Celiac Friendly Samosas

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I. Abstract

People with celiac disease (CD) suffer from a number of clinical manifestations caused by the ingestion of gluten. Nutrient deficiencies are commonly seen in newly diagnosed CD patients. Strict adherence to a gluten-free diet is currently the primary treatment of the disease to prevent further complications. The purpose of this study was to create a 100% gluten-free food product safe for consumption by CD patients. Our group modified an Indian samosa recipe by substituting the gluten-containing all-purpose flour (APF) for a 50/50 mixture of hemp flour (HF) and glutinous rice flour (GRF). The addition of HF is beneficial in this recipe as it contains nutrients that many CD patients are often deficient in. Objective and subjective tests were conducted to evaluate the viability of the samosa dough. The modified recipe was found to be acceptable.

II. Introduction

CD has a 1% of prevalence worldwide (Arias et al., 2015). Patients with CD suffer from immune-mediated enteropathy in result of consuming foods that contain the glutenin and gliadin protein complex derived from wheat, barley, and rye. The inflammatory response is thought to be triggered by an abundance of proline and glutamine amino acid residues in the gluten proteins. The causes of CD are unknown, and the only treatment is strict adherence to a completely gluten free diet (Tack et al., 2013). Damage to the small intestine can result in malabsorption of key vitamins, minerals, and nutrients. Protein, B6, folic acid, iron, calcium, and zinc are commonly deficient in patients suffering from CD (Wierdsma, van Bokhorst-de van der Schueren, Berkenpas, Mulder, & van Bodegraven, 2013).

Wheat is by far the most difficult source of gluten to eliminate from the diet. APF is derived from wheat kernels. It is extremely common and found in a variety of food products. From a nutritional standpoint, gluten-free flours generally contain lower amounts of protein, vitamins, minerals, and dietary fiber than APF (Korus, Witczak, Ziobro, & Jusczak, 2008). From a culinary standpoint, gluten-free flours do not provide the same functional properties as gluten-containing flours. The goal of this experiment was to develop a gluten-free dough that would provide nutrients commonly deficient in patients suffering from CD and still be culinarily viable.

HF is derived from the seeds of the cannabis plant. HF contains albumin and edestin proteins, which both have an extremely high biological value. HF also contains beneficial amounts of iron, zinc, calcium, and dietary fiber (Callaway, 2004). GRF is named that because of its functional similarities to gluten-containing flours. GRF can be derived from different varieties of very short grain rice that are collectively referred to as glutinous rice. Although GRF has a relatively low nutritional value, combining it with HF may result in a nutritious and functional gluten-free replacement for traditional wheat flour.

III. Literature Review

Celiac Disease and Nutrient Deficiencies

Micronutrient deficiencies are often found in newly diagnosed CD patients. Symptoms of CD such as intestinal inflammation and diarrhea can significantly affect nutrient absorption (Lauret and Rodrigo, 2013). In a cohort study conducted by Wierdsma et al. (2013), the nutrient status of 80 newly diagnosed CD patients was assessed. Folic acid, vitamin A, E, D, B6, B12, zinc, copper, calcium, and iron were determined to be deficient in untreated patients. Approximately 90% of the newly diagnosed CD patients were reported to have at least one of the assessed nutrient deficiencies, with zinc being the most common (67%) deficiency (Wierdsma et al., 2013).

Vitamin D supports calcium absorption within the intestine. Children with untreated CD often times have low bone mineral density (Friedman, 2012; Mager, Qiao, & Turner, 2012). Low levels of calcium and vitamin D present in people with CD can be attributed to impaired fatty acid absorption. Topal et al. (2015) found that increased levels of intra-luminal fatty acids can bind to calcium and inhibit absorption. Furthermore, this impaired fatty acid absorption may also contribute to the low levels of vitamins A, E, D, and K. These inferences are supported by the findings of Arias et al. (2015), which state that patients with CD have a diminished expression of intestinal fatty acid binding proteins. These proteins are necessary for the absorption of dietary long chain fatty acids into the enterocyte. Based on these studies, it is apparent that the malabsorption resulting from untreated CD can lead to suboptimal bone health.

A gluten-free diet is the primary intervention for patients with CD. A clinical study of 52 children with CD examined the interrelationships between vitamin D and K status and bone mineral density over the course of one year. They witnessed improvements in the children's bone mineral density. Other factors, such as physical activity, may also affect how the body responds to the gluten-free diet (Mager, Qiao, & Turner, 2012). Close monitoring of nutrient deficiencies in CD patients is important in creating an individualized gluten-free diet to treat CD.

Comparison of Hemp Flour, Glutinous Rice Flour, and All-Purpose Flour

All 3 flours used in our experiment are derived from different sources and have different nutritional compositions. HF is derived from the seeds of the cannabis plant. GRF is derived from waxy, glutinous rice, which contains mainly amylopectin and little to no amylose (Brady, 2015). APF is derived from the endosperm of the wheat kernel from the wheat plant. The greatest differences between these flours is their protein content. The protein content of HF is 33g per 100g. The two types of protein in HF are edestin and albumin, both of which contain adequate amounts of all nine essential amino acids, classifying it as a complete protein. In comparison to wheat, hemp contains larger quantities of both essential and conditionally essential amino acids. Hemp also contains high amounts of arginine, glutamic acid, and the sulfur containing amino acids methionine and cysteine (Callaway, 2004). The protein content of APF ranges from 10.5%-14% (Khan, Anjun, Pasha, Sameen, & Nadeem, 2012; Callaway, 2004). Furthermore, it is considered to be low in protein and high in carbohydrates (Idowu, 2014). APF has an amino acid score of 43, and is not considered a complete protein. This is due to its low levels of lysine. The two amino acids of highest concentration are glutamic acid and proline, respectively. The vitamin content of enriched APF consists mostly of B vitamins, such as thiamin (1.0 mg), riboflavin (0.6 mg), niacin (7.4 mg), folate (220 mcg), and trace amounts of B6 (0.1 mg) (nutritiondata.self.com, 2015). Limited nutrient facts specific to GRF were found, however, 100 g cooked glutinous rice contains 2 g of protein (nutritiondata.self.com, 2015).

