

Enhancing whole grain, fiber, and iron content of pancakes: Impacts on quality attributes and adult receptivity

Anna M. R. Hayes^a, Sarah C. Howe^a, Teri L. Burgess-Champoux^a

The 2010 Dietary Guidelines recommend that individuals increase their daily intake of whole grains and fiber, as research has shown these dietary practices help reduce the risk of high blood pressure, coronary heart disease, and diabetes. Iron deficiency is the most common nutrient deficiency in the world, and maintaining appropriate levels of iron is of particular concern for women who are capable of becoming pregnant. The purpose of this study was to develop a pancake product which contained enhanced levels of whole grains, fiber, and iron to address recent health concerns. A baseline pancake recipe was modified with soy milk, sorghum flour, and teff grain in varying ratios and preparation methods to formulate the best combination of all three into one pancake product. Sensory panelists from the Department of Nutrition and Exercise Sciences at St. Catherine University evaluated the baseline and enhanced pancakes for appearance, tenderness, taste, texture, and overall likeability on a hedonic scale of 1 (“very poor”) to 7 (“excellent”). Findings indicated a pancake product can achieve acceptable taste while providing 16 percent of the recommended values for both iron (18 g) and dietary fiber (25 mg) for women of child-bearing years. Further research is needed to develop a nutritionally superior pancake with improved appearance through further manipulation of modified ingredients.

Keywords: Pancakes; Whole grain; Fiber; Iron

Introduction

Previous studies show that the majority of the U.S. population consumes less than the recommended amount of whole grains and dietary fiber on a daily basis and fewer than 5 percent of Americans obtain the average recommended 3 ounce amount of whole grains per day (Centers for Disease Control and Prevention & National Center for Health Statistics, 2012). The 2010 Dietary Guidelines suggest individuals consume at least half of their grains as whole grains and to replace refined grains with whole grains (U.S. Department of Health and Human Services [USDHHS] & U.S. Department of Agriculture [USDA], 2010). Increased intake of whole grains is of immense importance to the adult population, as this practice, along with corresponding higher fiber intakes, has been associated with reduced risk of high blood pressure, coronary heart disease, diabetes, and potentially, some cancers (Jacobs, Meyer, & Solvoll, 2001; Meyer, Kushi, Jacobs, Slavin, Sellers, & Folsom, 2000). Dietary fiber found in whole grains aids in digestion and specifically functions in lowering risks for type 2 diabetes, obesity, high cholesterol levels, cardiovascular disease, and strokes. With the low whole grain and fiber intakes observed among populations in the United States, the need for acceptable whole grain and fiber products is evident. Studies have previously been conducted among school-aged children determining their receptivity to a gradual incorporation of whole grain based foods (Keast, Rosen, Arndt, & Marquart, 2011; Chu et al., 2012; Rosen et al., 2008). However, studies examining such factors among the wider adult population are currently lacking.

Iron deficiency is the most common nutrient deficiency in the world (Hoppe, Brun, Larsson, Moraeus, & Hulthen, 2013). Consumption of iron among women who are of child-

bearing age, including adolescent girls, is of particular concern due to the loss of iron stores through menstruation (USDHHS & USDA, 2010). Iron is crucial for erythrocyte function, tissue growth and development, and hemoglobin formation within the body and when lacking, constitutes iron deficiency anemia (Miller, 2013). Poor mental performance, cold intolerance, fatigue, exercise-related dyspnea, and potential future cognitive problems are all side-effects of iron deficiency anemia. A lack of iron during pregnancy can have devastating effects on both the mother and the child, including reduced fetal brain maturation, future cognitive defects for the child, and maternal depression. Although the most bioavailable form of heme iron is found in animal-based products, absorption of the non-heme form of iron found in many plant-based products can be heightened when accompanied with vitamin C (Rolfes, Pinna, & Whitney, 2012) and can, therefore, significantly contribute to iron stores (Hansen, Bæch, Thomsen, Tetens, & Sandstrom, 2005). Obtaining iron from non-animal sources is important for individuals who may not be able to afford expensive animal products or for those who choose to avoid consuming animal products (USDHHS & USDA, 2010; Miller, 2013).

