Functional Foods: A Comparison of Blueberry Muffin Ingredients

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Keywords: Functional foods, soymilk, flaxseed

Abstract

Functional foods have increasingly gained attention regarding their ability to reduce the onset of chronic diseases, such as cardiovascular disease. The objectives of this study were the following: 1) to evaluate blueberry muffins for protein, lipid, ash, moisture, and carbohydrate content differences when incorporating traditional ingredients compared to soymilk and flaxseed, and 2) to determine through sensory evaluation if untrained panelists could detect a difference among those blueberry muffins. Four muffins were prepared (control, soymilk, flaxseed, and soymilk/flaxseed) using a blueberry muffin mix. Sensory evaluation was performed by 107 untrained panelists among four different muffin batches. Sensory panelists were asked to rate the appearance, blueberry muffin flavor, sweetness, and the overall impression of each product on a 1 to 5 Hedonic scale rating, using 1 for dislike extremely and 5 for like extremely. Statistical analyses were determined using Statistical Package for Social Sciences (SPSS), Analysis of Variance (ANOVA) at $p<0.05$. Quantitative measurements indicated that soymilk muffins had a higher moisture (34.0%) and protein (6.42%) content, flaxseed and soymilk muffins had a higher level of ash (1.65%) and lower lipid content of 10.7%. Sensory evaluation concluded that there was no significant difference for the appearance, blueberry muffin flavor, sweetness, or the overall impression among the four different muffin types. Soymilk muffin was rated highest in appearance (3.87) and blueberry muffin flavor (3.51). Compared to the other muffins types, flaxseed muffins were rated highest in moistness (4.02). This study showed that functional foods can be incorporated into traditional food products with no discernable loss in appearance, flavor, or sweetness and the additional soy protein and minerals may assist in the prevention of the onset of chronic diseases.

Introduction

Cardiovascular diseases (CVDs) are the number one killer of Americans, responsible for approximately one million deaths per year (American Heart Association, 2005). In order to reduce the risk of CVDs, more functional foods should be incorporated into the typical American diet. A functional food is often referred to as any food that exhibits health benefits beyond the common nutrients it contains. Research has shown that functional foods, such as soy protein and flaxseed, help reduce the risk of CVD (Bloedon, 2004) and can easily be included in the diet. For example, flaxseed can be used to replace eggs in baking or cooking, which will add valuable α–linolenic acid (ALA) and soluble fiber that are important to consume since they have been found to reduce total cholesterol levels (Bloedon, 2004).

Recently, flaxseed has shown potential for CVD prevention due to its composition of ALA, soluble fibers, and lignans. These components are believed to protect the cardiovascular system by reducing serum cholesterol, platelet aggregation and inflammatory markers (Bloedon, 2004). Epidemiological data suggest that the consumption of ALA, soluble fiber, and lignans have an inverse correlation with the development of CVD. One controlled study (Jenkins, Kendall, Vidgen, Agarwal, & Rao, 1999) using 29 hypercholesterolemic adults investigated the effect of the dietary intake of wheat and de-fatted flaxseed via the consumption of muffins. After three weeks, the flaxseed muffin intervention group had a significant difference ($p<0.001$) in lowered total cholesterol levels and LDL cholesterol levels as opposed to the wheat muffin control group. This short-term study suggests that fiber and lignan components from the flaxseed incorporated into muffins helped to reduce total cholesterol levels (Bloedon, 2004). However, there was no indication as to the analysis of the protein, fat, or mineral content of the muffins, or mention of preference for the flaxseed muffins compared to traditional muffins commonly made using milk, eggs, or oil.

Soymilk, an additional functional ingredient, is rich in a class of phytochemicals called isoflavones. The most commonly occurring isoflavones in soy, diadzein, genistein, and glycitein have been found to display potent antioxidant effects such as the prevention of LDL oxidation (Murphy & Wilson, 2001). These antioxidant effects of soy are important for maintaining cardiovascular health. Since a primary cause of CVD is the build-up of plaque in arterial walls of the cardiovascular system, and any plaque taken up by the arterial walls due to oxidative damage to LDL cholesterol particles (Murphy & Wilson, 2001) can lead to CVD, it is believed that consumption of soy products may prevent lipid oxidation, which subsequently prevents plaque buildup in arterial walls, hence inhibiting CVD.

