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Mendini, Courtney L. ***Consumer Acceptance of Flavored Oatmeal Prepared with Flaxseed and Chia Seeds***

Abstract

Three natural oatmeal flavors (apple crisp, blueberry peach cobbler and mocha dark chocolate chip) were developed with addition of flaxseed and chia seed. Nutritional content was enhanced (omega 3, fiber and protein) and samples were shelf life stable ($a_w < 0.35$; moisture content < 10%). Focus group (n=6) results revealed that college-aged consumers prefer products with simple packaging and label and are willing to pay $0.50/per oatmeal packet. Sensory assessments of liking (using a 7 point hedonic scale from like extremely to dislike extremely) of flavor attributes, granola mix in flavor, aftertaste, appearance and convenience using 127 consumers (~70% female; ~ 70% 18-23 years old) revealed that samples were liked above the midpoint. A one-way ANOVA of results from a 5 pt hedonic scale revealed that mocha dark chocolate chip ($M = 3.41 \pm 1.08$) and blueberry peach cobbler ($M = 3.29 \pm 1.16$) had significantly greater intent to purchase than apple crisp ($M = 2.92 \pm 1.08$). Overall, the mocha dark chocolate chip received the greatest liking scores for flavor attributes (chocolate, coffee and bitterness), appearance, granola flavor, aftertaste and intent to purchase.

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Chapter I: Introduction

Cereal is considered the number one food choice for at least half of the American population who consume breakfast (Lee, Moskowitz & Lee, 2007). Breakfast consumption has been linked with weight management and weight loss when consumed properly. Due to increasing concerns about obesity, cholesterol levels, celiac disease and cardiovascular disease, many consumers are transitioning to a healthier lifestyle. Breakfast cereals were one of the first "health foods" developed to be a part of a whole grain diet (Clark, 2006). Results obtained from a focus group (Lee & Lee, 2007), reported that consumers expect healthy breakfast cereals (HBC) to contain adequate quantity of fiber, low fat and sugar, and to also contain multigrain ingredients. Lee (2007) also identified that respondents thought that taste was the most important factor in purchasing a HBC, followed by weight control and reducing or preventing the risk of heart disease. Most of these expectations can be met by developing a proper combination of ingredients and micronutrients to an already common HBC known as oatmeal. Oatmeal (1 cup) is an excellent source of fiber (3.98 g), protein (5.94 g), is low in fat (0.73 g), and is reported for its heart healthy benefits as well as promotion of weight loss. Other ingredients such as flaxseeds and chia seeds are also excellent sources of fiber (3.82 g in 2T flaxseed; 11 g in 2T chia seed) and contain essential omega-3 fatty acids (3.19 g in 2T flaxseed; 2.28 g in 2T chia seed) that are important in heart health, digestive health and weight management (Correia, 2009; Dorsey-Kockler, 2011; Kromann & Green, 1980; Lehtinen et al., 2009; Oomah, 2003). Flavor enhancement and additional health benefits to cereal grains can be achieved by the addition of dried fruit and dark chocolate due to their antioxidant activity that helps to lower the risk of many types of cancers and heart disease (Kasote, Hedge & Deshmukh, 2011; Routray & Orsat, 2011; Ryan, Thondre & Henry 2011).

There are two types of grains; whole or refined. The difference between the two is the refining process where the bran and the germ are removed from the grain. The outer covering is referred to as the bran and has a large quantity of fiber while the inner section is the germ has a large quantity carbohydrates and proteins (Lehtinen et al., 2009). White flour is an example of a refined grain and whole wheat flour is an example of a whole grain. Whole grains are much more nutritious than refined, because whole grains still contain the bran and germ. According to the Whole Grains Council, whole grains have been documented with the following healthy components dietary fiber, vitamin E, magnesium, sterols, lignans, polyphenolics and carotenoids (Ohr, 2009). Amaranth, barley, chia seeds, flaxseed, sunflower seeds, hemp seeds, brown rice, quinoa, rye, oats, teff and wheat are all examples of whole grains.

Healthy breakfast cereals are often recognized as "heart healthy", because of their ability to aid in weight loss and their reported ability to lower cholesterol from the large quantities of dietary fiber (Bazzano, Ogden, Loria, & Whelton, 2003; Chen et al., 2004; Djousse & Gaziano, 2007). There are two types of fiber, soluble and insoluble. Soluble fiber slows down digestion by attracting water and forming a gel within the intestine, which makes the consumer feel full longer. It has been observed to lower low-density lipoprotein (LDL or "bad") blood cholesterol by hindering dietary cholesterol's absorption (Othman, 2011). Oatmeal, apples, nuts, flaxseeds, blueberries, cucumbers, and carrots are all sources of soluble fiber. Insoluble fiber is known to have a laxative effect on the body which helps to prevent constipation. This fiber is not digested within the body, but instead passes through the body almost entirely intact. Whole wheat, whole grains, nuts, zucchini, onions, carrots, seeds, grapes and root vegetable skins are sources of insoluble fiber. According to the Dietary Guidelines for Americans (2010), it is recommended that women under 50 years' old and teenage girls consume about 25 grams of fiber and for men

under 50 and teenage boys to consume about 30-38 grams of dietary fiber daily. In addition, it is also recommended that omega-3 fatty acids be consumed at levels of 1.1 grams per day for women and 1.6 grams per day for men (Institute of Medicine, 2005).

Omega-3 fatty acids are essential fatty acids that are required in the diet for the body to function properly and cannot be made by the body. Common sources of omega-3 fatty acids are chia seeds, flaxseeds, olive oil, algae oil, fish oil, anchovies, bluefish, herring and salmon. Since most of the Western population does not consume enough fish each week, most of the omega-3 fatty acids will often be obtained from seeds, nuts and oils. Plant-sourced omega-3 fatty acids are in the form of alpha linoleic acid (ALA) and marine-sourced omegao-3 fatty acids are in the form of eicosapentaenoic acid/docosahexaenoic acid (EPA/DHA). Non-fish sources can easily be added to ready to cook (RTC) breakfast foods to directly boost the amount of ALA and indirectly boost the amount of EPA/DHA. ALA, designated as 18:3, can be converted to EPA/DHA (20:5/22:6) with an estimated rate of 0.2-15% (Kris-Ehterton, 2002; Tweed, 2012). It is very vital to incorporate EPA/DHA in the diet because of the many health benefits since numerous studies have shown these essential fatty acids aid in cardiovascular health due to their anti-inflammatory effects (Dorsey-Kockler, 2011).

Additional healthy ingredients, fruit and dark chocolate, are often added to breakfast foods because of their antioxidant activity. Antioxidants are important in the diet because they prevent oxidative damage within the body that can cause cancer, heart disease and aging (Kasote, Hedge & Deshmukh, 2011; Routray & Orsat, 2011; Ryan, Thondre & Henry, 2011). Oxidizing agents enter the body through air, food, water, smoke, pollution and normal every day activities and produce highly unstable compounds called free radicals. Free radicals, compounds with unpaired electrons harm the body by damaging DNA strands through base mutation, single and

double stand breakages, DNA cross-linking, and chromosomal breakage and rearrangement (Lui, 2003). Damage to the DNA can cause cancer, various diseases, and tumors. Oxidizing agents and their subsequent oxidative stress is unavoidable, but the damage can be minimized by the addition of antioxidants to the diet.

Consuming whole grains, fiber, omega-3, and antioxidants daily will help prevent many types of diseases, cancers, tumors, and aging (Correia, 2009; Dorsey-Kockler, 2011; Kasote, Hedge & Deshmukh, 2011; Kromann & Green, 1980; Lehtinen et al., 2009; Oomah, 2003; Routray & Orsat, 2011; Ryan, Thondre & Henry, 2011). This study will be incorporating these nutrients into an oatmeal breakfast cereal by developing new flavors containing oats, flaxseed, chia seeds, and antioxidants (from blueberries and dark chocolate). The new oatmeal flavors under evaluation are apple crisp, blueberry peach cobbler and mocha dark chocolate chip based on initial consumer feedback during sensory evaluation.

Statement of the Problem

In an ideal world, all food products would be nutritionally beneficial, contain acceptable flavor, texture and appearance, and would not contain any unwanted ingredients. But this is not the case; there is a wide variety of food choices that are available to consumers. There is food from fast food restaurants to fine dining restaurants, from wild game in the woods to the frozen section in the grocery store, and from crops on a farm to packaged food in a kitchen pantry. As food products became more convenient, low in cost, and more accessible (e.g. extended shelf-life, heating, and drying) many essential nutrients are lost through processing including omega 3 fatty acids. Omega 3 fatty acids have been greatly reduced because of the increase in processed foods, grain-fattened livestock and hydrogenated vegetable fats (Simopoulos, 1999). When omega 3 fatty acids, an essential nutrient, are not consumed within the diet, the body may not

function properly and there may be an increased risk of many life threatening diseases. Epidemiological studies (Kromann & Green, 1980) have shown that a high intake of omega 3 fatty acids supports the treatment and prevention of cardiovascular disease. Omega 3 fatty acids have also been shown to enhance brain health and function (Correia, 2009).