Breakfast foods have served as a popular avenue for increasing intake of whole grains (Maras, Newby, Bakun, Ferrucci, & Tucker, 2009). Ready-to-eat breakfast cereals, hot cereals, multi-grain bread, and whole wheat bread have been identified as top contributors of whole grains in typical American diets. Past receptivity to whole grain breakfast foods indicates that the general population may be more receptive to a wider variety of other whole grain breakfast foods. Pancakes, relatively common breakfast entrees, serve as a potential vehicle for further increasing whole grain, fiber, and iron consumption, due to their ease in preparation and

a. Department of Nutrition and Exercise Sciences: St. Catherine University; St. Paul; MN; 55105; USA
Contact: hayes100@purdue.edu

inclusion of a simple leavening agent such as baking powder (Case, 2008).

The purpose of this study was to develop a pancake product for the adult population, specifically women capable of becoming pregnant, which incorporated significant amounts of whole grains, fiber, and iron. Although whole grain and multigrain versions of pancakes currently exist, they may not be palatable to the general population, and further testing to optimize recipe formulation could improve their overall taste and texture characteristics. Also, few pancake recipes specifically target iron enhancement.

For this study, a basic pancake recipe was adapted to include sorghum flour, teff grain, and soy milk in order to innovatively enhance the nutritional content with minimal sacrifice of taste. Sorghum flour's light color and mild flavor allow it to be combined with other flours to produce palatable baked products, and sorghum is higher in antioxidants, fiber, and iron than all-purpose flour (Case, 2008; Larson Duyff, 2012; Hager, Wolter, Jacob, Zannini, & Arendt, 2012; Viraktamath, Raghavendra, & Desikachar, 1971). Teff is a nutrient-dense ancient grain that is high in fiber and iron. Flour made from teff has been used in gluten-free baking, substituting for 25 to 50 percent of the total flour blend (Case, 2008; Larson Duyff, 2012). Few recipes, however, have attempted to use teff grain as an additional whole grain component. Since teff grains are very small in size, they were thought to be readily incorporated into a pancake batter without drastically changing the consistency. Soy milk is notably higher in iron than cow's milk (Rolfes, Pinna, & Whitney, 2012). Previous research indicates that dried soy milk can be successfully substituted for dried regular milk in pancake mixes (Cruz, Chang, Hernandez, & Carrasco, 1998). This suggests that soy milk could serve as an acceptable alternative to cow's milk in pancakes.

The main research goal was to investigate the effect of altering the all-purpose flour to sorghum flour ratio, adding teff as an additional whole grain ingredient, and substituting soy milk for 1% milk on the overall taste and sensory evaluation of pancakes among the adult population. Objectives were to develop an acceptable pancake product which was higher in whole grain, fiber, and iron, compared to the baseline recipe; contained over half of its grains as the whole variety and 10 percent of the recommended values for both iron and dietary fiber for women of child-bearing years (1.8 mg and 2.5 g, respectively); was well-received by the target population due to the careful manipulation of the recipe to maintain appropriate tenderness, taste, and overall texture of the pancake; and incorporated the best combination of soy milk, sorghum flour, and teff—ingredients which have successfully been individually incorporated into existing pancake recipes (Case, 2008; Hager, Wolter, Jacob, Zannini, & Arendt, 2012).

Experimental Procedures

Participants and Recruitment

Participants were recruited from the Department of Nutrition and Exercise Sciences at Saint Catherine University via an email recruitment message sent twice during the period of two weeks before the day of data collection. Individuals with any food allergies were excluded from serving on the

panel. Institutional Review Board (IRB) approval was granted for this study through Saint Catherine University.

Research Design

The independent variables in this project were the alterations to the flour-grain and milk content of pancakes. The baseline recipe (Figure 1) was adapted by changing the dry flour component to an experimentally determined mixture of all-purpose flour, sorghum flour, and teff whole grain (Figure 2). The liquid portion was manipulated by substituting soy milk for 1% milk and changing the amount used. The dependent variables were the target group's qualitative sensory evaluation of the baseline and final enhanced pancake products and the pancakes' whole grain, fiber, and iron nutrient contents.

A series of four experimental phases was conducted to determine the optimal incorporation of teff grain, sorghum flour, and soy milk in an enhanced pancake product. After each phase, informal notes about general likeability and receptivity were collected in order to inform changes to be made in the following phases. Once a final enhanced pancake version was developed, sensory panel evaluations of the baseline and final enhanced pancakes were conducted on a final data collection day.