Atrophy of the epithelial lining of the proximal small intestine is a common symptom of CD. The amino acid glutamine can stimulate the proliferation of gut mucosa cells (Gropper and Smith, 2013). Per 100 g, HF contains 4.57g of glutamic acid, 0.98g of isoleucine, 1.72g of leucine, and 1.28g of valine (Callaway, 2014). These amino acids can serve as precursors to glutamine.

Upon comparing the nutritional profile of HF to the common nutrient deficiencies suffered by CD patients, HF can be a valuable component of a gluten-free diet. Per 100 g, HF contains 100% daily value (DV) of copper, 110% DV iron, 80% DV zinc, 70% DV thiamine, 70% DV folate, 60% DV of vitamin B6, 33 grams of protein, 150 mg calcium, 5 grams of gamma linoleic acid (GLA), and 2 grams of alpha linolenic acid (ALA) (CHI, 2015).

Endocannabinoid System and Modulation of the Inflammatory Response

HF may provide benefits other than nutritional value to patients suffering from CD. The human body contains a regulatory system known as the endocannabinoid system (ECS). The main function of the ECS is to promote homeostasis by modulating cellular reactions in the central nervous system and peripheral tissues (Pacher, Batkai, & Kunos, 2006). In a study performed by Battista et al. (2013) cannabinoid receptor (CBR) expression in the duodenal mucosa of untreated CD patients was compared to CD patients that have been "treated" by adhering to a gluten free diet (treated with a gluten free diet; don't need quotes). CBR presence was drastically higher in the CD tissue samples. CBR mRNA levels were also monitored after treating CD and control group tissue samples with PT-gliadin, which is a compound derived from gluten. Upregulation of CBR mRNA occurred specifically in the tissue samples derived from patients with CD. Increased levels of anandamide (AEA), an endogenously synthesized cannabinoid receptor ligand (EC), were found in the plasma of patients with untreated CD. All of these factors indicate that the ECS plays a role in controlling the inflammatory response which occurs in patients with CD.

AEA and 2-arachidonoyl-glycerol (2-AG) are the two most studied EC and have been found to inhibit excessive release of both excitatory and inhibitory neurotransmitters at the synapse. 2-AG and AEA are both arachidonic acid derivatives, and are synthesized on demand from fatty acid precursors in the phospholipid bi-layer of cells throughout the body in response to injury, stress, inflammation, or general overactivity (Bisogno, Ligresti, & Marzo, 2005). Arachidonic acid is a conditionally essential fatty acid, meaning that normally the human body can synthesize adequate amounts of it using fatty acids consumed in the diet, specifically GLA. However if dietary intake of GLA is inadequate, arachidonic acid becomes essential and must be consumed through exogenous sources (George, 2015).

An arachidonic acid deficiency can suppress the synthesis of 2-AG and AEA, diminishing the boy's natural ability to suppress inflammatory reactions within the body. The fatty acid content of HF is 56% GLA and 22% ALA. This ratio provides adequate amounts of GLA to provide the building blocks of 2-AG and AEA, while also providing the anti-inflammatory benefits of ALA (Callaway, 2004). Being that patients with CD upregulate CBR production, they have an inherently higher requirement for GLA. Theoretically, consuming HF will assist in controlling the inflammatory response associated with CD by providing the precursors for EC synthesis.

IV. Methods & Study Design

The HF was purchased online from Chi Hemp Industries in Canada. GRF was purchased from Manila Market in San Francisco. APF was provided by the San Francisco State University (SFSU) Miele lab. See procedure in appendix A for original recipe. Three variations of samosa dough were prepared as follows: 100% APF, 50%:50% APF and HF, and 50:50 GRF and APF. A 100% HF dough and a 25%:75% GRF and HF were made, however they proved to be infeasible because they were not pliable enough to form and hold the samosa shape. The filling used in the samosas remained consistent for each product variation. The authors performed objective tests; subjective tests were conducted using a convenience sample of SFSU students and their friends and family. The objective tests performed were a wettability test and a line-spread test. The subjective evaluations were recorded on individual scorecards containing four categories rated on a scale of 1-7, with one being horrible and seven being delicious. To conduct the wettability tests one inch pieces of each dough variation were submerged in ¼ cup of water for five seconds, and their weights were recorded both before and after in grams and the percentage weight change was calculated. To conduct the spreadability test a 1-ounce ball of each type of dough was flattened over a measuring tool using a tortilla press, and the length of spread was recorded in millimeters. Background on these tests are listed below.

Wettability Test

The wettability test is used to measure the moisture of a product. The more water a product initially contains the more water it will attract during submersion. Furthermore, the wettability test provides major implications to understanding a product's water holding capacity, which is the ability of a food product to hold water against gravity (Raikos, Neacsu, Russell, & Duthie 2014). Water holding capacity is also an important characteristic of gelling ability. A gel is a network between denatured molecules cross-linking to form aggregates containing large amounts of water (Batten, 2015). In the case of our product, good water holding capacity and strong gelling ability are ideal, as these characteristics would make for a dough that is pliable and strong enough to be molded into pockets to stuff with filling without breaking or becoming too sticky.