Developing healthier food products that contain omega 3 fatty acids may improve public health and lower the risk of heart disease. For this study, oatmeal, one of the world's leading heart healthy foods, will be further enriched with the addition of omega 3 fatty acids found in flaxseed and chia seed. Three distinctive flavors (apple crisp, blueberry peach cobbler and mocha dark chocolate chip) were developed with natural flavorings and evaluated for consumer acceptance. Qualitative data were collected by conducting a focus group with consumers who frequently consume oatmeal, flaxseed and/or chia seed. Two sensory evaluations were conducted to gather quantitate data on the flavor, texture, appearance, aftertaste and the intent of purchasing these products.

Objectives of the Study

The main objective of this study was determine consumer acceptability of the new oatmeal flavors prepared with flaxseed and chia seed and the potential of placement on the market. Specific sub-objectives were to:

1. Develop three oatmeal flavors (apple crisp, blueberry peach cobbler and mocha dark chocolate chip) containing flaxseed and chia seeds with three corresponding granola mix-in flavors (cinnamon, vanilla and mocha dark chocolate).
2. Determine safety and shelf life of the product by measuring the moisture content and water activity.

3. Conduct a focus group to obtain consumer input on the new oatmeal concept, new oatmeal products and to optimize the sensory score-sheet.
4. Conduct sensory analysis to obtain consumer acceptance of the new oatmeal products.

Assumptions and Limitations

An assumption for this study is that the untrained sensory panelists will be able to understand the process and the questions involved with the sensory analysis. Directions and questions must be clearly written so untrained panelists will be able to follow and answer truthfully. A limitation to the study is that majority of the panelists will be college aged (18-26 years old) and may not consume oatmeal regularly or consume no oatmeal. A large sample size increases the precision of the collected data. Another limitation is that the collected data will only represent the University of Wisconsin Stout population and may not accurately represent the general population's acceptability of the new oatmeal flavors. All age groups will not be represented. Using untrained panelists for measuring data is a limitation in itself. Panelists vary individually and with other panelists. Food previously consumed throughout the day may also add variation to the data collected from the panelists.

Purpose

The purpose of this study was to evaluate consumer acceptance of three newly developed oatmeal flavors containing flaxseed and chia seeds. The developed oatmeal flavors are apple crisp, blueberry peach cobbler and mocha dark chocolate chip and corresponding granola mix in flavors cinnamon, vanilla and mocha dark chocolate. The flavor development, focus group, and a sensory analysis were all conducted at the University of Wisconsin Stout in Heritage Hall during 2012 fall semester and 2013 spring semester. Focus group and sensory panelist consisted of

students, faculty and staff on the UW-Stout campus. The data collected determined if the products were ready to be placed on the market or if further development was necessary.

Definition of terms

The following terms have been defined for the purpose of this research paper to help the reader fully understand the information.

Antioxidant. According to Merriam-Webster (2013), an antioxidant is a substance that inhibits oxidation or reactions promoted by oxygen, peroxides, or free radicals.

Apoptosis. According to Merriam-Webster (2013), apoptosis is a genetically directed process of cell self-destruction that is marked by the fragmentation of nuclear DNA, is activated either by the presence of a stimulus or removal of a suppressing agent or stimulus, and is a normal physiological process eliminating DNA-damaged, superfluous, or unwanted cells — called also *programmed cell death.*

Auto-oxidation. According to Ward (2007), auto-oxidation is a complex chain reaction that starts when lipids are exposed to oxygen.

Beta-glucan (β-glucan). According to Merriam-Webster (2013), β-glucan is any of several polysaccharides consisting of glucose units and including one found in endosperm cell walls of cereal grains (as barley and oats).

Free radical. According to Ward (2007), a free radical is an atom or compound that has lost one or more electrons, causing it to become very unstable and likely to quickly react with other substances to form more stable compounds.

Focus group. According to Murano (2003), a focus group is an interactive panel composed of about 10 consumers plus a trained moderator to obtain detailed attitudes regarding the concept of a proposed new product.

Low-density lipoproteins (LDL). According to Ward (2007), low-density lipoproteins are clusters of lipid and protein molecules that transport cholesterol from the liver throughout the body.

Milling. According to Ward (2007), milling is the process of moving kernels of grain between a series of rollers to grind the grain into fine particles.

Omega-3 fatty acid. According to Ward (2007), omega-3 fatty acid is a polyunsaturated fatty acid that has a double bond between the third and fourth carbon from the end with the methyl group (CH_3).

Oxidation. According to Ward (2007), oxidation is the reversible chemical reaction that adds oxygen to a compound.

Rancidity. According to Ward (2007), rancidity is a form of food spoilage that occurs when the addition of oxygen causes the formation of new compounds, which have an unpleasant flavor.

Sensory evaluation (analysis). According to Murano (2003), a sensory evaluation is the assessment of all the qualities of a food item perceived by the human senses (taste, smell, sound, feel and appearance).

Shelf life. According to Ward (2007), shelf life is the time a food can be stored and still be safe to eat.

Water activity. According to Ward (2007), water activity is the measure of the partial water pressure over a food as compared to the vapor pressure (gaseous water) over pure water at a given temperature.

Chapter II: Literature Review

The selected combination of ingredients developed for a naturally flavored oatmeal breakfast cereal will not only contain acceptable flavor attributes but also be an adequate source of nutrients. The addition of both flaxseed and chia seed enhances the omega-3 fatty acid, protein, and fiber content within this oatmeal product. Various studies (Correia, 2009; Dorsey-Kockler, 2011; Kromann & Green, 1980; Lehtinen et al., 2009; Oomah, 2003) have shown that these nutrients could aid in the prevention of cardiovascular disease, boost brain health and function, improve digestive health and help weight management. Therefore, the addition of dried fruit and dark chocolate ingredients would enhance the antioxidant content. Antioxidants have been observed to prevent and lower the risk of many types of cancer by inhibiting oxidative damage caused by free radicals (Kasote, Hedge & Deshmukh, 2011; Routray & Orsat, 2011). Previous consumer acceptance studies (Aliani, Ryland, & Pierce, 2012; Rendón-Villalobos, Ortíz-Sánchez, Solorza-Feria, & Trujillo-Hernández, 2012) on products containing flaxseed or chia seed have shown that acceptable products can be developed. However, no consumer acceptance studies have yet been conducted on a breakfast product, containing both flaxseed and chia seed.

Oatmeal

History and description. The majority of ready to cook (RTC) breakfast foods contain large quantities of whole grains; such as wheat products and oat products. Oats are generally consumed as whole grain or bran-enriched products while wheat is mainly consumed as refined flour (Lehtinen et al., 2009). When grains are refined the bulk of the nutrients are stripped off; fiber being one of them. Oats, also known as *Avena sativa*, have been cultivated for over two thousand years and originated in Europe where they were used for medicinal purposes (Butt,

Tahir-Nadeem, Khan, Shabir, & Butt, 2008). In the 19th century oats began to replace many breakfast cereals and today are consumed regularly for their nutritional content and their heart healthy benefits (Duss & Nyberg, 2004).

Once such product derived from oats, oatmeal has grown in consumption 5 % annually since 1997 (Bittner, Burkholder, & McDaniel, 2011), and in 2012 the World's population consumed over 21,660 thousand metric tons of oats (USDA, 2013). The three most common types of oats are steel cut, old fashion rolled oats and quick rolled oats. Raw oats are harvested as kernels, or groats, and must be processed before human consumption. These kernels are separated, cleaned and their hulls are removed (Butt et al., 2008). Steel cut oats are made by cutting kernels into two or three thick pieces. They are very dense and can take over 30 minutes to cook. Rolled oats are made from thinner slices of kernels that are steamed and then rolled into flakes. Quick rolled oats have thinner flakes and take less time to cook compared with old fashion rolled oats. Quick oats are often used in prepackaged oatmeal, also known as instant oatmeal, and are very popular with consumers. This popularity of instant oatmeal may be due to the quick preparation by the addition of boiling water or by using a microwave for less than 5 minutes. Prepackaged oatmeal allows consumers to enjoy a convenient, warm, nutritious and tasty breakfast cereal.

Nutrient composition and health significance. Oatmeal has been approved as a heart healthy food by the US Food and Drug Administration (FDA) because of its bulky fiber content and low saturated fat content. One cup of oats contains 3.98 g of dietary fiber (15.92% DV), 5.94 g of proteins (11.88% DV) and 0.73 g of saturated fats (3.65% DV). Oats are also a very good source of manganese, selenium, magnesium, zinc and phosphorous. These are essential minerals that are needed for the body to function properly. Oats are also considered to be a part of the

gluten-free diet, because only a small amount of gluten may be present and is tolerable by many adults and children with celiac disease (Lehtinen et al., 2009).

Oatmeal, being a whole grain cereal, contains many of the nutrients that are beneficial to the heart. A 19.6 yearlong study (Djousse & Gaziano, 2007) determined that the consumption of whole grain cereal lowers the risk of heart failure. Another study (Bazzano, Ogden, Loria, & Whelton, 2003) showed that eating 21 g of fiber per day lowered the risk coronary heart disease and cardiovascular disease by 12% and 11%, respectively, when compared to consuming only 5 g of fiber per day. Oats contain a specialized type of fiber called beta-glucan that assists in a heart healthy claim. Fiber also lowers cholesterol levels by interacting and removing LDL cholesterol from the digestive system (Othman, 2011). Another compound linked with cholesterol is avenanthramide. This unique antioxidant compound is only found in oats and protects cholesterol by preventing free radical damage to LDL cholesterol (Chen et al., 2004). Oats contain a significant amount of other compounds with antioxidant activity such as vitamin E. Antioxidants protect the body from free radicals that are known to cause several types of diseases, cancers and aging (Ryan, Thondre & Henry, 2011).