Therefore, the objective of this study was to evaluate the protein, fat, moisture, and mineral content of traditional muffins using 2% milk and eggs compared to muffins having functional ingredients, soymilk and flaxseed incorporated, and to determine through sensory evaluation which muffin type is most acceptable.

Materials and Methods

Muffin Preparation

Four different batches of muffins (control = 2% milk, eggs, and oil; soymilk = soymilk, eggs, and oil; flaxseed = 2% milk, flaxseed, and oil; soymilk and flaxseed = soymilk, flaxseed, and oil) were prepared as follows using a purchased blueberry muffin mix (Betty Crocker Wild Blueberry, General Mills, Minneapolis, MN) for sensory evaluation and analytical testing. Control muffins were prepared by combining three-fourths cup of 2% cow's milk (Land-O-Lakes, Franklin Park, IL), one-fourth cup pure canola oil (J. M. Smucker Co., Orrville, OH), and 2 large grade A eggs (Country Creek Farms, Rogers, AZ) with the blueberry muffin mix and dropping one-third cup portions of batter into each paper lined muffin cup. The muffins were baked at 425º F for approximately 16 minutes. The soymilk muffins were prepared by combining three-fourths cup plain Silk soy milk (White Wave Inc., Boulder, CO), one-fourth cup pure canola oil, and two large grade A eggs with the blueberry muffin mix and dropping one-third cup portions of batter into each paper lined muffin cup. The muffins were baked at 425º F for approximately 16 minutes. The flaxseed batch of muffins was prepared by combining three-fourths cup of 2% cow's milk, one-fourth cup pure canola oil, 2 Tbsp. ground flaxseed (Arrowhead Mills, Hereford, TX) and 6 Tbsp. tap water with the blueberry muffin mix and dropping one-third cup portions of batter into each muffin cup. The muffins were baked at 425ºF for approximately 16 minutes. The flaxseed and soy milk batch was prepared by combining three-fourths cup plain Silk soy milk, one-fourth cup pure canola oil, 2 Tbsp. ground flaxseed and 6 Tbsp. tap water with the blueberry muffin mix and dropping one-third cup portions of batter into each muffin cup. The muffins were baked at 425ºF for approximately 16 minutes.

Moisture Content

Each muffin type was analyzed for total moisture content in triplicate according to the AOAC Official Method 931.04. Briefly, the muffin samples were finely ground with a coffee bean grinder to produce a homogeneous mixture for a 3 g muffin sample and were dried in an oven (Lindenburg Blue Mechanical) set at 105ºC for twenty-four hours. Following drying, samples were cooled in a dessicator for one-half hour and the mass taken. Moisture content was determined by a weight difference calculation.

Ash Content

Each muffin type was analyzed for ash content in triplicate according to the AOAC Official Method 923.03 as follows. The mass was recorded for a 3g homogeneous muffin sample. The weighed samples were then placed in conditioned ash crucibles and heated in a furnace (Thermolyne 1300) set at 575ºC for twenty-four hours. The samples were cooled in a dessicator for one hour and the mass dried. Ash content was determined by a weight difference calculation.

Protein Content

Each muffin type was analyzed for protein content in triplicate according to the AOAC Official Method procedure 920.87. Approximately 0.4 g of homogeneous muffin sample mass was recorded and placed in a Kjeldahl flask so that 1.6 g of Kjeldahl digestion tablet (K2SO4 + Se), 5.0 mL of sulfuric acid, and 2 Hengar granules were combined. The flask was then connected to an aspirator, heated to a boil, allowed to digest for approximately one hour, and then allowed to cool to room temperature. Next, 20.0 mL of distilled water was added to each flask. The Kjeldahl digestion flasks were connected to a distillation apparatus and a condenser tube from the distillation apparatus was placed below the surface of 50 mL of boric acid receiving solution. Blue indicator dye was added to the boric acid in the receiver adsorption flask to determine when the solution has been converted to ammonia. A layer of 20 mL of 10 M NaOH was added to the digestion flask without agitation. Two pieces of mossy zinc were added to each digestion flask to prevent bumping during the distillation process, and the contents were swirled gently to mix the two layers. The digestion flask was then connected to the condenser and heated to boiling at a temperature of 140º F until half of the solution was distilled. After the distillation was complete, the received boric acid/ammonia mixture was titrated with standardized 0.05 M HCl. The endpoint occurred when the indicator dye in the boric acid solution turned from blue back to its original color prior to the distillation. Protein calculation content was calculated from the quantified amount of ammonia ions in the receiving solution.