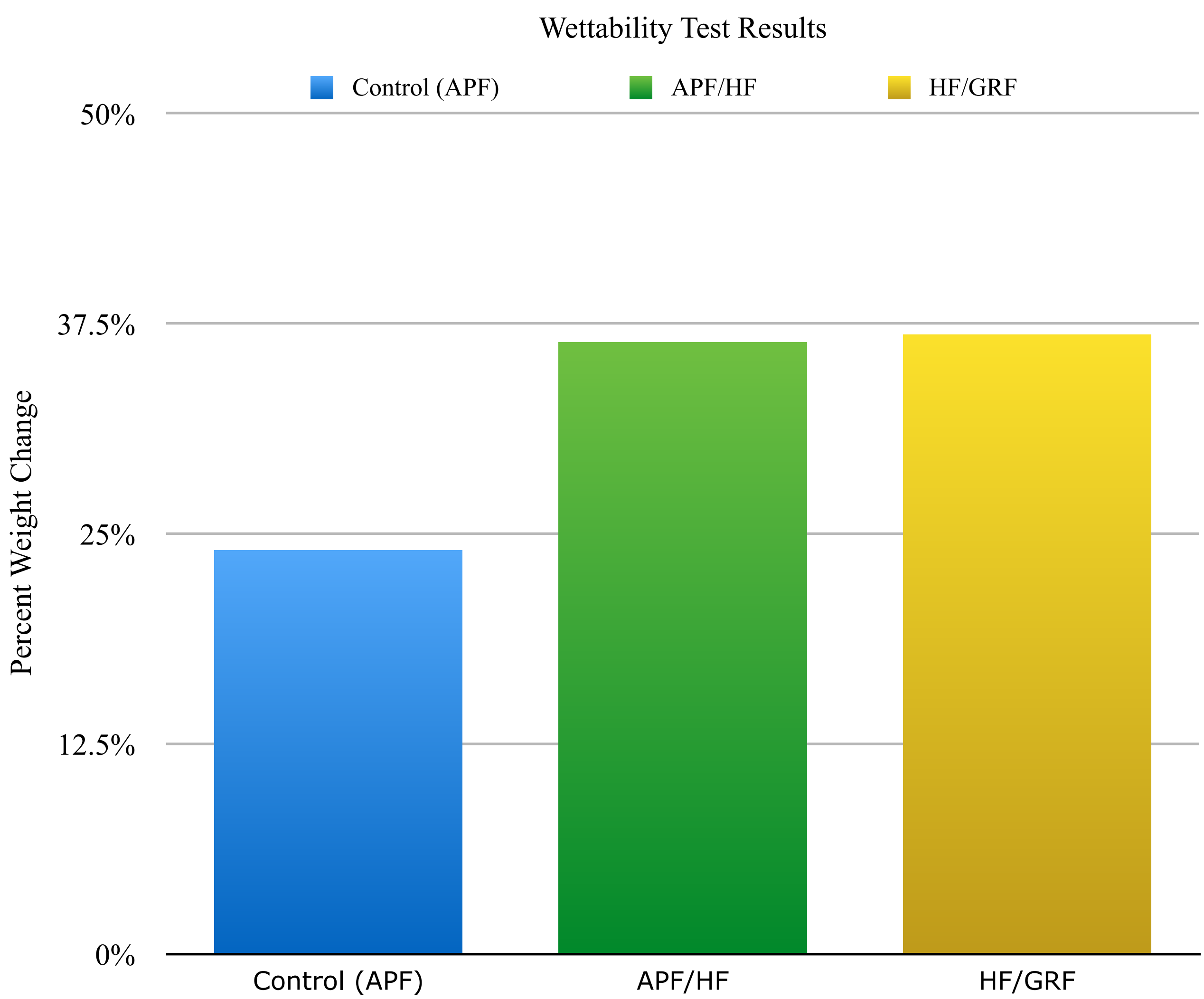
Line-Spread Test

A line-spread test is an objective test used to measure the flow of a viscous liquid or semisolid food. Due to the lack of instruments to conduct other objective tests, we created a modified version of this test as samosa dough is not a viscous liquid and will not spread under normal conditions of a line-spread test. Our modified version was used to determine how well the different types of dough would hold together. Equal amounts of dough were placed on the center of the measuring tool containing concentric rings that is used in the line-spread test. A protector sheet was placed on top of each sample then pressure was applied using a tortilla press. The average results for all 3 doughs are listed in the graph below.

