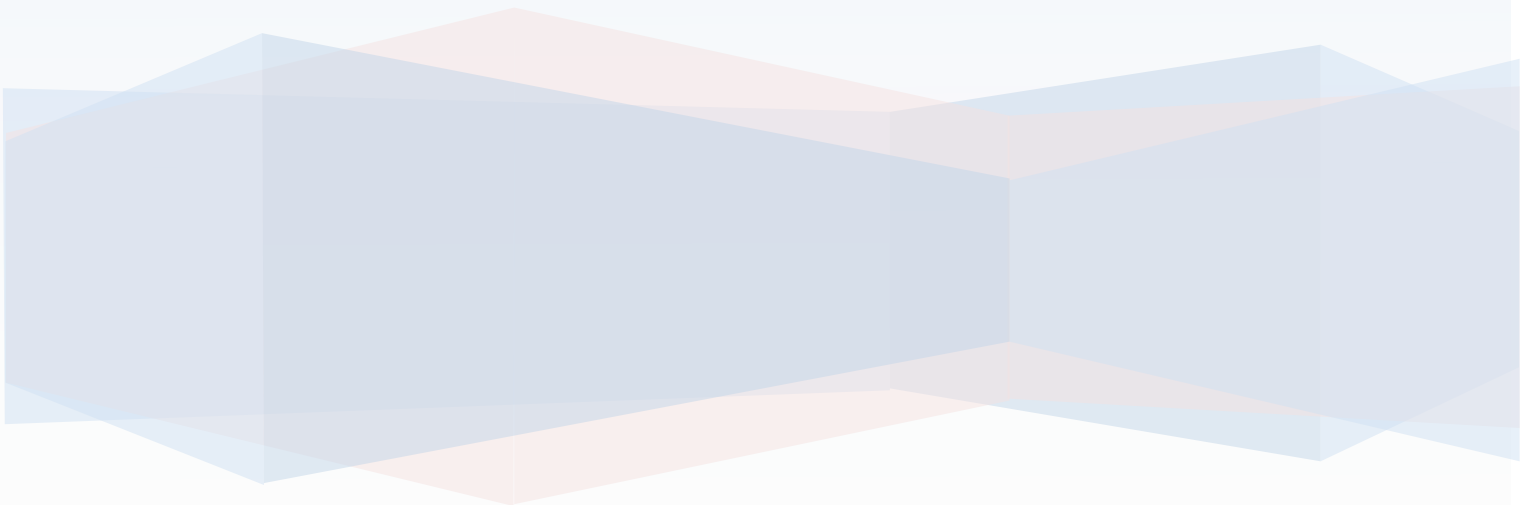


Chia Seed Chocolate Pudding

DFM 357 Experimental Foods

Diego Reyes

Joshua Lisan



Abstract:

This experiment demonstrates an optimal way to increase consumption of insoluble fiber, protein, antioxidants, and essential omega fats to promote and maintain healthy bodily functions. The design of the experiment focuses on the development of a Chia seed chocolate pudding from a standard stovetop starch pudding recipe. By modifying the starch ingredient with varying amounts of Chia seed, we focused on creating an acceptable product for our target population, which are college students. Experimental data on the acceptability of the developed product was gathered from an untrained random panel with the use of a Hedonic Scale rating system.

Introduction:

The study of experimental foods focuses on a scientific approach to food study. Integrating learned theories with laboratory research, participants are able to gain knowledge and experience on the effects that ingredients have on food preparation. Armed with both subjective and objective senses, researchers are able to apply scientific theories in a laboratory setting to gain a deeper understanding of the different characteristics of food.

Chia seeds, a member of the mint family has unique characteristics and many health-supporting benefits. Dating back to 1500 B.C., the Aztecs harvested Chia seeds and consumed for them for their nutritious properties. The edible seeds are either white or black and both types are a good source for insoluble fiber, protein, antioxidants, and essential omega fats.

Purpose:

The purpose of this experiment of this experiment is to determine the effect on flavor, texture, consistency, and over all acceptability when the starch ingredient in a standard stovetop chocolate pudding recipe is substituted with chia seeds.