Flaxseed

History and description. Flax, *Linum usitatissimum,* in Latin means "fabric of greatest use". Flaxseed was first cultivated to make fabric products such as sailing ships, bowstrings and clothing in the Mediterranean Sea and Middle Eastern regions (World's Healthiest Foods, n.d.). Today, Europe, France and Belgium are the largest producers of flaxseed. Soil with large proportions of organic matter is more favorable for the growth of flaxseed than heavy clay, gravelly or dry sandy soils.

Flaxseed is described as having a nutty flavor, crunchy texture, flat and oval shape, and a smooth and shiny appearance. Flaxseed is 3-6 mm in length and 2-3.5 mm in diameter (Tarpila, Weenberg & Tarpila, 2005). Flaxseed can be ingested as oil, whole or ground. The most common types of flaxseed are golden and brown. The color of seed will determine the color of the oil.

Flaxseed is commonly used within baked products, and grinding the flaxseed allows it to an ingredient substitution for fat, flour and even eggs. For example, three tablespoons of ground flaxseed can replace one tablespoon of oil (Sidhe, 2011). With this replacement the amount of liquid within the recipe must be increased by 75%. As a flour substitute, the amount of flour in the original recipe must be reduced by ½ to ¾ cup and amount of flour will be replaced with an equal amount of flaxseed flour. One tablespoon of ground flaxseed and three tablespoons of water will replace 1 egg within a baked good recipe (Sidhe, 2011).

Nutrient composition and health significance. Flaxseed contains a large amount of proteins, fiber, polyunsaturated fatty acids and antioxidants. In two tablespoons of flaxseed there are 2.56 g of protein (5.12% DV). The USDA (2012) recommends that women should consume 5-5.5 oz equivalents and men should consume 6-6.5 oz equivalents of protein a day. One tablespoon of flaxseed contains as much magnesium as one small banana (22.77 mg; 7% DV). Folate, thiamin, niacin, vitamin B-6, potassium, vitamin C, phosphorus and calcium are also found within flaxseed. There is 3.82 g of fiber (15.28% DV) within two tablespoons of flaxseed of which two-thirds is soluble fiber and the other one-third is insoluble fiber. The USDA (2012) recommends women under 50 years old to consume 25 grams of fiber and men less than 50 years old to consume 30-38 grams of fiber daily. Essential oils found within flaxseed are alpha-linolenic acid (ALA) and linoleic acid (LA) also known as omega-3 and omega-6 fatty acids,

respectively. It is noted that within two tablespoons of flaxseed there are 3.19 g ALA and 0.83 g LA. There is a significantly larger amount of these fatty acids within flaxseed oil than in soy, sunflower, rapeseed and olive oil (Tarpila, Weenberg & Tarpila, 2005). The most common antioxidants found within flaxseed are flavonoids, tocopherols (vitamin E), isoflavones such as genistein and daidzein.

Another group of antioxidants found in flaxseed are phytoestrogen compounds; such as matairesinol (MATA) and secoisolariciresionol (SECO). These Phytoestrogen compounds have very similar structure to estrogen and have been noted to interact with estrogen receptors within the body which have been reported to improve serum lipid profiles, influence hormone metabolism, increase estrogen metabolism and exhibit chemo-preventive effects (Oomah, 2003). A clinical study on 25 prostate cancer patients, where patients were given 30 g/day of flaxseed for 34 days, reported a significant decreased ($p<0.05$) in total serum cholesterol (201 ± 39 mg/dL to 174 ± 42 mg/dL) and total testosterone (422 ± 122 ng/dL to 360 ± 128 ng/dL) levels (Demark-Wahnefried et al, 2001). It was also reported that the apoptosis rate within tumor cells was significantly ($p<0.01$) greater in patients consuming flaxseed compared to patients who did not consume any flaxseed.

Austria et al. (2008) conducted a double blind, randomized study to compare the bioavailability of ALA using muffins containing three different forms of flaxseed; 30 g whole, 30 g ground and 6 g ALA flaxseed oil. Three flavors of muffins were used to aid in the consumption by the subjects; raisin-spice, vanilla and cranberry-orange. Thirty healthy male and female subjects ages 18 to 49 were divided into three equal groups. Each treatment group ate either two small or one large muffin per day for 12 weeks.

Gas chromatography was used to determine confirm fatty acid levels in the baked muffins. Based on industry research and literature, the expected value of ALA within 30 g of flaxseed was approximately 6 g ALA (Austria et al., 2008). However, whole flaxseed was significantly lower ($p<0.05$) than expected, containing only 4.29 g of ALA. These results showed that there was an incomplete extraction of lipids from the whole seed (Austria et al., 2008). There was no significance change in milled flaxseed (6.50 g ALA) and oil extract (5.74 g ALA) when compared with the expected amount of ALA.

Blood samples of subjects were taken at week 0, 4 and 12 and it was noted that no significant change was observed in whole flaxseed samples. A three-fold increase ($p<0.05$) of ALA was observed at week 4 in subjects who consumed ground flaxseed sample (M=0.029, SD=0.004). A five-fold increase ($p<0.05$) of ALA was observed at week 4 in subjects who consumed flaxseed oil sample (M = 0.050, SD=0.008). No significant difference was observed in the cholesterol level, triglycerides level and platelet aggregation (Austria et al., 2008). Side-effects were self-reported by the subject on a scale 0 to 4 (0=*none*, 1=*mild*, 2=*moderate*, 3=*severe*, 4=*hospitalization*) and it was found that subjects consuming the whole flaxseed sample reported moderate pain that did not decrease as the study progressed; 3 subjects withdrew during 5-8 week period. Subjects consuming the ground flaxseed sample reported mild gastrointestinal pain that decreased with time. Subjects consuming the flaxseed oil muffin had moderate pain that did decrease as the study progressed; 2 subjects withdrew (one from influenza).

Austria et al. (2008) concluded that baking does not affect the amount of polyunsaturated fatty acids within flaxseed. The gastrointestinal discomfort observed by subjects could be caused by the sudden increase of fiber from the flaxseed. A gradual increase could have assisted with

alleviating some of the pain. It was concluded that flaxseed oil has the greatest amount of ALA delivery with a five-fold increase of ALA, ground flaxseed had a three-fold increase of ALA after week 4, and whole flaxseed had no observed increase of ALA. Although oil had the greatest ALA delivery, ground flaxseed was recommended over oil because oil has a very short shelf life (<30 days) due to the large levels of polyunsaturated fatty acids.

Sensory acceptance. A study conducted by Aliani, Ryland & Pierce (2012), analyzed the flavor profiles and acceptability of bagels prepared with flaxseed. Three flavors of bagels, plain, sunflower-sesame and cinnamon-raisin were prepared with 30 grams of ground flaxseed. Color was added to the non-flaxseed containing samples to allow for consistency in appearance. Nine trained panelists participated in a descriptive analysis to create a list of all the aroma and flavor attributes present in the bagel samples. A consumer test of 89 participants, 70% female, was conducted using a 9-point hedonic scale of the 6 bagel samples. The results showed that the samples containing flaxseed had a significantly (p<0.05) greater grain/flax aroma (M = 5.0) and grain/flax flavor (M = 5.5) compared to non-flaxseed samples (M = 1.5 and M = 1.2, respectively). The sunflower-sesame had the largest intensity rating for grain/flax aroma (M= 4.0) and grain/flax flavor (M = 3.9) followed by plain bagel (M = 3.9 and M = 3.8, respectively) and cinnamon-raisin (M = 1.8 and M = 2.4, respectively). The flaxseed samples also had a significantly greater bitterness (M = 2.1) and significantly lower sweet taste (M = 1.9) than the non-flaxseed bagels (M = 0.9 and M = 3.0, respectively). Overall consumer acceptance of flaxseed bagels was significantly greater for participants in the older age (35-64) panelists (M=6.3) than the younger aged (16-34) panelists (M=6.0). Cinnamon-raisin bagel had the greatest acceptance (M = 6.3), which was *like slightly* on the 9-point hedonic scale. It was believed that the cinnamon increased the sweetness aroma and helped to mask the bitterness

from the flaxseed. Aliani, Ryland & Pierce (2012) concluded that the addition of ground flaxseed affects the aroma and flavor attributes, has a significantly greater acceptance rating in older aged (35-64) panelists, and cinnamon-raisin flavor shows the greatest promise for future ALA fortified food products.

Chia Seed

History and description. Chia seed, *Salvia hispanica* ,was first cultivated by the Aztecs as an important food crop in the pre-Columbian times. In Mayan, chia is the word for "strength". Mayan warriors consumed chia seed to last on long hunts, because it contains large levels of proteins, fiber, polyunsaturated fatty acids and antioxidants (Dorsey-Kockler, 2011). In the 1980's, chia seeds became very popular with children and were grown on clay animal figurines known as *Chia Pets*. Today, chia seed are cultivated in Mexico, Guatemala, Australia, Bolivia, Argentina and Ecuador (USDA, 2010).