V. Results

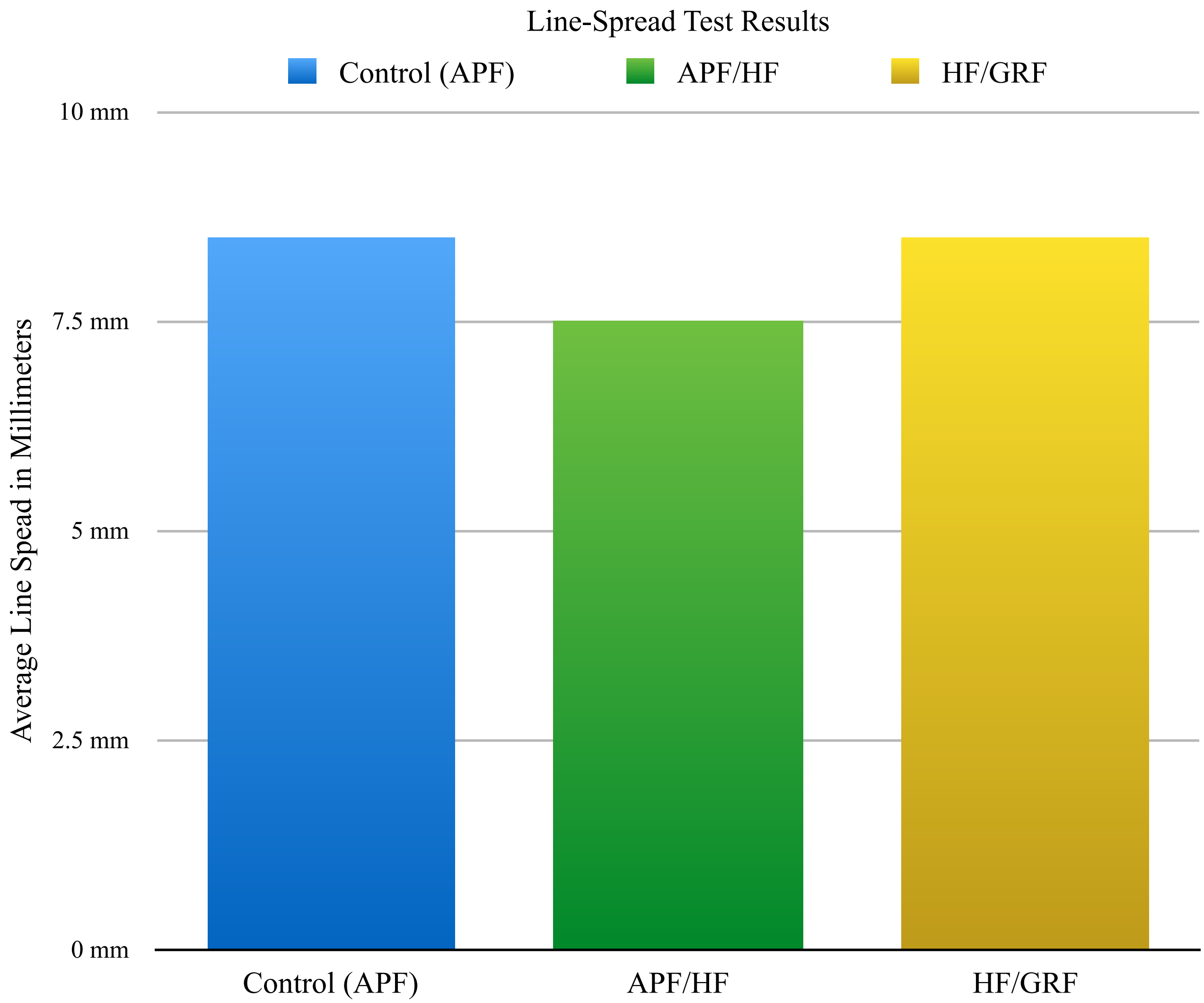
Objective Evaluation

Graph 1: Wettability Results



APF had a weight increase of 24%, the APF/HF an increase of 36.36%, and finally the HF/GRF an increase of 36.84%; the APF attracted the least amount of water, while HF/GRF attracted the most water. The results indicate the cooked HF/GRF dough has the highest moisture content.

Graph 2: Line-Spread Results



The average line spread for APF was 8.5mm, for APF/HF 7.5mm, and finally HF/GRF 8.5mm. The results suggest that the functional properties of HF/GRF will be similar to that of APF.

Subjective Evaluation

Table 1: Scorecard averages (42 total)

Sample Number	Flavor	Texture	Aftertaste	Overall Acceptability
379 (50% HF/ 50% APF)	5.5	5.1	5.2	5.3
614 (APF)	6.2	5.9	6.0	6.2
528 (50% HF/ 50% GRF)	5.5	5.2	5.3	5.4

Although the HF samosas did not receive as high of a score as the APF samosas, the results indicate the gluten-free samosas were still deemed good by the tasters.

VI. Discussion

HF has the highest protein content of all the flours at 25% (Callaway, 2004), effectively placing it at the top of the list for water holding capacity of all the flours used. APF and GRF have protein percentages of 14% and 2% respectively (nutritiondata.self.com, 2015). A study conducted by Raikos et al. (2014) examined the water holding capacity of various flours, including HF and APF. Experiments determined that protein content appears to be a critical factor in the ability of flours to imbibe in water. According to this study, APF's decreased ability to bind to water, in comparison to HF, must be due a relatively low protein content (Raikos et al., 2014).

The difficulty we encountered when attempting to make a dough with 100% HF can be attributed to a combination of having a considerably high water holding capacity with a low gel forming ability. In our experience, the 100% HF dough mixture was very dry, crumbly, and resembled wet sand in both its feel and pliability. We infer that although the HF has the ability to attract a great deal of water, it appears to have an impaired ability to form strong cross links possibly due to intermolecular interactions too weak to overcome repulsive forces (Raikos et al., 2014).

GRF is extremely waxy due to it containing solely amylopectin. A major functional characteristic of amylopectin is its strong gel forming ability (Brady, 2015). Furthermore, carbohydrates decrease the intensity of the thermodynamic affinity that proteins have for water and increase the amount of protein to protein interactions, thereby improving gelling ability (Raikos et al., 2014). Literature was not found denoting the water holding capacity of GRF specifically, however rice flour in general is reported to have a higher water holding capacity than APF (Joshi, Liu, & Sathe, 2015). The wettability results in conjunction with understanding water holding capacity and gelling ability provide implications to better understand how well these flours can imitate the viscoelasticity of the glutenin and gliadin complexes in APF.

VII. Conclusion

The nutrient deficiencies of CD patients could be a result of many factors including inflammation in the small intestine, inadequate nutritional intake, or diarrhea. In most cases, following a strict gluten-free diet can alleviate symptoms of CD. A common issue CD patients face when attempting a gluten-free diet is the diminished flavor and texture of gluten-free foods. Based on subjective tests, our gluten-free samosas were considered good, while delivering beneficial amounts of essential fatty acids, amino acids, dietary fiber, zinc, iron, calcium, and copper.