A baseline pancake recipe was identified by an Internet search (Figure 1) (Stewart, n.d.). In each phase, the preparation instructions for the baseline pancake recipe were adhered to, save the following changes: the baseline recipe was modified by substituting the all-purpose flour with a combination of equal volumes of all-purpose flour (1/3 cup, 45.9 g), sorghum flour (1/3 cup, 45.9 g), and teff grain (1/3 cup, 68.2 g), and the milk component was changed from 1% cow's milk to soy milk. Additional manipulations were as follows:

Phase 1: Teff grain left raw and incorporated with dry ingredients

Phase 2: Teff grain soaked in milk for 10 minutes and incorporated with wet ingredients

Phase 3: Teff grain ground in food processor and incorporated with dry ingredients; soy milk reduced to 2/3 original amount

Phase 4: Teff grain cooked and incorporated with wet ingredients; soy milk reduced to 2/3 original amount

Within each phase, a standard electric griddle was used to control temperature (300°F) and total cooking time (~2 minutes per side) for each pancake. The amounts of all ingredients in the recipes were measured using a calibrated balance scale for optimal consistency and precision in methodology.

On the day of the food sensory evaluation, participants completed a consent form and were asked to assess the sensory characteristics of the baseline and final enhanced (phase 4) pancake products according to their personal preference. Participants were given a plate with numbered pre-cut samples of both pancake varieties and asked to rank each on a scale of 1 ("dislike extremely") to 7 ("like extremely") for appearance, odor, texture, tenderness, taste, and overall likeability. Afterward, participants were given the option to complete a similar evaluation with the addition of a self-selected amount of pancake syrup. Water was available for participants to cleanse their palates between samples.

Recipe Development

The baseline pancake used only all-purpose flour as its dry flour component (Figure 1). All-purpose flour, a refined form of the endosperm from wheat, is high in gluten (Rolfes, Pinna, & Whitney, 2012; Case, 2008). The addition of baking powder as a leavening agent allows a gluten-based structure to be filled with air. Because of these interactions, the baseline pancake was a typical fluffy pancake.

To enhance nutritional qualities of the final pancake product, the four experimental phases incorporated both sorghum flour and teff grain in addition to all-purpose flour (Figure 2). This alteration of ingredients dramatically impacted the batter consistency, texture, and sensory characteristics of the experimental pancake. Since sorghum flour is a sweet, mild flour that has been used successfully in pancakes in the past, it is unlikely that major changes in texture between the baseline and enhanced recipes resulted due to its incorporation (Case, 2008; Larson Duyff, 2012). Addition of the teff grain, however, made noticeable changes. Even though teff grain itself has a very small particle size, its incorporation into pancakes produced peculiar results that posed a challenge during the phases of recipe development.

The batter in phase one was extremely runny and thin which was likely due to the reduction in flour, an ingredient that readily absorbs liquids. The resulting pancakes were described as spongy and moist with visible holes uncharacteristic of traditional pancakes. The longer the batter rested before cooking, the fewer holes were observed.

In phase two, attempts were made to reduce the runny consistency of the batter by soaking the teff grain in the milk component prior to mixing the wet and dry ingredients. Numerous bubbles formed in this mixture, presumably the cause for the sponge-like characteristics of the previous product. Soaking the teff resulted in a thicker batter and a product with finer holes; however, the resulting pancakes were still uncharacteristic of a typical pancake.

In an attempt to break down the teff into a unit that was better able to absorb liquid, the teff grain was ground in a food processor during phase three. Due to the small size of the teff grain, this measure was ineffective and no breakdown or change in particle sizes resulted. Therefore, the milk component was decreased during phase three to create a thicker batter. Cooking was more consistent between sides of the pancakes, but the spongy holes were still prominent. The batter did not spread much from where it was poured, resulting in thicker pancakes which resembled a "sausage-like patty."

To overcome the previously observed effects of raw teff grain on structure, in phase four the grain was cooked according to standard package directions (1/3 cup teff in 1 cup

water, brought to a boil, reduced to simmering for 20 minutes or until water was absorbed). Because some liquid was incorporated through this process, the milk component was reduced from 1 cup to $\frac{2}{3}$ cup. The batter was again thicker and resulted in pancakes with smaller diameter. The products maintained more structure and had fewer, smaller holes. The phase four product more closely resembled a traditional pancake and was acceptably moist and fluffy. This product was selected for the sensory panel evaluation.