These seeds are small and oval, approximately 1 mm in diameter and contain a mild nutty flavor. They are speckled with brown, gray, black and white colors. The majority of the seeds are black (90%) while the remaining are white (10%). Chia seeds can be consumed in four different forms; whole, ground, flour, or oil. The most common and recommended consumption is the whole chia seed. Whole chia seeds can be added directly to any type of food in dry form or used within recipes as a gel. When chia seeds are mixed with water in a 1:6 or 1:8 ratio, they obtain gelatinous properties that can be added to foods such as puddings and smoothies (Dorsey-Kockler, 2011). A chia gel can be used as a fat replacer in many types of recipes. For example, one-fourth cup of oil can be replaced with a chia gel containing one-fourth cup water and one tablespoon of chia seeds. Ground chia is another way to consume chia seed, which is theoretically more bioavailable, but no studies have been conducted to confirm this (Dorsey-

Kockler, 2011). The third form of consuming chia seed is chia flour which is de-oiled chia seeds. Chia flour contains fiber, protein, and antioxidants, but loses all of the omega 3 benefits due to the refining process. Lastly, there is chia oil which contains opposite nutrients of chia flour, because it has omega 3, but loses all fiber, protein and antioxidants during the processing.

Nutrient composition and health significance. Chia seeds are an adequate source of proteins, fiber, polyunsaturated fatty acids and antioxidants. Their protein content is 20% by weight and contains all the essential amino acids. In 2 tablespoons of chia seeds, there is 4 grams of protein and 11 grams of fiber (42%DV). The fiber content in chia seed is 27% by weight which is much larger than other grains (3-18%). Twelve percent of the total fiber content is soluble and 88% is insoluble (Dorsey-Kockler, 2011). The polyunsaturated fatty acids found within chia seeds are known as omega 3. There are three forms of omega 3; ALA (alpha linolenic acid), EPA (eicosapentanoic acid) and DHA (docosahexanoic acid). Alpha linolenic acid is found in plants sources with chia seeds being one of these top sources, and EPA/DHA are found in marine sources. The conversion rate of ALA to EPA/DHA is 0.2-15% (Kris-Ehterton, 2002; Tweed, 2012). With this conversion, chia seeds can offer just as much EPA/DHA as marine sources, but without the fishy flavors. Physicians specializing in Integrative medicine recommend a daily consumption of 2-3 grams of ALA (Tweed, 2012). The most common antioxidants found within chia seed are chlorogenic acid, caffeic acid, myricetin, quercetin (only found in black chia), and kaempferol. The large level of antioxidants contained in chia seeds greatly reduces the risk of rancidity of both whole and ground chia seeds.

Sensory acceptance. A study conducted by Rendón-Villalobos, Ortíz-Sánchez, Solorza-Feria, & Trujillo-Hernández (2012), analyzed the physicochemical, nutritional and sensory differences among corn tortillas formulated with chia flour. The 4 flour variations of the tortilla

formulations were 5%, 10%, 15%, and 20% of chia seed flour. The sensory analysis had 17 panelists who were untrained, but familiar with tortilla products. A 3-point hedonic scale (1= *Most disliked* and 3 = *Most liked*) was used to evaluate the color, flavor, taste, aroma intensity, and general acceptability. No significant difference ($p>0.05$) was obtained among the four variations of chia flour and the control. The 5% chia seed flour was most preferred for all attributes, but this difference was not significant. The nutritional analysis showed a significant ($p<0.001$) increase in fiber, lipid and protein content compared to the control. Physicochemical analysis showed a significant decrease in the rate of digestion and decrease in glycemic index values as the concentration of chia seed flour increased. Rendón-Villalobos et al. (2012) concluded that tortilla containing chia seed can be labeled as a nutraceutical food product. The addition of chia seed flour improves the nutritional value and should be considered a new "staple" ingredient.

Antioxidants

Antioxidants are compounds that inhibit the oxidation of molecules caused by reactive oxygen species such as free radicals. The formation of free radicals is impossible to avoid because oxidizing agents enter the body by normal activities such as breathing, eating and drinking (Ward, 2007). During cellular respiration, oxygen enters into the mitochondrial electron transport chain and is reduced to water. Three to five percent of the oxygen molecules escape from this reduction reaction (Kalt, 2005; Castro & Freeman, 2001). The incomplete reduction of oxygen forms reactive oxygen species such as hydroxyl radical (•OH), hydrogen peroxide (H_2O_2) and superoxide ($•O_2$) (Perron & Brumaghim, 2009). Free radicals are unstable compounds that contain a highly reactive unpaired electron. Free radicals can cause damage to both food products and to the human body.

Oxidative damage to unsaturated fatty acids, also known as auto-oxidation, can affect the flavor, odor and color of foodstuff (St. Angelo, Crippen, Dupuy & James, 1990). There are three phases to lipid oxidation; initiation, propagation and termination. Initiation phase is the formation of a free radical from a triglyceride molecule. Oxygen reacts with a double bond on a triglyceride (RH) creating a hydrogen free radical (•H) and a triglyceride free radical (•R) (Talbot, 2004). Heavy metal ions, salt, light, and heat act as catalysts to this reaction. During the next phase of propagation, the triglyceride free radical (•R) reacts with oxygen (O_2) to produce peroxy free radical (•ROO) (Talbot, 2004). The peroxy free radical will continue to react with another triglyceride molecules to form an additional triglyceride free radical (•R) and a hydroperoxide (•ROOH) molecule (Talbot, 2004). The propagation phase will repeat itself until the free radicals become neutralized by reacting with other free radicals (Talbot, 2004). This phase is called termination.

Lipid oxidation can be minimized by optimizing packaging, processing and storage conditions. Colored glass bottles can be used to prevent the exposure of light (Talbot, 2004). Packaging can be flushed with nitrogen to remove oxygen from the package (Ward, 2007). Products can be stored and processed at low temperatures and in stainless steel equipment (Talbot, 2004). Another way to prevent lipid oxidation is by addition of antioxidants, synthetic or natural. The most common synthetic antioxidants are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and tert-Butylhydroquinone (TBHQ) (Rojas & Brewer, 2007). Natural antioxidants are preferred over synthetic because they provide potential health benefits to consumers (Kumpulainen & Salonen, 1999). Vitamin E (Tocopherol) and Vitamin C (ascorbic acid) are two examples of naturally occurring antioxidants.

Oxidative damage to DNA can cause cancer (Huang, 2003; Hajiliadis, 1997), aging and neurodegenerative diseases such as Alzheimer's and Parkinson's (Markesbery & Lovell, 2006; Drew & Leeuwenburgh, 2002; Halliwell, 2001) and many other types of diseases by creating base mutations, breaking double strands, causing DNA cross-linking and breaking and rearranging chromosomes (Liu, 2003). The body has mechanisms to repair the DNA on its own, but when the damage goes unrepaired tumors and other types of cancer may form. Studies have shown that the consumption of antioxidants prevents and lowers the risk of cancers of the lung, colon, breast, cervix, esophagus, oral cavity, stomach, bladder, pancreas, and ovary (Liu, 2003). Antioxidants have also been associated with reduction in risk of cardiovascular disease (Vinson, et al., 2006), Alzheimer's disease, cataracts, asthma, and thrombotic stroke (Kasote, Hedge & Deshmukh, 2011; Routray & Orsat, 2011; Ryan, Thondre & Henry 201; Stracke, 2010).

Polyphenols and phytochemicals are chemicals naturally synthesized in plants that carry antioxidant activities. They are commonly found in fruits (Vison, Su, Zubik & Bose, 2001; Mertens-Talcott, Jilma-Stohlawetz, Rios, Hingorani & Deredorf, 2006), vegetables (Vinson, Hao, Su & Zubik, 1998; Oboh & Rocha, 2007), green and black tea (Carbrera, Artacho & Giménez, 2006; Gardener, Ruxton & Leeds, 2006), red and white wine (Lodovici, Guglielmi, Casalini, Meoni, Cheynier & Dolara, 2001; Makris, Psarra, Kallithraka & Kefalas, 2003), chocolate (Vinson, Proch & Zubik, 1999) and olive oil (Gutiérrez, Arnaud & Garrido, 2001; Visioli, Bellomo & Galli, 1998). The basic structure of an antioxidant is a three-member carbon ring ($C_6C_3C_6$) with varying side chains (typically H, OH, OCH_3, galloyl esters or carbohydrate groups) (Perron & Brumaghim, 2009) that aid in the stabilization of the free radical by donating an electron. Catechins, flavonols, flavanols, flavones, anthocyanins, proanthocyanidins, and phenolic acids are several sub-classes of polyphenols (Perron & Brumaghim, 2009).

Blueberries are a great source of flavonoids, which include anthocyanins. Anthocyanins demonstrate high levels of antidiabetic, antibacterial and anticarcinogenic activities (Routray & Orsat, 2011). Blueberries are consumed fresh, frozen, dehydrated or powdered to add flavor, health benefits, and can even be used as a natural food colorant (Espin, Soler-Rivas, Wichers & Garcia-Viguera, 2000). Several studies (Lyrene 1988; Hancock, Lyrene, Finn, Vorsa & Lobos, 2008) have shown a correlation between color and concentration of anthocyanins; darker color showed greater concentration of anthocyanins compared to lighter berries.