Another issue that arises when attempting to replace APF in conventional cooking is the functional difference. The results of our objective tests conclude that a 50/50 mixture of HF/GRF is a successful gluten-free substitute for APF. Individual gluten-free flours such as HF and GRF lack the ability to create the same cross linkages that glutenin and gliadin do in gluten-containing flours. As a solution in the commercial production of gluten-free products, hydrocolloids and gums (ex: carrageenan, xanthan, guar) are used to achieve the same structure that gluten would otherwise provide (Mariotti, Lucisano, Pagani, & Ng, 2009). In the absence of using these hydrocolloids and gums, the combined functional properties of GRF and HF appropriately mimic gluten in APF. The high water binding capacity of HF, due to its protein content, very well compliments the gelling ability of GRF, due to its high amylopectin content, thus creating a gluten-free product that is both nutritionally and functionally viable.

References

Bottasso Arias NM, García M, Bondar C, Guzman L, Redondo A, Chopita N, Córsico B, Chirdo FG. Expression Pattern of Fatty Acid Binding Proteins in Celiac Disease Enteropathy. Mediators Inflamm. 2015;2015:738563. doi: 10.1155/2015/738563.

Batten C. (2015). Starch [PowerPoint Slides and Lecture]. San Francisco State University

Battista N, Di Sabatino A, Di Tommaso M, Biancheri P, Rapino C, Giuffrida P, Papadia C, Montana C, Pasini A, Vanoli A, Lanzarotto F, Villanacci V, Corazza GR, Maccarrone M. Altered expression of type-1 and type-2 cannabinoid receptors in celiac disease. PLoS One. 2013 Apr 19;8(4):e62078. doi: 10.1371/journal.pone.0062078.

Bisogno T, Ligresti A, Di Marzo V. The endocannabinoid signalling system: biochemical aspects. Pharmacol Biochem Behav. 2005 Jun;81(2):224-38. doi: 10.1016/j.pbb.2005.01.027.

Brady J. (2013). Carbohydrates. *Introductory Food Chemistry* (p. 457). Ithaca and London: Comstock Publishing Associates

Callaway JC. Hempseed as a nutritional resource: An overview. *Euphytica* 140, 65–72 (2004). https://doi.org/10.1007/s10681-004-4811-6

Friedman A. (2012). Micronutrient deficiencies in pediatric celiac disease. *ICAN: Infant, Child, & Adolescent Nutrition*, *4*(3), 156-167.

George G. (2015). Fatty Acids [Powerpoint Slides and Lecture]. San Francisco State University

Gropper S, Smith J. (2013). *Advanced Nutrition and Human Metabolism*. Belmont, CA: Wadsworth/Cengage Learning.

Idowu A. (2014). Development, nutrient composition and sensory properties of biscuits produced from composite flour of wheat and African yam bean. *British Journal of Applied Science & Technology*, *4*(13), 1925-1933.

Khan MI, Anjum FM, Pasha I, Sameen A, Nadeem M. (2012). Nutritional quality and safety of wheat-soy composite flour chapattis. *British Food Journal*, *114*(2), 239-247.

Joshi AU, Liu C, Sathe SK (2014). Functional properties of select seed flours. LWT-Food Science and Technology, (60), 325-331. doi: 10.1016/j.lwt.2014.08.038

Korus J, Witczak M, Ziobro R, Juszczak L (2009). The impact of resistant starch Characteristics of gluten-free dough and bread. *Food Hydrocolloids, 23(3), 998-995.*

Lauret E, Rodrigo L. Celiac disease and autoimmune-associated conditions. Biomed Res Int. 2013;2013:127589. doi: 10.1155/2013/127589.

Mager D, Qiao J, Turner J. (2012). Vitamin d and k status influences bone mineral density and bone accrual in children and adolescents with celiac disease. *European Journal of Clinical Nutrition*, *66*(4), 488-495.

Mariotti M, Lucisano M, Pagani MA, Ng PKW. (2009). The role of corn starch, amaranth flour, pea isolate, and Psyllium flour on the rheological properties and the ultrastructure of gluten-free doughs. Food Research International, (42), 963-975. doi: 10.1016/j.foodres.2009.04.017

Pacher P, Bátkai S, Kunos G. The endocannabinoid system as an emerging target of pharmacotherapy. Pharmacol Rev. 2006 Sep;58(3):389-462. doi: 10.1124/pr.58.3.2.

Raikos V, Neacsu M, Russell W, Duthie G. Comparative study of the functional properties of lupin, green pea, fava bean, hemp, and buckwheat flours as affected by pH. Food Sci Nutr. 2014 Nov;2(6):802-10. doi: 10.1002/fsn3.143.

Tack GJ, van de Water JM, Bruins MJ, Kooy-Winkelaar EM, van Bergen J, Bonnet P, Vreugdenhil AC, Korponay-Szabo I, Edens L, von Blomberg BM, Schreurs MW, Mulder CJ, Koning F. Consumption of gluten with gluten-degrading enzyme by celiac patients: a pilot-study. World J Gastroenterol. 2013 Sep 21;19(35):5837-47. doi: 10.3748/wjg.v19.i35.5837.

Topal E, Catal F, Acar N, Ermistekin H, Sinanoglu M, Karabiber H, Selimoglu MA. (2015). Vitamin and mineral deficiency in children newly diagnosed with celiac disease. *Turkish Journal of Medical Sciences*, *45*(4), 833-836.