Statistical Analysis

Data analysis techniques of descriptive statistics, including measures of central tendency and demographics, were used to draw conclusions and interpret the data obtained using IBM SPSS Statistics (SPSS, Version 20.0.0, 2011, IBM, Armonk, New York). T-tests were conducted to determine if there were differences in the mean participant ratings for each sensory characteristic between the baseline and final enhanced pancake products ($P < 0.05$). Food Processor Software (Version 10.11.0, 2012, ESHA Research, Inc, Salem, Oregon) was used to determine nutritional content of both the baseline and enhanced recipe versions.

Results

Sixteen volunteers from the Saint Catherine University Nutrition and Exercise Sciences Department participated in the sensory panel evaluation, the majority of whom were white female students with at least some college education. Ages of participants ranged from 20 to 59 years with a mean age of 28.2 years. All identified themselves as being of non-Hispanic and non-Latino ethnicities.

Descriptive analyses indicated that baseline pancakes weighed an average of 39.6 g, had a mean height of 0.6 mm, and were 11.0 mm in diameter. Final enhanced pancakes weighed an average of 46.9 g, had a mean height of 0.8 mm, and were approximately 9.0 mm in diameter.

Per 120 g serving, the baseline pancakes contained 1.0 g dietary fiber and 1.8 mg iron per serving, while the final enhanced pancakes contained 4.0 g dietary fiber and 2.8 mg iron per serving (Table 1). The final enhanced pancake was more calorically dense and carbohydrate-rich than the baseline pancake, for the final enhanced version contributed 290 kilocalories and 44 g carbohydrate and the baseline contained 240 kilocalories and 36 g carbohydrate (Table 1). The final enhanced pancakes also included 8 percent of the daily recommended value for vitamin A and 30 percent of the daily recommended value for calcium; increases from the amounts in the baseline version by 2 and 5 percent, respectively.

Prep time: 35 minutes
 Total time: 50 minutes
 Yield: Serves 4
 Ingredients:
 1/3 cup all-purpose flour
 1/3 cup sorghum flour
 1/3 cup teff whole grain
 2 tablespoons sugar
 2 teaspoons baking powder
 1/2 teaspoon salt
 2/3 cup soy milk
 2 tablespoons butter, melted
 1 large egg
 1 tablespoon vegetable oil

Directions:
 1. Cook teff grain by combining 1/3 cup teff and 1 cup water in a pot and bringing this mixture to a boil. Reduce heat to low, cover, and simmer 20 minutes or until water is absorbed.
 2. In a small bowl, whisk together flours, sugar, baking powder, and salt; set aside.
 3. Combine milk and cooked teff in a medium-sized bowl; whisk in butter and egg.
 4. Add dry ingredients to wet mixture; whisk until just moistened (do not overmix; a few small lumps are fine). Let sit for 2 minutes.
 5. Heat an electric griddle over medium (300 degrees Fahrenheit). Fold a sheet of paper towel in half and moisten with oil; carefully rub griddle with oiled paper towel.
 6. For each pancake, spoon 1/4 cup of batter onto griddle and monitor closely.
 7. Cook until surface of pancakes have some bubbles and a few have burst, about 2 minutes. Flip carefully with a thin spatula and cook until browned on the underside, about 2 minutes more.
 8. Transfer pancakes to a baking sheet or platter. Continue with more oil and remaining batter. Makes 10 to 13 pancakes. Serve warm.

Figure 1. Baseline Pancake Recipe

Prep time: 35 minutes
 Total time: 50 minutes
 Yield: Serves 4
 Ingredients:
 1/3 cup all-purpose flour
 1/3 cup sorghum flour
 1/3 cup teff whole grain
 2 tablespoons sugar
 2 teaspoons baking powder
 1/2 teaspoon salt
 2/3 cup soy milk
 2 tablespoons butter, melted
 1 large egg
 1 tablespoon vegetable oil