In 2006, fruits, vegetables and chocolate were the top three sources for antioxidants in America (Vinson, et al., 2006). Dark chocolate has been shown to contain more than double the amount of polyphenols of milk chocolate. A study by Visioli et al. (2009) showed that there were only 394 mg phenols/serving size in milk chocolate compared with 951 mg phenols/serving size in dark chocolate. One of the major flavonoids found in chocolate is epicatechin. *Ex vivo* studies (Vinson et al., 2006) showed that chocolate has beneficial effects that may lower the risk of heart disease. The presence of epicatechin significantly inhibited atherosclerosis, lowered cholesterol, low-density lipoprotein and triglycerides and raised high-density lipoproteins. Epicatechin also acted as an inhibitor of plasma lipid oxidation due to its large binding capacity of lower density lipoproteins (Vinson et al., 2006).

Shelf Life Studies

Water is a major ingredient in food and greatly affects shelf life of the food system. A water molecule, H_2O, contains one oxygen and two hydrogen atoms. There are three different forms of water within the food system; free water, bound water and hydrate (Ward, 2007). Free water is water separated from food tissues. This type of water evaporates when food is heated and acts as a dispersing agent and solvent. Free water can be seen by the consumer (e.g. a juicy

piece of watermelon), while bound water is water attached to the molecular structure of larger molecules, such as proteins in meat or starch in fruits and vegetables. Bound water is not easily frozen or boiled, because of the strong chemical bonds of the water complex. Hydrate is the water loosely bound to a chemical compound (e.g. caffeine). This type of water is also known as adsorbed water or structural water and forms layers of water molecules surrounding hydrophilic food molecules (Murano, 2003). The type of water plays a large role in determining the rate of food spoilage (Ward, 2007).

The difference between moisture content and water activity is best described by Anon (2012), "Moisture content is a quantitative measurement of the amount of water in a system, while water activity is a qualitative measurement of the energy, quality and chemical stability of the water in a system" (p. 48). Moisture content is measured by the amount of water within a food product relative to all of the solid compounds and non-water liquids (Murano, 2003). This value is calculated as a percentage of moisture content by measuring the weight of the product before and after being placed in a humidity chamber. The weight of the solid compounds and non-water liquids will remain the same while the water weight will decrease from evaporation. Moisture content can vary greatly depending on the type of food. A banana is 74% water, while a zucchini is 95% water. A slice of pizza cheese will consist of 45% water and a baked brownie will consist of 10% water. Some food products may go through dehydration process to lower the moisture content. Dehydrated foods contain 1.0% to 15% water, have a longer shelf life and a lower risk of perishing. Herbs, spices, fruits and vegetables are the most common food items that are dehydrated.

Water activity (a_w) measures the energy state of water that may enter into microbial, enzymatic or chemical reactions (Murano, 2003). This value is calculated as the ratio of the

water vapor pressure of the food over the water vapor pressure of pure water at a given temperature (Ward, 2007). Water activity levels can be used to predict the growth rates and specific types of bacteria, mold and fungi (Anon, 2012). Since water is a critical factor in growth, it is important to keep water activity levels low to prevent microbial proliferation. Pure water has a water activity of 1.00. Microorganisms grow at a_w 0.85-1.00 and stop growing in at a_w 0.70-0.85 (Ward, 2007). The greater the water activity level the more perishable the food item. Bread crust has a_w of 0.30, pasta and spices have a_w of 0.50, dried fruit have a_w of 0.60-0.65, juice concentrates have a_w of 0.80-0.87 and hard cheeses have a_w of 0.91-0.95 (Ward, 2007).

Consumer Studies

Qualitative analysis. The purpose of qualitative analysis is to gather the thoughts and feelings of consumers about a particular product (Meilgarrd, Civille & Carr, 2007). This information aids in the understanding of consumers' needs and wants and helps to explain consumers' behavior in purchasing and/or consuming particular products. Products attributes, qualities, pros and cons are defined and discussed during the assessment. Researchers can collect data on consumers' initial reaction to a specific product prototype which gives researchers direction to make alterations to product prototypes before further testing is conducted and before the product is placed on the market (Meilgarrd, Civille & Carr, 2007).

Types of qualitative analysis include focus groups, mini- groups, focus panels and one-on-one interviews (Meilgarrd, Civille & Carr, 2007). Each tests uses similar format but vary in the number of consumers, length and number of sessions. Focus groups generally include 8-12 consumers, last for 1-2 hours and consist of 2-3 sessions. Mini-groups are the smaller forms of focus groups that consist of 4-6 consumers. Focus panels are multiple session groups that involve the initial meeting, require consumers to use the product in their home and final meeting to share

their experiences with the product (Meilgarrd, Civille & Carr, 2007). One-on-one interview involves one consumer for a more in-depth discussion, generally, there are 12-50 individuals interviewed. A critical part of qualitative analysis is selecting qualified consumers. This is typically achieved by having consumers answer a series of prescreening questions (e.g. consumption habits, food allergies, willingness to discuss thoughts and opinions in a group setting).

Quantitative analysis. The purpose of quantitative analysis is to gather a large number of consumers' response for series of questions about a particular product (Meilgarrd, Civille & Carr, 2007). The consumers' response is used to represent the populations, so researchers must select the correct demographics for the panelists (e.g. gender & age). The datum is used to determine preference or liking for a product's sensory attributes and can also be measured to identify the level or intensity. Hedonic scales are the most common type of scale used for quantitative analyses because the collected data can be further analyzed using statistics.

For a successful sensory analysis, there are a several protocols the sensory research team must follow (Meilgarrd, Civille & Carr, 2007). The sensory questionnaire test design should easy to understand since most of the panelists are not trained. The length of the test should be kept to a minimum, only containing questions that pertain to the research object. All of the questions should follow the same scale and format. New terminology should be explained (e.g. aftertaste) and clear language should be used for each question. The testing facility should be in a central location free from noise or distractions and free from interfering odors (Meilgaard, Civille & Carr, 2007). Samples whose colors are different can be masked by using different colored lights; control over lights is very important. Each panelist should be given privacy when tasting and answering questions. The test administrator must be trained, experienced and be able to follow

the test design. Samples must be handled with care during storage, handling, preparation and presentation to insure safety for the panelists and to have consistently between samples. To decrease antidotal errors, sample should be distributed in a random and balanced order. Information about samples should not be given to panelists prior to the sensory evaluation to minimized panelists' bias (Meilgaard, Civille & Carr, 2007).

The most common types of sensory evaluations are paired preference tests, acceptance tests and attributes diagnostics. Paired preference tests force consumers to pick one sample over another. When there are 3 or more samples, a rank preference test can be used. Preference tests do not inform the researcher if the selected sample was liked or disliked (Meilgaard, Civille & Carr, 2007). Acceptance tests are much more useful in determining how much a consumer likes or dislikes a product. Acceptance scores can infer preference; larger the scores means larger consumer preference. Hedonic scales are generally used for acceptance testing. Hedonic scales can be 3, 5, 7 or 9 point scales. A 5 point hedonic scale for liking would be (1) *dislike extremely* (2) *dislike moderately* (3) *neither like nor dislike* (4) *like moderately* (5) *like extremely*. Scales must always be balanced; equal number of positive and negative choices (Meilgaard, Civille & Carr, 2007). Attribute diagnostics can be used to identify the intensity of specific attributes (e.g. aroma, texture, flavor) and the appropriateness of the intensity ("just right" scales). Hedonic scales and line scales are commonly used for intensity scoring. A "just right" scale would include (a) *much too little* (b) *somewhat too little* (c) *just right* (d) *somewhat too much* (e) *much too much.* Descriptive statistics cannot be calculated for "just right" scales, because the scale may not be evenly spaced or balanced (Meilgaard, Civille & Carr, 2007).

Chapter III: Methodology

This chapter discusses the materials and methodology of the study on consumer perception of naturally flavored oatmeal. Oatmeal prototypes were developed using bench top product development. The moisture content and water activity were collected from the dry samples to evaluate the shelf life and safety of the products. A focus group was conducted to gather consumer insight on the oatmeal prototypes and two sensory analyses were conducted to evaluate consumer acceptance of the flavored oatmeal products. Participants were college students, faculty and staff at the University of Wisconsin-Stout. This chapter also covers data collection, data analysis, sample preparation, instrumentation and limitations of the sensory evaluation.

Product Development of Oatmeal

Three oatmeal flavors were developed containing flaxseeds and chia seeds. The three flavors were apple crisp, blueberry peach cobbler and mocha dark chocolate chip. The process known as benchtop product development, which consists of product formulations and informal sensory evaluations, was used to develop the flavors. Informal sensory evaluations were conducted with oatmeal prototypes with Food Science graduate students and faculty. Prototypes were developed in sets of 2 or 3 variations and further modifications were made following the informal sensory evaluations. Nutritional analysis was determined using the FoodProSQL (Food Processor Software). Serving size (35 g of dried mix) was optimized based on nutritional content and volume of final product. Nutritional content can be found in Appendix A for oatmeal (by itself) and the developed final product (oatmeal with granola). The three finished products contained $\geq$5 grams of dietary fiber, $\geq$ 5 gram of protein, $\leq$ 115 mg sodium, $\leq$ 6 total fat and $\leq$ 200 calories per 35 gram serving. The samples contained 10.08 % milled brown flaxseed, 2.00 %

whole brown flaxseed and 4.70% chia seeds; which provided 1.26 grams of omega 3 fatty acid per serving.