Wierdsma NJ, van Bokhorst-de van der Schueren MA, Berkenpas M, Mulder CJ, van Bodegraven AA. Vitamin and mineral deficiencies are highly prevalent in newly diagnosed celiac disease patients. Nutrients. 2013 Sep 30;5(10):3975-92. doi: 10.3390/nu5103975.

Appendix A: Control Recipe

Samosas

Dough

2 cups AP Flour
1 tbsp Canola Oil
1/8 tsp Baking Powder
1/8 tsp Ground Cardamom
1/4 tsp Salt
+/- 1/2 cup water (to mix everything together)
Mix dry ingredients, then add oil and mix well. Slowly add water until the dough reached desired consistency.

Filling

12 oz Russet Potatoes (mashed and lumpy, not riced)
1 cup Peas (fresh)
4 oz Onion (fine dice)
2 oz Garlic (minced)
2 oz Serrano Peppers (minced, remove seeds)
2 tbsp Cilantro (leaves only, chopped)
2 tbsp Coconut Oil
1 tsp Cayenne Powder
1 tsp Whole Cumin Seeds (toasted)
1 tsp Masala Powder
1 tsp Ground Turmeric
Salt and Ground Black Pepper to taste
Heat oil and add onions, garlic, Serrano pepper, turmeric, and some salt. Once onions have cooked down add the potatoes, cilantro, masala, cayenne, and cumin seeds. Season to taste with salt and ground black pepper. Fold in peas last. Remove from heat and let mixture cool.

Assembly

Roll dough out and form a tube 1-2 inches thick. Cut 1-2 inch length segments and roll them into balls. Flatten them out into 4-5 inch circles with a rolling pin and cut in half. Use a little water to moisten the flat edge and roll into a cone in your palm with the flat opening up and seem facing you. Fill with potato mixture and seal the edges using a little water. Deep fry until golden brown.

Appendix B: Weekly Product Development Documentation

Date: 08/28/2015

Lab Conditions: Classroom, moderate

Purpose: The purpose of this lab was to form a group for the research project, select a population with a specified disease and select a recipe to be modified by one ingredient to meet the dietary needs of the specified population.

Experimental Procedures: Three individuals were selected to form the group for this research project. The members of the group discussed diseases they would be interested in researching. Cardiovascular disease, celiac disease, and diet around these diseases were discussed. The group also discussed potential recipes for modification.

Results: Celiac disease was chosen as the population. After careful consideration of multiple recipes, the group chose potato samosas. The ingredient that will be modified in the recipe is flour, as flour contains gluten and the population cannot consume gluten products of any kind. Further research is needed to determine which type of flour would be a good substitute for the selected population.

Date: 09/04/2015

Lab Conditions: classroom, moderate temp

Purpose: The purpose of this lab was to discuss the variety of flours that could be used as a substitute in a samosa recipe to make the final product safe to consume for people with celiac disease.

Experimental Procedures: During this part of lab our group discussed possible substitutes to replace the all-purpose flour in our samosa recipe. One of our group members was missing this week, so the decision was made between the remaining two members. Careful thought and consideration, such as common nutrient deficiencies of persons with celiac disease, was taken into account when selecting our replacement ingredient to create a gluten-free version of our samosa recipe.

Results: Our group selected hemp flour as the replacement ingredient in our samosa recipe. We chose hemp flour because of its high nutritional value compared to other alternative flours. Further testing will be conducted to determine its ability to bind and reach the desired elasticity to hold together the samosa during the cooking process.

Date: 09/11/2015

Lab Conditions: classroom, moderate temp

Purpose: The purpose of this week's lab was to discuss how our selected ingredient could be beneficial as a substitution in our original recipe. We also briefly discussed subjective tests to use during our product development.

Experimental Procedures: Each member of our group contributed 2-3 peer-reviewed journal articles associated with celiac disease, common nutrient deficiencies in people with celiac disease, and alternative flours not containing gluten. We searched various websites to find the most affordable hemp flour to purchase for our recipe modification.

Results: Our group now has 8 sources to reference for the final paper of the recipe modification project. After reviewing a few of these sources, we concluded that hemp flour would be a good substitute because of its high nutritional value. A grocery list was compiled to begin production and testing of our samosa recipe. Hemp flour was purchased from a company called Chii based in Canada. Possible objective tests for our recipe development are penetrometer test and color test. Further research and discussion of objective testing is needed to determine which tests are best suitable during our product development.

Date: 09/18/2015

Lab Conditions: moderate temp

Purpose: The purpose of this week's lab was to choose 2 objective tests, and begin preparation of the original samosa recipe to determine if it needs adjustments.

Experimental Procedures: 12 samosas were prepared and cooked. Samples of samosas were given to classmates to obtain determine acceptability and get feedback on the flavor. Each group member was involved in the preparation of the ingredients for the original samosa recipe, including the assembly and cooking processes. The samosa recipe is listed below.

<u>Dough</u>
2 cups AP Flour
1 tbsp Canola Oil
1/8 tsp Baking Powder
1/8 tsp Ground Cardamom
1/4 tsp Salt
+/- 1/2 cup water (to mix everything together)
<u>Filling</u>
12 oz Russet Potatoes (mashed and lumpy, not riced)
1 cup Peas (fresh)
4 oz Onion (fine dice)
2 oz Garlic (minced)
2 oz Serrano Peppers (minced, remove seeds)
2 tbsp Cilantro (leaves only, chopped)
2 tbsp Coconut Oil
1 tsp Cayenne Powder
1 tsp Whole Cumin Seeds (toasted)
1 tsp Masala Powder
1 tsp Ground Turmeric
Salt and Ground Black Pepper to taste

Results: Overall, the samosas had good flavor but lacked salt. The filling turned out really spicy, and the ratio of spices/ingredients to potatoes was a little high, so twice the amount of potatoes was added. The recipe will be adjusted to contain ½ the amount of garlic, cilantro, and cayenne; No adjustments will be needed for the potatoes.