Directions:
 1. Cook teff grain by combining 1/3 cup teff and 1 cup water in a pot and bringing this mixture to a boil. Reduce heat to low, cover, and simmer 20 minutes or until water is absorbed.
 2. In a small bowl, whisk together flours, sugar, baking powder, and salt; set aside.
 3. Combine milk and cooked teff in a medium-sized bowl; whisk in butter and egg.
 4. Add dry ingredients to wet mixture; whisk until just moistened (do not overmix; a few small lumps are fine). Let sit for 2 minutes.
 5. Heat an electric griddle over medium (300 degrees Fahrenheit). Fold a sheet of paper towel in half and moisten with oil; carefully rub griddle with oiled paper towel.
 6. For each pancake, spoon 1/4 cup of batter onto griddle and monitor closely.
 7. Cook until surface of pancakes have some bubbles and a few have burst, about 2 minutes. Flip carefully with a thin spatula and cook until browned on the underside, about 2 minutes more.
 8. Transfer pancakes to a baking sheet or platter. Continue with more oil and remaining batter. Makes 10 to 13 pancakes. Serve warm.

Figure 2. Final Enhanced Pancake Recipe

Table 1. Ingredient list, nutritional content, and cost for baseline and final enhanced pancakes		
	Baseline	Final Enhanced
Ingredient amount per recipe		
All-purpose flour (g)	137.7	45.9
Sorghum flour (g)	None	45.9
Teff whole grain (g)	None	68.2
Sugar (tbsp)	2	2
Baking powder (tsp)	2	2
Salt (tsp)	0.5	0.5
1% milk (g)	245.1	None
Soy milk (g)	None	156.4
Butter, melted (g)	28.5	28.5
Egg (whole)	1	1
Nutrient content per 120 gram serving ^a		
Kilocalories	240	290
Total fat (g)	8	9
Saturated fat (g)	4.5	4.5
Cholesterol (mg)	60	70
Sodium (mg)	580	670
Total carbohydrate (g)	36	44
Dietary fiber (g)	1	4
Sugar (g)	9	9
Protein (g)	7	8
Vitamin A (%)	6	8
Vitamin C (%)	0	0
Calcium (%)	25	30
Iron (%)	10	15
Cost per recipe	\$0.67	\$1.95

^aNutritional information determined using Food Processor Software (Version 10.11.0, 2012, ESHA Research, Inc, Salem, Oregon).

T-test analyses indicated a statistically significant difference in appearance ($P<0.05$) between baseline and final enhanced pancakes served without syrup, with the baseline product having a mean rating of 5.8 and the final enhanced product a mean rating of 3.9 on a scale of 1 to 7 (1="dislike extremely" and 7="like extremely") (Table 2). Such a statistically significant difference in appearance rating was

not found for pancake evaluations with syrup (Table 3). No statistically significant differences resulted for ratings of odor, texture, tenderness, taste, and overall likeability sensory characteristics between pancakes served both without and with pancake syrup (Tables 2 and 3).

Table 2. Characteristics (sensory and acceptability) of baseline and final enhanced pancakes without syrup		
	Baseline	Final Enhanced
Characteristics	\leftarrow mean \pm standard error of mean \rightarrow	
Appearance	5.8 \pm 0.3 ^a	3.9 \pm 0.3 ^a
Odor	5.3 \pm 0.4	4.7 \pm 0.3
Texture	5.5 \pm 0.3	5.2 \pm 0.4
Tenderness	5.6 \pm 0.3	5.6 \pm 0.3
Taste	5.4 \pm 0.4	6.0 \pm 0.2
Overall Likeability	5.5 \pm 0.3	5.5 \pm 0.2

^aIndicates significantly different mean between characteristics ($P<0.05$). Scale for all characteristics: 1=dislike extremely, 2=dislike moderately, 3=dislike slightly, 4=neither like nor dislike, 5=like slightly, 6=like moderately, 7=like extremely.

Table 3. Characteristics (sensory and acceptability) of baseline and final enhanced pancakes with syrup		
	Baseline	Final Enhanced
Characteristics	\leftarrow mean \pm standard error of mean \rightarrow	
Appearance	5.1 \pm 0.5	4.5 \pm 0.4
Odor	4.9 \pm 0.5	5.2 \pm 0.2
Texture	5.7 \pm 0.4	5.5 \pm 0.3
Tenderness	5.0 \pm 0.3	5.6 \pm 0.3
Taste	5.9 \pm 0.3	6.1 \pm 0.3
Overall Likeability	5.6 \pm 0.4	5.7 \pm 0.3

No statistically significantly different means were found between characteristics ($P<0.05$). Scale for all characteristics: 1=dislike extremely, 2=dislike moderately, 3=dislike slightly, 4=neither like nor dislike, 5=like slightly, 6=like moderately, 7=like extremely.