Granola formulations were developed for each oatmeal flavor; cinnamon granola for apple crisp oatmeal, vanilla granola for blueberry peach cobbler oatmeal and mocha dark chocolate granola with mini dark chocolate chips for mocha dark chocolate chip oatmeal. Several variations of granola were developed using several fat replacers (100 % egg whites, 50/50% butter/egg whites, 75/25% vegetable oil/egg whites, 75/25% butter/egg whites) and compared to 100% butter. Informal sensory investigation was conducted to determine which fat replacer had an acceptable texture and flavor compared to the 100% butter sample. The sample containing 50/50% butter/egg whites had the most acceptable crisp, crunch, flavor and aftertaste and allowed for the total fat to be decreased by 60%. Therefore, the 50/50% butter/egg whites were used in the final granola formulation.

Shelf Life Studies

The moisture content of the dry oatmeal mixture and granola was measured. Pre-weighed and pre-labeled metal dishes were used to mass 5 g samples of dry oatmeal mix and granola; samples were conducted in triplicate. Metal dishes were transferred to an oven and heated at 105°C for 24 hours (AOAC, 1999). After 24 hours of drying, samples were massed to determine the moisture loss. Moisture content was expressed as percent of moisture content. Water activity of dry oatmeal mixture and granola was measured in triplicate using Aqua Lab 3TE water activity meter (Pullman, Washington, Decagon Devices, Inc.).

Description of Independent Variables

The University of Wisconsin-Stout was chosen for this study for several reasons; a.) the Heritage Hall location at the university housed proper sensory testing facilities, b.) participants ranged from 18 to 30 years old, and c.) willing to participant in the study itself, and d.)

University population includes international students. The study was conducted to evaluate consumer perception of three different types of naturally flavored oatmeal. The independent variables were the percentages of milled flaxseed (10.08%), whole flaxseed (2.00%) and chia seeds (4.70%) and the oatmeal preparation methods. The dependent variables were the sensory attributes measured.

Selection of Samples

A focus group was conducted with 6 participants. Each participant had to answer a pre-screening survey (Appendix B) to determine if they qualified for the study. The questions were based on consumer consumption habits of oatmeal, flaxseed and chia seeds, perceived importance of consuming natural ingredients, and their willingness to learn and taste new flavored oatmeal products. The pre-screening survey was distributed by email to UW-Stout students. Out of the six focus group participants, five were female. Five of the participants were within the age range 24-27 and one participant was 28 years or older. Out of these six participants, 83.3% of the panelists consumed flavored oatmeal monthly or weekly, 100% consumed flaxseed monthly or weekly, and 83.3 % consumed chia seed monthly, weekly or daily. The purpose of the focus group was to evaluate consumer importance of natural ingredients, thoughts towards healthy breakfast cereals and packaging for the new oatmeal products and to determine the validity of the sensory score sheet for the subsequent consumer sensory analysis (Appendix C) and to optimize the flavored oatmeal prototypes. This focus group allowed for determination of the top 3 flavors to use in subsequent consumer acceptance testing, apple crisp, blueberry peach cobbler and mocha dark chocolate chip.

Two sensory analyses were performed; the first one with apple crisp and blueberry peach cobbler and second one with mocha dark chocolate chip. The flavors were separated into two

sensory analyses to avoid sensory and mental fatigue of the panelists and to avoid flavor carryover among samples. The modified questionnaires from focus group were used for the sensory analyses (Appendix D & E). Participants for each sensory analysis testing were informed about the evaluation by several different methods; use of advertisement in *Campus Today* (daily email sent to all students faculty and staff), posters which were placed in buildings throughout the campus, and by word of mouth. Participation was on a voluntary basis. Advertisements included information of what, where, when, who and why with general information of study.

The population sample that participated in the first sensory evaluation of apple crisp and blueberry peach cobbler flavors consisted of 127 untrained panelists. Each panelist evaluated one small portion of each of the two oatmeal flavors and answered every question in the survey. Out of the 127 panelists, 73% were female and 27% were male. The age ranges of the panelists included 18-20 (42%), 21-23 (34%), 24-27 (12%) and 28 + (12%). The frequencies of oatmeal consumption among the panelists were 12% consumed oatmeal daily, 32% weekly, 28% monthly, 16% yearly and 12% never consumed flavored oatmeal.

The population sample that participated in the second sensory evaluation of the mocha dark chocolate chip flavor consisted of 127 untrained panelists. Each panelist evaluated one small portion of oatmeal and answered every question in the survey. Out of the panelists, 69% were female and 31% were male. The age ranges of the panelists included 18-20 (40%), 21-23 (29%), 24-27 (15%) and 28+ (16%). The frequencies of oatmeal consumption among the panelists were 7% consumed oatmeal daily, 28% weekly, 32% monthly, 18% yearly and 14% never consumed flavored oatmeal.

Instrumentation

On January 21, 2013, permission to conduct this study was allowed through the University of Wisconsin- Institutional Review Board (Appendix F). The software used to conduct this study was computerized data acquisition system (Compusense® *five* software, version 5.0 Compusense Inc, Guelph, Ontario, Canada) The sensory questionnaire was reviewed in the focus group and the modified questionnaire was input into Compusense® Five (Compusense Inc, Guelph, Canada)

Materials

The materials used were the flavored oatmeal samples which were placed in labeled containers with a random three-digit code to eliminate bias of the panelist during the data collection. Bowls, bottled spring water, and two microwaves were used in the preparation of the oatmeal samples. Other materials required to conduct the sensory were 400-two oz paper cups for the prepared oatmeal, 400-one oz paper cups for the granola, 400 Spoons, 260 small water cups, and 9 sample trays were used.

Sample Preparation and Presentation

All samples were pre-screened and preparation methods were optimized to insure in sample consistency throughout the analysis. In an effort to collect reliable results, antidotal errors were minimized by distributing samples in a random and balanced order and expectation errors were minimized by not releasing product information prior to the sensory analysis. Panelists were not informed of oatmeal flavors and ingredients used within products, except for dietary restrictions written on the consent form.

The oatmeal products were prepared using good manufacturing practices (GMP) in the sensory evaluation laboratory at the University of Wisconsin-Stout. Oatmeal was pre-screened to

determine the most efficient preparation method for the flavored oatmeal. Flavored oatmeal was prepared by adding 35 grams of dry oatmeal mix oats with 1/3 cup of spring water into a bowl and cooked in the microwave for 1 minute. Finished oatmeal was scooped into 6-two oz sample cups. The corresponding oatmeal granola mix in (GM) was placed into one oz sample cups labeled "GM". Both oatmeal and GM sample cups, cup of water and spoon were placed on tray and sent to panelists through the sensory booth window.

Upon entering the sensory evaluation laboratory, panelists sat down at an individual, private booth. A sign was placed in the booth to inform the panelists to turn on the green light when ready to begin the analysis. The panelist was first given a consent form (Appendix G & H) before receiving any samples. Once this form was completed panelists were informed to turn on the red light. The researcher then delivered the first sample to the panelist through the sensory booth window. The panelist received a plastic tray of a one flavored oatmeal sample, granola mix in (GM), spoon and cup of water. The panelists were asked to pour the granola mix in (GM) onto the flavored oatmeal and stir. They were asked to answer a few questions about the appearance of the sample and the convenience of adding the oatmeal topping before tasting the sample. After the first two questions, panelists were informed to taste the sample and answer several questions about the taste, flavor and texture. When the panelist finished the first sample they were informed to turn on the green light to receive the second sample (for the first sensory analysis only; second analysis had only one sample). For the first analysis, panelists received samples in a randomized and balanced order. When sensory evaluation was completed, panelists turned on the red light, and left the testing area.

Data Collection Procedures

A focus group of 6 subjects was conducted to gather consumer feedback and recommendations regarding the new natural oatmeal flavors. Focus group participants were greeted by a moderator and asked to complete a consent form (Appendix I) before the focus group began. A discussion guideline (Lee & Lee, 2007) was followed by the moderator (Appendix J). The participants were informed that their participation was very important in gathering data and that there were no “right” or “wrong" answers. Panelists were also informed that everything said in the room stayed in the room and confidentially will be kept. It also stated that the focus group session would be video recorded and videos would be destroyed upon completion of the report. Last, they were told that individuals are not required to stay and can leave at any time throughout the study. Ice breaker questions were asked to get everyone acquainted with one another and to get the group to start thinking about breakfast foods. The discussion included questions about the factors that influenced consumers’ decision of selecting breakfast foods, definition of a health breakfast, thoughts on the food labels, health claims, packaging and consumer willingness to pay for prepackaged naturally flavored oatmeal product. Informal sensory evaluations of the prototypes were given. The apple crisp and blueberry peach cobbler were given first with corresponding questionnaire. The third sample was given, mocha dark chocolate chip with a corresponding questionnaire. Discussion questions were asked about the samples and about the clarity of the questionnaire. Participants were asked if they had any last comments.