Review of Literature:

Today, a typical diet is consistent of foods that are highly processed, full of unhealthy fats, and are void of many of the nutrients that are vital to help keep us feel satiated and to maintain healthy bodily functions. For this reason, proper nutrition and a diet that contains the recommended amount of fiber is important to promote a long and healthy life. Generally the amount of fiber depends on the amount of calories that an individual consumes per day. Intake of dietary fiber has been recommended for many years as part of the guidelines from the American Heart Association, the Institute of Medicine, and other groups. The recommended Adequate Intake for dietary fiber for adults is 25 to 38 g/day (14 g/1,000 kcal/day) (King, 2008).

Studies have shown that daily dietary fiber intake is not nearly as close to the recommended amount that the Academy of Nutrition and Dietetics has prescribed. Mean daily dietary fiber intake for 1999-2000 was 15.6 g/day, for 2001-2002 intake was 16.1g/day, for 2003-2004 intake was 15.5 g/day, for 2005-2006 intake was 15.8 g/day, and for 2007-2008 intake was 15.9 g/day (King, 2008). Though this study was dated a few years ago, the length of time in which the study was conducted shows data about general population not consuming the recommended amount of dietary fiber. Also, there has been no significant rise in the consumption of fiber. As student researchers, one of our goals for the development of our product is to provide an easy way to increase the intake of dietary fiber through the consumption of Chia Seeds.

Dietary fibers exert various types of physiologic effect in our gastrointestinal system. Dietary fiber consists of chemical compounds called non-starch polysaccharides (NSPs), which occur, naturally in many foods. The effects that these compounds have on gastrointestinal health have very important health consequences if they are absent or lacking from a normal diet. By

examining the prominent causes for a deteriorating gastrointestinal system we are able to make links between the actual benefits of nutrients that can be found in chia seeds and suppression of certain of certain disease risk factors. The remarkable properties of dietary NSPs are water dispersibility, viscosity effect, bulk, and fermentability into short chain fatty acids (SCFAs) (Kumar, Sinha, Makar , Becker & de Boeck, 2012). These properties contribute to decreased risk factors for gastrointestinal complications such as colo-rectal cancer, inflammatory bowel disease, disordered laxation, and chronic constipation.

Lack of fiber consumption does not protect the integrity of our gastrointestinal system. This specially becomes more relevant as we get older. Due to the bulking properties that chia seeds possess, toxic waste spend less time passing through our gastrointestinal system. Chia seeds have about 11 grams of dietary fiber per 100 calorie serving making it an excellent source.

Cell damage in each of our different organ systems can come as a result of reactions happening in our body on a molecular level. Oxidative damage to cells is the result from free radicals produced by oxidative reactions, a crucial process for life. Free radicals can then start chain reactions within a cell and cause damage or cell death. Antioxidants work to terminate these chain reactions by removing free radicals and prevent oxidative damage to cells by being oxidized themselves. For this reason, antioxidants are most often reducing agents. Oxidative damage can happen to any type of cell in the body and DNA which makes antioxidants ever more important.

Chia seeds are rich in antioxidants. Some of these antioxidants include: Quercetin, a powerful fatigue-fighting antioxidant; Chlorogenic Acid, an antioxidant that possess anti cancer properties; and Caffeic Acid, which is an antioxidant that has anti-inflammatory properties.

High levels of sugar in blood also known as high blood glucose contributes to many problems, such as diabetes and heart disease. In a 2006 published article by the Harvard School of Public Health it was found that higher than optimum glucose levels in blood is the leading cause of mortality in most world regions (Lawes, Danaei, Hoorn, Murray & Ezzati, 2006). The study collected data from 52 countries in which they found that diabetes accounts for 959,000 deaths, 1,490,000 deaths from ischaemic heart disease and 709,000 from stroke that are attributed to high blood glucose (Lawes, Danaei, Hoorn, Murray & Ezzati, 2006). High blood glucose leads to diabetes which also affects cardio vascular health. The problem here is higher than normal glucose levels that affect cardio vascular health and overall health. It was also found that based on age ischaemic heart disease attributed to high blood glucose occurred in people that were of 70 years or older.