Discussion

The main objectives were to develop an acceptable pancake product that was higher in whole grain, fiber, and iron than the baseline version; contained over half of its grains as the whole variety and 10 percent of the recommended values for both iron and dietary fiber for women of child-bearing years (1.8 mg and 2.5 g, respectively); was well-received by the target population and maintained appropriate tenderness, taste, and overall texture; and incorporated the best combination of soy milk, sorghum flour, and teff. These objectives were met for the most part. However, careful consideration of the results is necessary and further improvements can still be made to enhance the pancake product.

The 1.0 g dietary fiber and 1.8 mg iron amounts per serving of the baseline pancake recipe constituted 10 percent or less of the recommended values for both iron (1.8 mg) and dietary fiber (2.5 g) for women of child-bearing years, readily

providing opportunities to improve the nutritional content of this highly refined traditional breakfast food (Maras, Newby, Bakun, Ferrucci, & Tucker, 2009). The final enhanced recipe exceeded the 10 percent recommendation amounts by contributing 4.0 g dietary fiber and 2.8 mg iron per serving (Table 1). A detailed breakdown of the Food Processor recipe analyses indicated that the addition of teff grain contributed additional iron to the final enhanced recipe (Table 4). This outcome provided a novel suggestion that teff grain can be used as a whole grain substitute for pancakes that additionally serves as a rich source of iron. Although pancakes contain plant sources of non-heme iron with limited bioavailability, absorption of iron from pancake products could be enhanced when accompanied with vitamin C (Rolfes, Pinna, & Whitney, 2012). Future avenues of research could aim to incorporate a vitamin C rich fruit ingredient into pancakes to optimize absorption of non-heme iron.

Table 4. Iron contributions (mg) from pancake ingredients per recipe serving^a

Ingredient	Baseline	Final Enhanced
All-purpose flour	1.53	0.59
Sorghum flour	--	0.54
Teff grain	--	1.13
Sugar	0.00	0.00
Baking powder	0.00	0.00
Salt	0.00	0.00
1% milk	0.02	--
Soy milk	--	0.32
Butter	0.00	0.00
Egg	0.21	0.24
Total	1.77	2.83

^aNutritional information determined using Food Processor Software (Version 10.11.0, 2012, ESHA Research, Inc, Salem, Oregon).

As indicated by the lack of statistically significant differences between ratings of odor, texture, tenderness, taste, and overall likeability among sensory evaluation participants, little-to-no difference was found between pancake varieties and thus the final enhanced pancake was as well-received as a traditional pancake on most sensory levels. In fact, several panelists commented that they preferred the taste of the final enhanced recipe over baseline. Such findings correlate with the existing market for whole grain pancake products, although few scientific studies are currently available to support this assertion (Maras, Newby, Bakun, Ferrucci, & Tucker, 2009).

Despite the overall positive reception of the final enhanced pancake, the statistically significant difference between ratings of appearance of the baseline and final enhanced versions was evidence of the challenges posed by incorporating whole grain products in typically highly refined foods. Often, whole grain ingredients change the color and taste of the final product because they include the entire edible grain (inner germ, endosperm, and bran) instead of only the white starchy endosperm (Rolfes, Pinna, & Whitney, 2012). As indicated in past studies conducted among children, a gradual incorporation of whole grains may be the best approach in decreasing the negative effect of appearance on likeability among children and adults (Keast, Rosen, Arndt, & Marquart, 2011; Chu et al., 2012; Rosen et al., 2008).

Conversely, the darker color characteristic of whole grains may sometimes function in the opposing manner, as more health-conscious individuals may select darker varieties of foods because such a color characteristic is associated with a more wholesome product. In such cases, a drastic change in appearance may actually increase overall receptivity toward whole grain products (Challacombe, Seetharaman, & Duizer, 2011). Further research is required to investigate this phenomenon and how it impacts food choices and preferences, especially those of women of child-bearing age.