Overall, focus group discussion session resulted in providing attributes for the subsequent consumer studies. Questionnaires were entered into the Compusense® program. The questionnaires for the two sensory analyses contained the same basic questions and directions.

The flavor questions were altered to fit either the fruit flavored samples (tartness, fruit flavor and spice flavor) or the chocolate flavored sample (bitterness, chocolate flavor and coffee flavor). The questionnaire included questions about the intensity (1-*no flavor*, 2- *weak flavor*, 3-*slight flavor*, 4-*moderate flavor*, 5-*strong flavor*, 6-*very strong flavor*, 7- *extremely strong flavor*) and liking (1-*dislike extremely*, 2-*dislike moderately*, 3-*dislike slightly*, 4-*either like nor dislike*, 5-*like slightly*, 6-*like moderately*, 7- *like extremely*) of these flavors. The 7-point hedonic scale for liking was also utilized for appearance, convenience of granola, granola flavor and aftertaste for each of the three samples. Intent to purchase was asked using a 5-point hedonic scale (1-*definitely would not buy it*, 2-*probably would not buy it*, 3-*might or might not buy it*, 4-*probably would buy it*, 5-*definitely would buy it*) for each of the oatmeal flavors. Demographic questions including gender, age range (18-20, 21-23, 24-27, 28+) and consumption habits (daily, weekly, monthly, yearly, never) were asked.

Data Analysis

A summary transcript for the focus group was created using the video recording, questionnaires and written notes. Each question was analyzed and comments unrelated to the discussion were omitted. Informal sensory analysis results were analyzed using Microsoft Excel 2010.

Data from each panelist were collected using a computerized data acquisition system (Compusense® *five*, version 5.0, Compusense, Inc., Guelph, ON, Canada) for sensory evaluation. Data from both sensory analyses were entered into Microsoft Excel 2010 and further statistical analyses of appearance, convenience, granola mix in flavor, aftertaste and intent to purchase was conducted using Statistical Package for the Social Sciences (IMB SPSS Statistic

20) where *P* values indicated a significant difference among the three sample means, Tukey's honestly significant difference (HSD) was used to examine significant differences ($p \leq 0.05$).

Limitations

The main limitation to the study was the panelists themselves. Panelists, as measuring instruments, can vary within their individual measuring capabilities and with other panelists. The participants could have become fatigued with tasting two samples and could have previously conceived opinions of oatmeal products that results in bias results. Participants were not trained and may not have been able to quantify the perceptions asked within survey. The majority of the participants may have been from the nutrition and food science courses, which would not be an accurate representation of the student population at UW-Stout.

Chapter IV: Results & Discussion

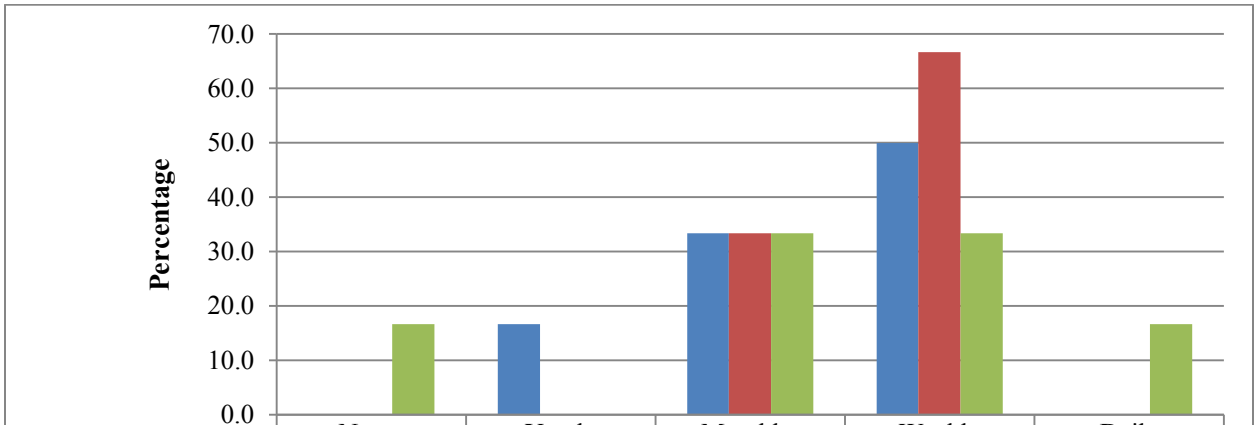
Focus Group Discussion

Consumption and interest. Six participants were selected to participate in the focus group based on answers provided on a prescreening questionnaire. Five of the participants were female and one male. Five of the participants were within the age range 24-27 and one participant was 28+. Participants all tended to consumer flavored oatmeal (83.5%), flaxseed (100%) and chia seed (83.3%) on a monthly or weekly basis (Figure 1). Five of the 6 participants strongly agreed and one somewhat agreed with a given statement that said "Consuming products with natural ingredients is important to me." All six participants strongly agreed with the second given statement of "I am interested in learning about new naturally flavored oatmeal products." All six participants strongly agreed with the last statement that said "I am interested in tasting new naturally flavored oatmeal products."

Discussion questions. Focus group participants were asked a series of discussion questions. Participants were asked what factors influence their decision of selecting a breakfast item. The amount of fullness after breakfast was very important to the participants. Currently, two participants indicated that they often feel full after consuming one package of oatmeal and a piece of fruit, while one participant needed to consume two packages of oatmeal to achieve the desired fullness. The five of the participants also felt that price and convenience were two additional factors that influence their decision in selecting a breakfast food. Five of the participants wanted a breakfast item that takes only a few minutes to prepare. The last and most important factor that influenced the six participants was the healthiness of the product, which lead into the next discussion question: "What is your definition of a healthy breakfast cereal?" The answer to this definition included terms such as carbohydrates, protein, fiber, fruit and again the sensation of feeling full. Two of the participants added fresh fruit when eating oatmeal for

breakfast. Four of the participants felt that breakfast was the best meal to consume large qualities of fiber. Five of the participants appeared intrigued about the idea of consuming omega- 3 fatty acids with their morning breakfast meal.

These results are comparable to a research investigation of consumers' attitudes and food choice toward healthy eating (Carrillo, Varela, Salvador & Fiszman, 2011), in which sensory appeal, price and convenience were the top three factors of a Spanish consumer panel (n=200), while other factors included natural content, ethical concern, health, weight control, mood and familiarity (Carrillo, Varela, Salvador & Fiszman, 2011). Additional research (Lee & Lee, 2007) on breakfast cereal using a consumer panel determined that the main factors in selecting breakfast items were based on healthy ingredients and sensory acceptance (for "Healthy Choosey" subgroup) and basic nutrition (fiber, sugar and fat), price and sensory acceptance (for "Basic" subgroup). Overall, consumers prefer breakfast items that are affordable and convenient, contain nutrients such as fiber, protein, healthy fat and possess appealing sensory attributes.



	Never	Yearly	Monthly	Weekly	Daily
Flavored Oatmeal	0.0	16.7	33.3	50.0	0.0
Flaxseed	0.0	0.0	33.3	66.7	0.0
Chia Seed	16.7	0.0	33.3	33.3	16.7

*Figure 1.*Focus group participants (n=6) consumption frequencies of flavored oatmeal, flaxseed and chia seed.

The next questions regarded the meanings of words "natural" and "organic." The panelists felt the word "natural" included ingredients that did not contain any alterations from their initial state and felt it was less meaningful than "organic" because it is not as heavily regulated as organic foods. The participants felt "organic" food items were grown and processed differently than the more common conventional foods. Participants did not associate "organic" with being healthier or more nutritious. Participants felt having a simple food label was more important than having the label "natural" or "organic." The definition of a simple ingredient label is not clearly defined but according to the focus group participants a simple label generally consists of ingredients that consumers are familiar with (e.g. whole foods) and would not have any artificial denoting name.

Consumers' opinions and thoughts on "organic" food products vary greatly between demographics. Students from the Food and Nutritional Sciences program at UW-Stout, preferred organic or natural foods, but would rather purchase a product with a simple food label. These results are similar to data obtained from Spanish consumers (Carrillo, Varela, Salvador & Fiszman, 2011) which indicates that the importance of ingredient type is slightly important or greater for Spanish consumers based on food products that contain natural ingredients (5.73), contain no artificial ingredients (5.11), and contain no additives (4.65) using a 7 point scale of importance, where 1 = *not at all important* to 7 = *very important*. European consumers (Zander, Stolz & Hamm, 2013) report slightly different results which state that rated "local production" as the first factor in purchasing food products, followed by "higher animal welfare" and "fair producer prices." While, a Brazilian consumer study (Lopes Souza Soares, Deliza, & Pedroso Oliveira, 2008) reports that most of the participants did not know what "organic meant" and how of the few that did, they related organic with very expensive, small in comparison to

conventional and an untrustworthy certification. Overall, studies reveal that consumers do not have a common consensus of "organic" food products, but general prefer foods that contain "healthy ingredients."