High glucose levels in blood in the short run may cause: dehydration, weakness, infections and even blurry vision. In the long run, high levels of glucose may lead to diabetes, heart disease and eventually death. In an effort to stop this from continuing the Harvard School of Public Health urges to programs for cardiovascular risk and diabetes management and control be more closely integrated at the population level (Lawes, Danaei, Hoorn, Murray & Ezzati, 2006). So what does mean for chia seeds? Chia seeds are blood glucose stabilizers due to its soluble fiber content. The ability of chia seeds to stabilize blood glucose levels make them a great food for diabetics and people who are trying to bring their blood glucose down to a normal levels and hence why it was chosen our food product.

A diet high in fat has been associated with cardio vascular disease, however, a diet high in healthy fats have been associated with the prevention of cardio vascular disease. The reason for the latter is that healthy fats are composed of omega-3 and omega-6. Omega-3 is derived

mostly from fish and some plant products, and omega-6 is mostly plant based. In a studied fueled by the eskimo diet interest it was found that there is a correlation between omega-3 and 6 fatty acids and prevention of heart disease. The Eskimos diet is primarily composed of fatty fish, this fatty fish is high in omega-3 and therefore it is believed that the eskimo's high intake of omega-3's that comes from the consumption of fish is what has allowed them to have such low levels of heart disease. To determine whether this correlation was true elsewhere the study focused on the population of China. In their study of 156 healthy individuals they found that omega-3 fatty acids are able to adjust blood level lipids and lower triglyceride levels which positively affect health. However they also found that consumption of omega-3 and 6 in the population studied was very low at 4.25% when the recommended amount is of more than 8% therefore this represents a deficiency of omega consumption in this population is still better than western diets (Wong,Chen,Li, 2012)

The study found that there is a positive correlation between omega-3 and HDL-C and a negatively association with triglyceride levels (Wong,Chen,Li, 2012). What this means is that consumption of omega-3's benefit cardio vascular health by increasing HDL and decreasing triglycerides and overall aid in the prevention of heart disease. Chia seeds are among one of the highest omega-3 and 6 plants sources. A diet containing chia seeds is a diet that high in omega-3 and 6 which like stated in this journal article helps in the prevention of cardio vascular disease and is good for overall good health.

Meat a great source of protein, but is not the only source of protein, there are various sources of protein including other seeds such as chia seeds. So why is protein important for most living things? Protein are important for growth and maintenance of cells and catalyze chemical reactions. The lack of adequate intake of protein can have dire results. In a studied in which

inadequate protein intake was studied it was concluded that inadequate intake of protein results in adverse metabolic, functional, and structural events such as muscle wasting (Thalacker-Mercer, fleet, Craig, Carnell, Cample, 2007). What this means is that the body will try to make up for the inadequate intake of protein by compromising the metabolic function by slowing it down, immune repose is compromise and the body is more susceptible to illness. In the long run, an inadequate protein intake may result in death.

The body when faced with decreased amounts of protein will do whatever it can to reduce its protein loss, but in consequence it affects the physiological aspects of the body. The decreased protein intake can be seen in the cells genetic transcription that is also adversely related to low protein levels. In relation to chia seeds and protein, chia seeds contain 23.4% of protein which is a high amount for a seed. Consumption of chia seeds along with other foods will help in preventing the the dire consequences of low protein intake.

Method/Design:

The formula that we have chosen for the ideal control product is a basic stove-top starch pudding recipe (refer to appendix 1.1) After we have determined the formula for the excellent standard which we will use to compare the other two samples, we proceeded to create our products. The basic procedure of our product creation is as follows: First we combined the cornstarch, sugar, salt, and milk in a 13 quart mixing bowl. With a whisk, mix vigorously in a circular fashion for about 10-15 strokes until the dry and wet ingredients are well incorporated and the milk has begun to form a slight foam. Transfer mixture to 11 quart double boiler making sure that the mixture is below the water line to ensure uniform heating. Let the water simmer over a medium heat for 15-20 minutes. Using a wooden spoon, stir the mixture every 5 minutes to prevent clumps from forming. Keeping an eye on the cooking process, watch for bubbles to