The lack of statistically significant differences for all sensory characteristic ratings between pancakes served with pancake syrup signified that whole grain foods served with an additional component could help increase their acceptability and thus overall consumption. However, research investigating the impact of whole grain products served simultaneously with additional components is currently lacking. Furthermore, since pancake syrup is often high in kilocalories and sugar, further considerations of the benefits of such a food component addition is required. The results from this study suggest that negative sensory characteristics of a food product could potentially be masked by the addition of an accompaniment such as syrup.

A notable limitation to this research project was that cost was not considered during recipe development. Teff grain, sorghum flour, and soy milk can all be relatively expensive

ingredients, as indicated by the higher cost per recipe of the final enhanced pancake compared to the baseline pancake (Table 1). Such ingredients may also be considered specialty items which are infrequently found in a typical American household's kitchen cupboard.

The sensory panel evaluations posed several limitations which could have impacted the observed outcomes. The small sample size (n=16) indicated that the study's participant preferences may not adequately reflect those of the general population. Since all panelists were females from the Nutrition and Exercise Sciences Department of an all-women's college, they may have been more receptive to healthier foods due to their educational level and background. Additionally, the taste preferences of this group, with its many similarities in ethnicity, educational level, and general environment, may not readily represent those of the broader population.

The procedure of sensory evaluation could also have impacted the results in several ways. The sensory data collection tool could have inadvertently affected the order in which participants evaluated the pancakes. In an attempt to simplify the testing process for participants, the pages were labeled with the appropriate sample numbers. However, this protocol could also have impacted participants' evaluations, as each probably tasted the final enhanced product first, which could have affected their palate for the following taste evaluations. Additionally, the pancake samples were presented side-by-side, enabling comparison between products even though such evaluations were not intended. A blind taste test sensory evaluation could probably have served as a better alternative for sensory evaluation, as it would have accounted for potential biases that developed from differences in appearance.

Conclusion and Implications for Research and Practice

The final enhanced pancake was higher in whole grain, fiber, and iron than the baseline pancake (Tables 1 and 4). Additionally, the enhanced pancake provided 15.7 percent of the recommended value of iron for women of child-bearing age (2.83 mg) and 16.0 percent of their recommended dietary fiber (4 g). Consumption of this enhanced pancake can help individuals increase their intake of nutrients commonly lacking in the American diet.

Overall, there were minimal differences in sensory ratings between the two pancake varieties. The lack of statistically significant differences suggests a reasonably acceptable pancake product was developed. However, the major drawback was in appearance (Table 2). As one sensory panelist commented, the enhanced pancake's "original appearance turned me away." The addition of syrup may mask this unfavorable attribute, and further investigation is needed to determine if appearance could actually increase overall consumer likeability of whole grain or other nutritionally enhanced products.

This study provided a basis for understanding the amount and correct ratio of whole grain-, fiber-, and iron-containing ingredients incorporated in pancakes to develop an acceptable product. Because of potential health and disease risks, it is important for the majority of the adult population to increase their whole grain and fiber intake (Jacobs, Meyer, & Solvoll, 2001; Meyer, Kushi, Jacobs, Slavin, Sellers, &

Folsom, 2000), and it is especially important for certain adolescent and child-bearing age women to increase their iron intake (Miller, 2013; Rolfes, Pinna, & Whitney, 2012).

Future research is needed to improve or mask the changes in appearance of nutritionally enhanced pancakes. Due to the small sample size and limited demographic variance among sensory panelists, a larger, more inclusive participant group is necessary in order to generalize the results to a wider population. Further opportunities for research and development include exploring how to best preserve nutritionally enhanced pancakes so that the general population is able to readily prepare them while receiving maximum nutritional benefit without loss of product quality or taste. Additionally, sodium levels were high in both pancake varieties, posing a concern when considering recent dietary guidelines to reduce sodium intake, and the iron sources provided were of low bioavailability (USDHHS & USDA, 2010). Limiting sodium content to align with the 2015 Dietary Recommendations or incorporating vitamin C rich fruit to increase iron absorption could also be parameters of interest in future research involving pancake products.

Acknowledgments

Special thanks to the Nutrition and Exercise Sciences Department at St. Catherine University. There were no conflicts of interest in this study.