Lipid Content

Each muffin type was analyzed for lipid content in triplicate. An accelerated solvent extractor (ASE 200, Dionex, Sunnyvale, CA) was used to extract total lipids of a 5 g homogenous sample. The pressure during extraction was maintained at 1,500 psi at a temperature of 105ºC. Each muffin sample was placed in an extraction cartridge containing a cellulose filter pad, loaded onto the ASE, and extracted three times with 25 mL of reagent grade petroleum ether with a static duration of 10 minutes. The total extraction was 30 min./sample for 12 samples. The extract (25 mL) was evaporated under a nitrogen flow until no petroleum ether was detected. The vials were placed in a drying oven (100ºC) for 30 minutes to evaporate residual solvent and transferred to a dessicator to cool for 30 minutes. The mass of the remaining lipids in the vials was used to calculate the total lipid content as a mass percentage of the original muffin mass (5 g).

Sensory Evaluation

Voluntary sensory evaluation panelists were asked to taste the four different blueberry muffin samples. Sensory panelists received a tray with each sample coded by a random 3-digit number, a cup of spring water, and a questionnaire. Panelists were given one sample at a time. The order of presenting the samples was randomized so that each sample appeared in a given position an equal number of times. Sensory panelists were asked to rate the appearance, blueberry muffin flavor, sweetness, and overall impression on a 1-5 Hedonic scale rating where 1=dislike extremely and 5=like extremely. Panelists were directed to take a sip of water between each muffin sample so that there was no carry-over taste.

Statistical Analysis

Statistical Analysis of the data was carried out using One-way Analysis of Variance (ANOVA) to determine the acceptability of the type of muffin. A significance level of $p<0.5$ and F value were considered. Statistical analysis was carried out using SPSS.

Results and Discussion

Moisture, Ash, Protein, and Lipid

Table 1 indicates the average percent values for the moisture, ash, protein, and lipid. The highest moisture content was in the soymilk muffin (34.2%), and the lowest was the flaxseed and soymilk muffin (31.6%). The average moisture content was 33.0%. The highest protein was found in the soymilk muffin (6.42%), and the lowest was in the flaxseed muffin (5.92%). The average protein content in the blueberry muffins was 6.12%. The overall ash content for all muffins was 1.62%. The flaxseed and soymilk muffin showed the highest ash content (1.65%) while the control and flaxseed muffins were the lowest (1.60%). The lipid content was highest, (14.4%) for the control muffin and lowest for the flaxseed and soymilk muffin (10.7%).

Table 1

Moisture, ash, protein and lipid (%) content in the four blueberry muffins [a]

Variable	Moisture (%)	Ash (%)	Protein (%)	Lipid (%)
Control	32.9	1.60	6.14	14.4
Soymilk	34.2	1.63	6.42	14.2
Flaxseed	33.4	1.60	5.92	10.8
Soymilk and Flaxseed	31.6	1.65	6.01	10.7
Mean (%)	33.0	1.62	6.12	12.5

Note. n=4; [a=] Results are the mean percent content of moisture, ash, protein, and lipid.

Sensory Ratings

Figure 1 shows the average appearance ratings for each muffin. The panelists rated the soymilk slightly better on appearance (3.87) than the other muffins. The lowest appearance rating was the flaxseed muffin (3.61). The sensory analysis was performed under red lights to mask any color differences and consumers still preferred the appearance of the soymilk muffin compared to other muffins.

Figure 2 indicates the average flavor ratings. A similar pattern was observed, as the soymilk muffin rated significantly higher in flavor

(3.51). People liked the flavor of these muffins more compared to the other muffins. The least liked muffin flavor was flaxseed (3.00). Soymilk muffin has the highest protein content which may have contributed to the desirable muffin flavor.