form on top of the milk mixture as this is a sign of over-heating. In the case of over-heating remove the top boiler from the water and stir to prevent the milk from burning. Once the mixture starts to have a more viscous consistency, add the chopped chocolate chips and use a whisk to ensure the chocolate has properly melted and there are no lumps. Once 20 minutes has elapsed, use a thermometer to make sure that the internal temperature of the mixture has reached 150°F and remove the top boiler containing the mixture to add the vanilla extract. Using a rubber spatula, proceed to pour the hot mixture through a strainer with a collection bowl, this will ensure no lumps will be in the final product. The cooling time for the pudding is about 10 minutes. Once 10 minutes have elapsed, use a plastic saran wrap to cover the bowl. Make sure to puncture about 10 holes on the plastic wrap to allow for ventilation and to prevent from skins to form over the pudding as it cools. heat-proof bowl and place over simmering water for approximately 15-20 minutes, stirring occasionally. The experimental sample recipes with 50% starch/50% chia and 100% chia (refer to appendix 1.1 for recipe) will follow the same procedure except the variation ingredient will be added instead.

Once we finished developing the control, modified 50% starch/50% chia, modified 100% chia recipes, we conducted 2 objective tests for our products. Due to the fact that pudding has a viscous consistency, we decided to use a Line-Spread Test and a Percent Sag Test. The percent sag test is an objective test that examines the comparative tenderness of a gel. The greater the percent sag, the more tender the gel. The line spread test is the measure of flow of a viscous liquid or semisolid food by determining the spread of a measured amount of sample in a specified length of time at 90° intervals on the template of concentric rings. All three samples had an internal temperature of 35°F before the objective test was conducted.

The subjective test that we chose to design for our experiment, is the triangle test. During the final run of the experiment we performed a triangle test where we presented the samples simultaneously which reduces the chance of guessing the right answer to 33.3%. The subjective aspect of the experiment consisted of a score card based on the hedonic scale of 1-7. With 1 being dislike very much, 2 dislike moderately, 3 dislike, 4 neither like nor dislike, 5 like, 6 like moderately, and 7 like very much. These values were used to rate the characteristics of our three pudding which included the consistency, flavor and over-all taste of the control, fifty/fifty and the extreme.

Results:

The objective results of our pudding products are as follows:

Control Recipe = 10% sag; little to no flow

Modified 50% starch/50% chia = 30.5% sag; moderate flow

Modified 100% chia substitute = 16.67% sag; little to no flow

Discussion:

Starch is a complex carbohydrate that has many unique properties. It is a very important component in food preparation for its thickening ability. Gelatinization is a unique physical process that is hallmark characteristic of starch. Gelatinization is the swelling of starch granules and migration of some amylose into the cooking water when starch is heated in water to thicken various products (McWilliams Margaret, 2012). During this process, the heat breaks the hydrogen bonds which holds the organizational structure of starch molecules. This permits liquid to enter the starch granule as some amylose leaks out into the surrounding liquid. As water continues to enter the granule, the starch molecule will begin to swell and form new bonds with the amylose and amylopectin molecules. As a result, water becomes bound in the swelling starch molecule and the liquid. This causes the amount of free water to decrease and the liquid will start to gel.

Gelatinization is responsible for the 10% sag that our control pudding recipe exhibited. This result comes to no surprise because the recipe contained about 33 grams of cornstarch. As the results will indicate, there is a major increase in the percent sag and rheology exhibited by the modified 50% starch/50% chia recipe. Evidently, decreasing the amount of starch to 50% compared to the control recipe will have significant effects on the thickness and flow of the modified pudding recipe compared to the control recipe.

Chia seeds contain insoluble fiber and have unique hydrophilic properties, which allow them to absorb, retain liquid, and swell to 12 times its original size. By being able to retain that much liquid, chia seeds form a gel when exposed to liquid for a period of time. This explains the relatively low sag percentage and flow rate in our modified 100% chia recipe. The health

benefits and binding capability of chia made it a winning candidate for substitution of starch in pudding.