References

- Case S. (2008). *Gluten-Free Diet: A Comprehensive Resource Guide*. Saskatchewan, Canada: Case Nutrition Consulting, Inc.
- Centers for Disease Control and Prevention [CDC], & National Center for Health Statistics [NCHS]. (2012). *National Health and Nutrition Examination Survey Data*. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Retrieved from <http://www.cdc.gov/nchs/nhanes/>.
- Challacombe, C., Seetharaman, K., & Duizer, L. (2011). Sensory characteristics and consumer acceptance of bread and cracker products made from red or white wheat. *Journal of Food Science*, 76(5), S337-S346. doi:10.1111/j.1750-3841.2011.02200.x
- Chu, Y. L. et al. (2012). Acceptance of two US Department of Agriculture commodity whole-grain products: A school-based study in Texas and Minnesota. *Journal of the American Dietetic Association*, 111(9), 1380-1384. doi: 10.1016/j.jada.2011.06.003
- Cruz, H., Chang, L., Hernandez, L., & Carrasco, M. (1998). Effectiveness of dried soymilk in confectionery products. *Alimentaria*, 292, 55-56. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Hager, A., Wolter, A., Jacob, F., Zannini, E., & Arendt, E. (2012). Nutritional properties and ultra-structure of commercial gluten free flours from different botanical sources compared to wheat flours. *Journal of Cereal Science*, 56(2), 239-247. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Hansen, M., Bæch, S. B., Thomsen, A. D., Tetens, I., & Sandstrom, B. (2005). Long-term intake of iron fortified wholemeal rye bread appears to benefit iron status of young women. *Journal of Cereal Science*, 42, 165-171.

- Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Hoppe, M., Brun, B., Larsson, M. P., Moraes, L., & Hulthen, L. (2013). Heme iron-based dietary intervention for improvement of iron status in young women. *Nutrition*, 29, 89-95. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Jacobs D. R., Meyer, H. E., & Solvoll, K. (2001). Reduced mortality among whole grain bread eaters in men and women in the Norwegian county study. *European Journal of Clinical Nutrition*, 55, 137-143. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Keast, D. R., Rosen, R. A., Arndt, E. A., & Marquart, L. F. (2011). Dietary modeling shows that substitution of whole-grain for refined-grain ingredients of foods commonly consumed by US children and teens can increase intake of whole grains. *Journal of the American Dietetic Association*, 111, 1322-1328. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Larson Duyff, R. (2012). Flour power. *Food & Nutrition Magazine*, 16-19.
- Maras, J., Newby, P., Bakun, P., Ferrucci, L., & Tucker, K. (2009). Whole grain intake: The Baltimore Longitudinal Study of Aging. *Journal of Food Composition & Analysis*, 22(1), 53-58. doi:10.1016/j.jfca.2008.10.005
- Meyer, K. A., Kushi, L. H., Jacobs, D. R., Slavin, J., Sellers, T. A., & Folsom, A. R. (2000). Carbohydrates, dietary fiber, and incident type 2 diabetes in older women. *American Journal of Clinical Nutrition*, 71, 921-930. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA.
- Miller, J. L. (2013). Iron deficiency anemia: A common and curable disease. *Cold Spring Harbor Perspective Medicine*, 3(5), 1-13. doi: 10.1101/cshperspect.a011866.
- Rolfes, S. R., Pinna, K., & Whitney, E. (Eds.). (2012). *Understanding Normal and Clinical Nutrition*. 9th ed. Belmont, CA: Wadsworth, Cengage Learning.
- Rosen, R. A., et al. (2008). Gradual incorporation of whole wheat flour into bread products for elementary school children improves whole grain intake. *Journal of Child Nutrition Management*, 32(2).
- Stewart, M. (n.d.). Basic Pancakes. Martha Stewart Living Omnimedia, Inc. Retrieved from <http://www.marthastewart.com/338185/basic-pancakes>.
- Viraktamath, C., Raghavendra, G., & Desikachar, H. (1971). Use of rice milling machinery for commercial pearling of grain sorghum (jowar) and culinary uses for pearled sorghum products. *Journal of Food Science & Technology (Mysore)*, 8(1), 11-13. Retrieved from FSTA - Food Science and Technology Abstracts, Ipswich, MA. Accessed February 28, 2013.
- U.S. Department of Health and Human Services [USDHHS] & U.S. Department of Agriculture [USDA]. (2010). *Dietary Guidelines for Americans, 2010*. 7th ed, Washington, DC: U.S. Government Printing Office.