Figure 3 shows the average muffin sweetness ratings. The rating pattern changed and panelists liked the sweetness of the control muffin (3.67) slightly better than the other muffins. The lowest rated muffin was flaxseed (3.25).

Figure 4 indicates the average ratings on moistness of the muffins. The panelists preferred the moistness of the flaxseed muffin more than the other types of muffins. The average value for the flaxseed moistness attribute was 4.02. The moisture content for the flaxseed muffin was 33.4% and the moisture content for the soymilk muffin was 34.2%, Interestingly, the moisture content of the flaxseed muffin was slightly lower than the soymilk muffin but higher than the average moisture content (33.0%) for the blueberry muffins. There is a correlation between the moisture content and the degree of moistness of the muffin. Higher moisture content indicates that the muffin would be moister. It is postulated that the panelists may have preferred the moderate moistness but did not like muffins that are either too dry or too moist. The control muffin with moisture content of 32.9% was the least rated in terms of moistness (3.38) and was significantly lower ($p<0.05$) than the soymilk muffin.

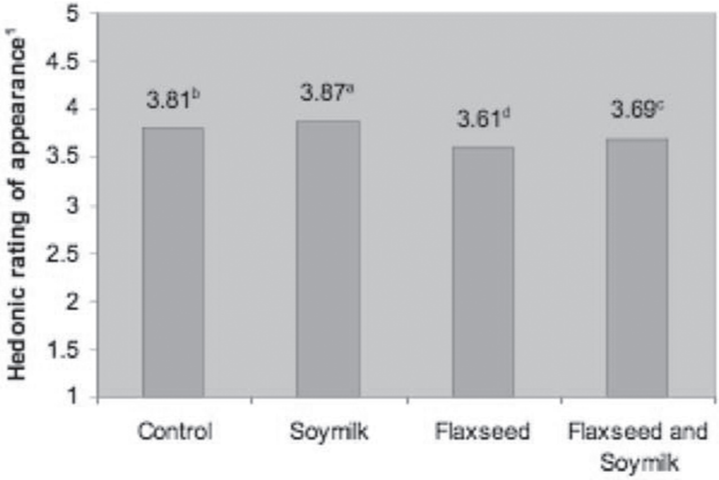

Figure 1. Average appearance rating of each Blueberry muffin

n=107; 1=Values followed by different lower cases letters are significantly different ($p<0.05$) Hedonic rating where 1=Dislike extremely, 5 =Like extremely

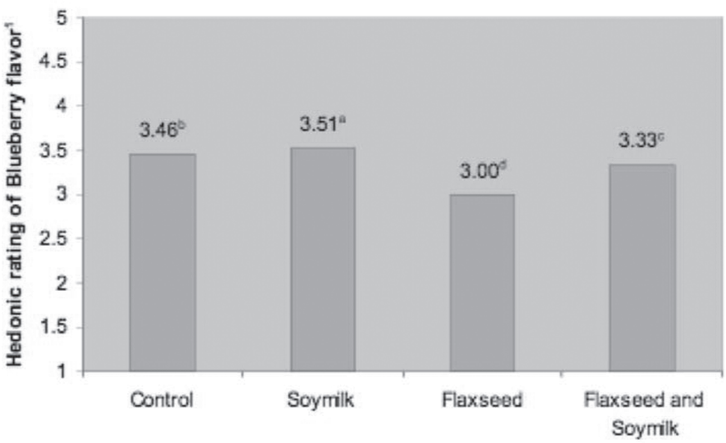

Figure 2. Average flavor rating of each Blueberry muffin

n=107; 1=Values followed by different lower cases letters are significantly different ($p<0.05$) Hedonic rating where 1=Dislike extremely, 5 =Like extremely