After discussion of various objective tests to conduct for the development of our food product, we decided on using pH, penetrometer, and colorimeter tests for objective evaluation. The pH test will be used to measure the pH of the filling, a penetrometer will be used to test firmness/texture of the dough, and colorimeter will be used to test the golden color of the finished product.

Date: 9/25/2015

Lab Conditions: BH 407 Miele Lab

Purpose: To prepare our 100% and 50/50 products.

Experimental Procedures: The normal recipe call for 2 cups APF. So for our 50/50 we used 1 cup of each flour (hemp and APF). For the 100% we used 2 cups hemp flour. This plus the recipe adjustments from last week.

Results:

100%

- Dough is not malleable; it has a texture similar to wet sand, so it's not suitable for stretching and forming into triangle pockets.
- still holds well when deep fried
- Texture: is a bit gritty, but still crunchy.
- Flavor: earthy taste

50/50

- much more malleable
- flavor and texture still the same

Next week: since 50/50 APF and hemp flour is not gluten free, we want to try a product with part hemp flour and part millet flour or some type of gluten-free flour. Also, the frozen filling still tasted good after microwaving.

Date: October 2, 2015

Lab Conditions: BH 407 classroom

Purpose: To look up and compare the amylopectin content of millet flour and glutinous rice flour, so that we can come to a decision for the other gluten-free flour that we will combine with hemp flour.

Experimental Procedures: Using Google scholar and the SFSU database to search for reliable sources.

Results: The lower the amylose content, the higher the amylopectin content. Amylopectin is associated with a sticker texture, resulting in a more pliable dough, which is what we need. So we're looking for a flour with a low amylose content. The amylose content of glutinous rice flour is 2% (C.Batten PPT slides). The values for millet flour were hard to find, but varied from about 12%-17%; but it's safe to infer that it has less amylopectin than glutinous rice flour.

Date: October 9, 2015

Lab Conditions: BH 407 Miele lab

Purpose: To finalize our "100%" product with either millet or glutinous rice flour; we can't actually do 100%, so either 50/50 or 75/25 is the closest we'll get. And to perform a pH test, on the dough to see if there are any changes between raw vs cooked.

Experimental Procedures: 75/25 and 50/50 hemp flour mixture was prepared for both hemp-glutinous rice flour and hemp-millet flour samosa recipes. The samosas were prepared in a similar to the way raviolis are prepared: two sheets were rolled out to about 1/4" thick, the potato filling was placed in the center of the bottom sheet, the covered with the other sheet, and carefully sealed. pH strips were used to test the pH of the dough.

Results: The millet flour creates a very gritty/grainy texture, with a bit of an after taste, and even though it has a little bit of a better nutritional profile than glutinous rice, it's still not as pliable; glutinous rice flour is final choice. 75/25 is manageable, but 50/50 is better for taste, texture, and workability. The pH results were neutral. Next week, will focus on measuring the thickness of dough before/after frying.

Date: 10/23/2015

Lab Conditions: warm/hot temp

Purpose: Prepare a control product for subjective testing. Conduct an objective test on the control dough and 50/50 dough.

Experimental Procedures: Recipes were followed for both the control dough (original recipe) and the 50/50 dough. A spreadability test was conducted on both doughs. Each dough was rolled into a ball then placed in the middle of a spreadability chart lined with plastic. Each ball was then pressed out using a tortilla press. The control samosas were then prepared and submitted for subjective testing. Each tester was asked to evaluate the control samosa, on a scale from 1-7, with 7 being the highest, based on flavor, texture, aftertaste, and overall acceptability. Space was left available for any comments or suggestions.

Results:

Subjective test

comments:

- just the perfect amount of heat
- very flavorful
- delicious, spicy, and savory
- love the spices
- spicy, but also greasy.

average ratings:

Flavor: 105/16= 6.56

texture: 94/16= 5.88

aftertaste: 103/16= 6.44

overall acceptability: 102/16= 6.38

Objective test

Spreadability Test: The 50/50 (hemp/APF) had a larger spreadability than the control (100% APF). This could be possibly that gluten keeps it held tighter together.

For next time: We will try and use bigger pot to fry to fry them all at the same time- so that none will get cold and lose crunchiness early. To keep them all as consistent as possible for the texture.

Date: October 30, 2015

CELIAC FRIENDLY SAMOSAS

Lab Conditions: Miele Lab

Purpose: Prepare 100% product, which for us is 50/50 of hemp flour and glutinous rice flour, and conduct spreadability test using tortilla press and spreadability sheet.

Experimental Procedures: Followed dough portion of the recipe with 1 cup hemp flour and 1 cup glutinous rice flour. The recipe calls for +/- ½ cup water, and over the weeks we've been seeing that more water is needed in the recipes containing hemp flour.

Results:

The line spreadabilty measured ~10mm.

Scorecard averages: 19 responses

Flavor: 5.7

Texture: 5.4

Aftertaste: 5.6

Overall acceptability: 5.4

Comments:

- a bit grainy, love it!
- eaten together it's fine, but just the dough is gritty and has a weird aftertaste
- dry, sticks to mouth
- color is a bit odd but flavor is soo good i don't care
- grainy and earthy aftertaste
- the filling was predominantly spicy, but still so good I would eat the pastry alone!
- bitter aftertaste
- bitter, burnt aftertaste

- awesome texture compared to the control. greasiness is less apparent due to texture
- love how crispy it is and the kick is nice and potent
- i just love it! crispy outside, soft inside, nutty initial flavor, spice on backend

The averages for flavor, aftertaste, and over acceptability fell just a little bit compared to the average for the control, but interestingly enough the average rating for texture showed little difference. Some responses noted a bitter aftertaste, which may be the result of an overcooked samosa. Perhaps these samples were the first batch and the oil temperature was too high. The appearance is probably our main challenge, as far as trying to keep the acceptability and flavor expectations positive; an earth-brown color is generally not as appealing as a golden-brown in the food world. The time and temperature of deep frying today, I think produced our best product yet, meaning that the dough was not too hard/crispy- it had a crunch on the outside and softness on the inside. Our scorecards are finalized, and better than last week as they have a space for additional comments and the sample numbers are more random.