In Figure 1 the bar graph depicts the mean acceptance of consistency for chocolate pudding. The control, which is represented by number 411, has an average acceptance of 4.92 on Hedonic Scale of 1-7 based on the average taken from the table found in the appendix. From our number system this number value for the control is a 4 which is a neither like or nor dislike, however since is 4.9 its closer to the number value 5 which stands for like. It is therefore more of a Like for consistence on the control value. Since this was the control it was expected to have a like since the control was to have a more familiar pudding consistency. The mean for 50/50 half starch half chia seed pudding labeled 623d received an average of 5.2 [a like]on the hedonic scale of acceptance for consistency. The 50/50 mixture was better liked since it was the best of both worlds since it had the consistency of familiar pudding with the new consistency provided by swelled chia seeds. The extreme pudding 212 received a 4.2 for consistency since it was the most different and the average tester seemed to like or dislike the pudding according to the hedonic scale of acceptance. This was expected since it was the most different in consistency and would definitely be different o the familiar pudding. From the pie charts it is easier to see the percentage of people and their acceptance of the various pudding samples. The most accepted pudding for consistency was the 50/50 mostly because its familiarity to regular pudding but with a new texture which 40% of testers liked. Second came the control at 33% and this is probably do the familiarity to regular pudding, and in last cam the extreme at 27% because of its uniqueness that seems to not be as readily accepted as the other puddings.

Figure 3 and 4 provide information about the testers acceptance of flavor. The average for the control 411 being 5.6 which closer to the like moderately than just like in the hedonic

scale. This is probably because its like the regular pudding that most people are used too. In second place came the 50/50 (#623) with an mean of 5.5 and third was the extreme(#212) with 4.3. Unlike consistency the testers when testing for flavor seemed to like to almost moderately like when testing for flavor. In Pie chart form this translates to 45% of people liking the control , 36% liking the 50/50 and 18% liking the extreme. Flavor was definitely a winning quality of the chocolate pudding in the control. Overall the flavor was better accepted over consistency.

In figures 5 and 6 over-all taste was measured using the hedonic scale and it was found that the control (#411) was 5.5 mean acceptance, 50/50 (#623) was a 5.3 and the extreme(#212) was 4.5 acceptance. For over-all taste the control was more like than he 50/50 or the extreme. The control was closer to moderately like than the 50/50 that was closer to like. The extreme is yet not very accepted by most testers and remained at almost like but did not make it there and remained in the neither like nor dislike for over-all taste. In pie form this looks as like 45% liking the over-all taste for the control, 36% for the 50/50 and 18% for the extreme.

Conclusion:

Analyzing the collected data from the untrained panel, we concluded that control pudding recipe was better accepted due to its familiarity to characteristics of commercial pudding. The 50/50 recipe was not received better than the control but was still liked due to its new texture. We can also conclude that there is a chance that the 50/50 product will be better accepted in the near future if it is promoted and marketed for its health benefits. The extreme received the lowest acceptability for all the characteristics. Overall, the control sample received the highest acceptability for all the characteristics. Even though the extreme recipe remains the healthiest option, it is not ready for the average consumer.

Appendix:

Appendix 1.1

Control Recipe	Modified 50% Starch and 50% Chia Recipe	Modified 100% Chia Recipe
-33 grams cornstarch -102 grams granulated sugar -pinch of salt -723.2 grams cold whole milk -160 grams semi-sweet chocolate -24 grams pure vanilla extract	-16.5 grams cornstarch -61.4 grams Chia Seeds -102 grams granulated sugar -pinch of salt -723.2 grams cold whole milk -160 grams semi-sweet chocolate -24 grams pure vanilla extract	-122.8 grams Chia Seed -102 grams granulated sugar -pinch of salt -723.2 grams cold whole milk -160 grams semi-sweet chocolate -24 grams pure vanilla extract

Appendix 1.2

	#411	#623	#212
Characteristics			
Consistency			
Flavor			
Over-all Taste			

Scale:

7 = Like Very Much

6 = Like Moderately

5 = Like

4 = Neither like nor Dislike

3 = Dislike

2 = Dislike Moderately

1 = Dislike Very Much

Appendix 1.3

Sample Number	Recipe
411	Control
623	50% Starch / 50% Chia
212	100% Chia

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