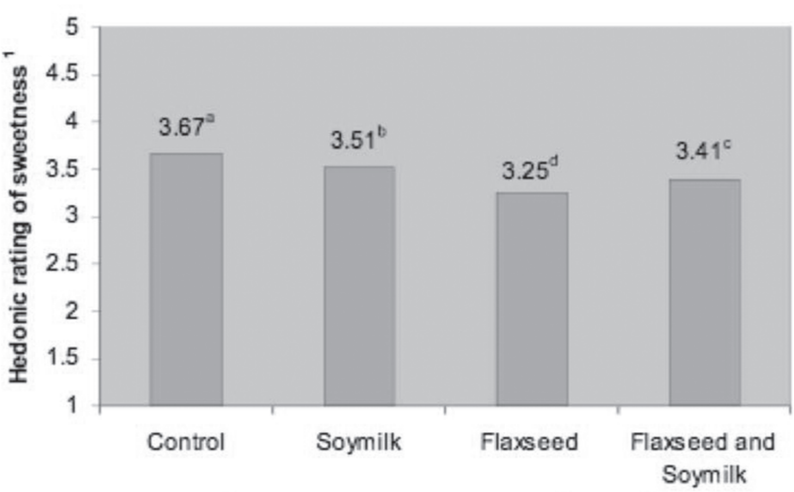

Figure 3. Average sweetness rating of each Blueberry muffin

n=107; 1=Values followed by different lower cases letters are significantly different ($p<0.05$) Hedonic rating where 1=Dislike extremely, 5 =Like extremely

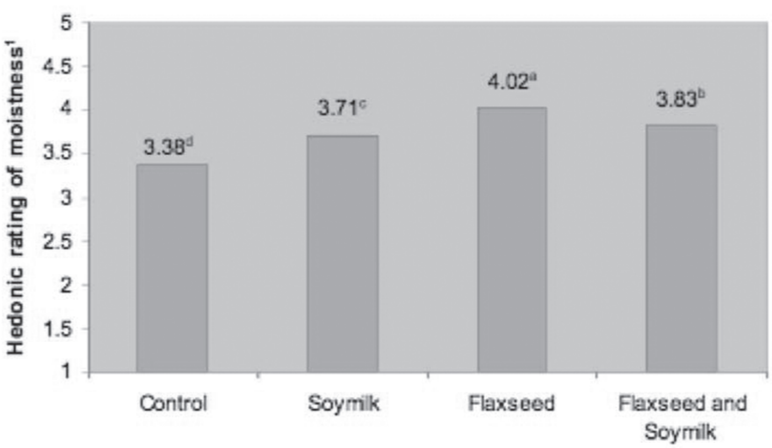

Figure 4. Average moistness rating of each Blueberry muffin

n=107; 1=Values followed by different lower cases letters are significantly different ($p<0.05$) Hedonic rating where 1=Dislike extremely, 5 =Like extremely

Overall Sensory Acceptability

The overall sensory acceptability rating results are summarized in Table 2. Overall there was no significant main effect from the sensory ratings on the four blueberry muffins (p=0.584, F =0.654). Therefore, panelists liked the four different muffins equally in terms of appearance, flavor, sweetness, and moistness.

Table 2

Overall sensory acceptability of the blueberry muffins[a]

Blueberry muffin	Average overall sensory acceptability
Control	3.58
Soymilk	3.65
Flaxseed	3.47
Flaxseed and Soymilk	3.57

n=107; [a=] Results are the mean of the four blueberry muffins overall sensory ratings.
F-value=0.654, p-value =0.585

Conclusion

Much research has been conducted on the health benefits of soy protein and it is suggested that incorporating 25 grams per day of soy protein as part of a low saturated fat and cholesterol diet may reduce the risk of heart disease. In the current study it was found that the soymilk muffin had a higher protein content mostly attributed to the soy protein. It is postulated that more health benefits will be obtained if using this functional food compared to traditional ingredients (eg., whole milk). The moisture content is a strong indicator of the degree of moistness in the muffins. The panelists liked the moistness of the flaxseed muffin, which is a functional food. Therefore, incorporating these ingredients into making muffins can improve the overall sensory attributes. The lipid results showed that soymilk, flaxseed, and flaxseed and soymilk muffins had a lower fat content than the control. In addition to being functional foods, soymilk and flaxseed decreased the fat content of the muffins.

This study demonstrated that functional ingredients can be incorporated into food products with no loss in appearance, flavor, or moistness. The important benefit of soy protein and a lowered lipid content from muffins using soymilk and flaxseed supports further use of incorporating these ingredients into foods.

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