Date: November 6, 2015

Lab Conditions: Miele Lab

Purpose: prepare 50/50 (hemp/APF) product.

Experimental Procedures:

Results:

Samosas: 50/50 Product, 10 responses

Please rate the characteristics of each sample based on a scale of 1-7

(**1**=Horrible, **2**=Poor, **3**=Tolerable, **4**=Neutral, **5**=Good, **6**=Very Good, **7**=Delicious)

Flavor	Texture	Aftertaste	Overall acceptability	Additional comments
5	5	2	4	Slight bitter aftertaste
5	5	3	4	Chewy dough
5	5	3	4	Love the spice
4	3	3	4	The filling is tasty but totally hides the dough which is gritty and tough
5	3	3	4	Slightly too spicy for me personally, the dough was a little too tough. Overall delicious treat though
5	3	4	4	I like the filling and the spice! Dough is a bit tough.
5	4	2	4	Very tough and hard shell
5	3	4	4	Hard shell, but maybe because its cold. Fillin is killin
5	4	5	5	So tasty
5	5	5	5	Crust was very flaky this time
Average: 4.9	**Average: 4**	**Average: 3.4**	**Average: 4.2**	

The dough was thinner and more compact than our 100% (hemp/glutinous rice flour), and ultimately a more tough dough.

Date: November 13, 2015

Lab Conditions: warm/hot conditions

Purpose: The purpose of this lab was to create an action plan for tasting day. We also conducted the rest of our objective tests, which includes spreadability test and wettability test.

Experimental Procedures: We produced all three variations of samosas for a final trial run before tasting day. The control, 50/50 and 100 samosas were prepared according to the recipe and its variation. To conduct wettability test 1" pieces of each dough were submerged in ¼ cup of water for 5 seconds, and their weights were recorded before and after. To conduct spreadability test used 1oz balls of dough and flattened over spreadability sheet using a tortilla press.

Results:

Our samosa products are time consuming. We have decided to prepare the samosa filling the night before to save prep time on tasting day. Our sample plates are numbered and ready to go for plating on tasting day. We will also be preparing a chutney (to be determined later this week) to serve with the samosas on tasting day. We'll also be changing the scorecard scale from 1-7 to 1-5.

Line Spread results:

Dough	**Line spread (mm)**
Control (100% APF)	8
50/50 (Hemp/APF)	9
100% (50/50 hemp/glutinous rf)	7

Wettability Results:

Dough	**Weight before (g)**	**Weight after (g)**	**% Increase**
Control (100% APF)	2.5	3.1	24%
50/50 (Hemp/APF)	1.1	1.5	36.36%
100% (50/50 hemp/glutinous rf)	1.9	2.6	36.84%

Raw Data: line-spread

Dough	Spreadability (mm)
Control (100% APF)	8
	9
	(8.5 avg)
HF/APF	9
	6
	(7.5 avg)
HF/GRF	10
	7
	(8.5 avg)

Date: November 20, 2015

Group writing lab: outline for final paper.

Appendix C: Spreadability results

Raw Data: line-spread

Dough	Spreadability (mm)
Control (100% APF)	8
	9
	(8.5 avg)
HF/APF	9
	6
	(7.5 avg)
HF/GRF	10
	7
	(8.5 avg)

Appendix D: Scorecard results

Handed in to Christine in separate envelope.

Appendix E: Nutrient Analysis: APF

Nutrition information was provided by nutritiondata.self.com.

Nutrient Analysis: All Purpose Flour, 1 cup
Serving Size: 1 cup (125 g)
Ingredients: Enriched, bleached, wheat flour

Per serving:

- Kcals: 455
- Carbohydrates (g) : 95.4
  - Sugar (g) : 0.3
  - Fiber (g) : 3.4
- Protein (g) : 12.9
- Fat (g) : 1.2
  - Saturated (g) : 0.2
  - Monounsaturated (g) : 0.1
  - Polyunsaturated (g) : 0.5

Appendix F: Nutrient Analysis: GRF

Nutrition information was provided by nutritiondata.self.com.

Nutrient Analysis: Glutinous Rice, 1 cup cooked
Serving Size: 1 cup (174 g)
Ingredients: Glutinous Rice

Per serving:

- Kcals: 169
- Carbohydrates (g) : 37
  - Sugar (g) : 0
  - Fiber (g) : 2
- Protein (g) : 4
- Fat (g) : 0.3
  - Saturated (g) : 0.1
  - Monounsaturated (g) : 0.1
  - Polyunsaturated (g) : 0.1

Appendix G: Nutrient Analysis: HF

Nutrition information was provided by Chi Hemp Industries, Canada

Nutrient Analysis: Hemp Flour

Serving Size: 100 g
Ingredients: Hemp Flour

Per serving:

- Kcals: 400
- Carbohydrates (g): 45
    - Sugar (g): 2
    - Fiber (g): 41
- Protein (g): 33
- Fat (g): 9
    - Saturated (g): 1
    - Monounsaturated (g): 1
    - Polyunsaturated (g): 7