When asked about the benefits and disadvantages of food labels, five of the participants did not like seeing health claims on packages. Three of the participants did not believe that health claims are truthful or trustworthy. They felt marketing was using "trendy words" to sell their product; with antioxidants being one of the current marketing trends. Continuing with the topic of label advertisement, panelists were asked about specific labels found on food packages such as omega-3 fatty acids and high fiber content. Three of the participants liked the idea of being notified on the amount omega-3 fatty acids and high fiber content; they preferred advertisement of ingredient content over advertisement of health claims. Five of the participants preferred simple packaging over excessive advertisement of health claims. Again, four of the participants felt that breakfast is the meal of the day to consume fiber and thus prefer breakfast foods having high fiber content. All of the participants agreed that the best way to grab their attention is to have a simple label with simple packaging. They purchase food items based on the ingredient list, not on the health claims written on the front of the packaging. Simple packaging would focus more on the ingredients within the food (e.g. fiber content) instead of health claims (e.g. may lower cholesterol). According to the focus group participants, a simple packaging would only contain the basics about the food product.

These results reflect the thoughts and opinions of college-age students within the Food and Nutritional Sciences at UW-Stout and are not comparable to research obtained from Spanish consumers (Carrillo, Varela, Salvador & Fiszman, 2011). Spanish consumers did not know the nutritional benefits of individual ingredients found within food products, such as proteins or

fiber. Carrilo (2011) also noted a positive correlation between weight control and health claims such as “low in sugar,” low in calories,” and “low in fat.” Overall, research suggests that not all consumers have the knowledge to directly relate additional health benefits from specific ingredients and the use of health claims may increase the consumers’ awareness of health benefits including weight lost.

When asked about pricing for a prepackaged oatmeal product, all of the focus group participants avoid products that are inexpensive. Cheaper type products are generally associated with less expensive ingredients having very poor quality and flavor. They also tend to avoid products that are too expensive as well. Pricier products do not infer greater quality. Participants wanted a product they can afford to buy continuously. One participant felt that a price of $0.50 per an individual oatmeal packet (or $2.50 for a box a five) would be an acceptable price. Three of the participants felt prices similar to Quaker instant oatmeal was acceptable as a box of18 packets prices around $5.00 ($0.30 per packet).

In addition to the correlation between price and quality, Spanish consumers suggest a correlation between price and convenience (Carrillo, Varela, Salvador & Fiszman, 2011) , where saving money and saving time is very important, but compared with other European consumers, price and convenience were not important factors when selecting a food item (Pieniak, Verbeke, Vanhonacker, Guerrero & Hersleth, 2009). According to a panel of 367 individuals, results indicated that consumers were willing to pay $1.49 to $2.49 per 14 oz of healthy breakfast cereal food product (Lee, Moskowitz & Lee, 2007). Another focus group investigation (Lee & Lee, 2007) of consumers (n=30) ages 18-65 years old, indicated that participants from “Healthy Choosey” subgroup were willing to pay higher a price range ($2.00 to $ 5.00) than the “Basic” subgroup ($2.00 to $3.99) for a box of healthy breakfast cereal.

Because the small number of focus group participants and all being college-aged, an acceptable price for prepackaged oatmeal cannot be concluded, although based on previous research, suggested price range of $1.49 to $3.99 per box can be made. Research also suggests, consumers who purchase products based mainly on its "healthiness" are willing to pay more, even up to $5.00 per box of healthy breakfast cereal.

Informal sensory evaluation. The focus group participants were asked to participate in an informal sensory evaluation of the three oatmeal products. The questionnaire included questions about the liking using a 7-point hedonic scale (1-*dislike extremely*, 2-*dislike moderately*, 3-*dislike slightly*, 4-*either like nor dislike*, 5-*like slightly*, 6-*like moderately*, 7- *like extremely*), and the intensity using a 7-point hedonic scale (1-*no flavor*, 2- *weak flavor*, 3-*slight flavor*, 4-*moderate flavor*, 5-*strong flavor*, 6-*very strong flavor*, 7- *extremely strong flavor*).

Table 1 shows the average liking for appearance, convenience of granola, granola flavor and aftertaste for apple crisp, blueberry peach cobbler and mocha dark chocolate chip samples. The appearance was liked moderately to liked extremely for apple crisp (6.00 and mocha dark chocolate chip (M = 6.17) samples. Blueberry peach cobbler appearance was liked slightly to liked moderately with a mean of 5.67. Mean scores of liking for the convenience of granola for the three samples were comparable with ranges of 6.67 to 6.83 and were comparable for granola flavor liking with ranges of 6.17 to 6.67; indicating like moderately to like extremely. Aftertaste was liked slightly to liked moderately with mean scores ranging from 5.67 to 6.17. Overall, the panelists moderately (or greater) liked the appearance, the convenience of the granola mix in, the granola flavor and the aftertaste of all three samples.

From the focus group participants, apple crisp was liked the most (M = 6.17) for its moderate to strong spice intensity (M = 4.50), followed by a slight to moderate liking (M = 5.83)

for tartness (*M* = 3.17) and liked the least (*M* = 5.50) for its moderate fruit flavor (*M* = 4.33) (Table 2). Blueberry peach cobbler was liked the most (*M* = 6.33) for its moderate fruit flavor (*M* = 4.17), followed by a slight to moderate liking (*M* = 5.83) for tartness (*M* = 3.17) and liked the least (*M* = 5.33) for its slight spice flavor (*M* = 3.17). Mocha dark chocolate chip was liked the most (*M* = 6.67) for its very strong coffee flavor (*M* = 6.00), followed a very strong liking (*M* = 6.50) for the sample's very strong chocolate flavor (*M* = 6.00) and liked the least (*M* = 5.83) for its strong bitterness (*M* = 5.00) (Table 3).

Table 1

Mean Values of Each Oatmeal Sample for Appearance, Convenience, Granola Flavor and Aftertaste Using Focus Group Participants.

		Descriptive Statistics	
Attribute	Sample	*M*	*SD*
Appearance – Liking[1]	Apple Crisp	6.00	1.41
	Mocha Dark Chocolate Chip	5.67	1.80
		6.17	1.86
Convenience - Liking	Apple Crisp	6.83	0.37
	Blueberry Peach Cobbler	6.67	0.47
	Mocha Dark Chocolate Chip	6.83	0.37
Granola Flavor - Liking	Apple Crisp	6.17	0.69
	Blueberry Peach Cobbler	6.33	0.75
	Mocha Dark Chocolate Chip	6.67	0.47
Aftertaste - Liking	Apple Crisp	6.00	1.00
	Blueberry Peach Cobbler	6.00	1.00
	Mocha Dark Chocolate Chip	6.00	1.00

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*. (n=6).

The questionnaire also included a question regarding the participants' intent to purchase (1-*definitely would not buy it* to 7- *definitely would buy it*). Mocha dark chocolate chip had the greatest mean score (5.80 ± 1.94) for intent to purchase followed by blueberry peach cobbler (5.67 ± 1.11) and apple crisp (5.33 ± 1.25).

Table 2

Mean Values of Apple Crisp and Blueberry Peach Cobbler Oatmeal Samples for Flavor Attributes Using a Focus Group.

		Descriptive Statistics	
Attribute	Sample	*M*	*SD*
Tartness – Liking[1]	Apple Crisp	5.83	0.90
	Blueberry Peach Cobbler	5.83	0.90
Tartness – Intensity[2]	Apple Crisp	3.83	1.21
	Blueberry Peach Cobbler	3.17	1.07
Fruit Flavor - Liking	Apple Crisp	5.50	1.80
	Blueberry Peach Cobbler	6.33	0.47
Fruit Flavor - Intensity	Apple Crisp	4.33	1.25
	Blueberry Peach Cobbler	4.17	0.69
Spice Flavor - Liking	Apple Crisp	6.17	0.90
	Blueberry Peach Cobbler	5.33	0.94
Spice Flavor - Intensity	Apple Crisp	4.50	1.12
	Blueberry Peach Cobbler	3.17	1.34

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.
[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor.* (n=6).

Table 3

Mean Ratings of Oatmeal Flavor Attributes for Mocha Dark Chocolate Chip Oatmeal Based on Focus Group.

	Descriptive Statistics	
Attribute	*M*	*SD*
Bitterness – Liking[1]	5.83	0.90
Bitterness – Intensity[2]	5.00	0.75
Coffee Flavor - Liking	6.67	0.47
Coffee Flavor - Intensity	6.00	0.47
Chocolate Flavor - Liking	6.50	0.76
Chocolate Flavor - Intensity	6.00	0.47

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.
[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=6).

The subsequent oatmeal formulations and consumer questions for successive evaluations were determined based on the focus group discussion. The final sensory evaluation for consumers is listed in Appendix E. It is noted that based on focus group recommendation that granola topping was renamed granola mix in to reflected its use by the consumers.

Sensory Analysis

Consumption frequency. Panelists (n=127), mainly 18-20 years old (42%) evaluated both apple crisp and blueberry peach cobbler oatmeal (73% female, 27% male) and had oatmeal consumption frequencies of 12% daily, 32% weekly, 28% monthly, 17% yearly and 12% never (Figure 2). Panelists for the evaluation of mocha dark chocolate chip (n=127), mainly 18-20 years old (40%) were again mainly female (69%) with oatmeal consumption frequencies of the panelists were 7% daily, 28% weekly, 32% monthly, 18% yearly and 14% never (Figure 2).

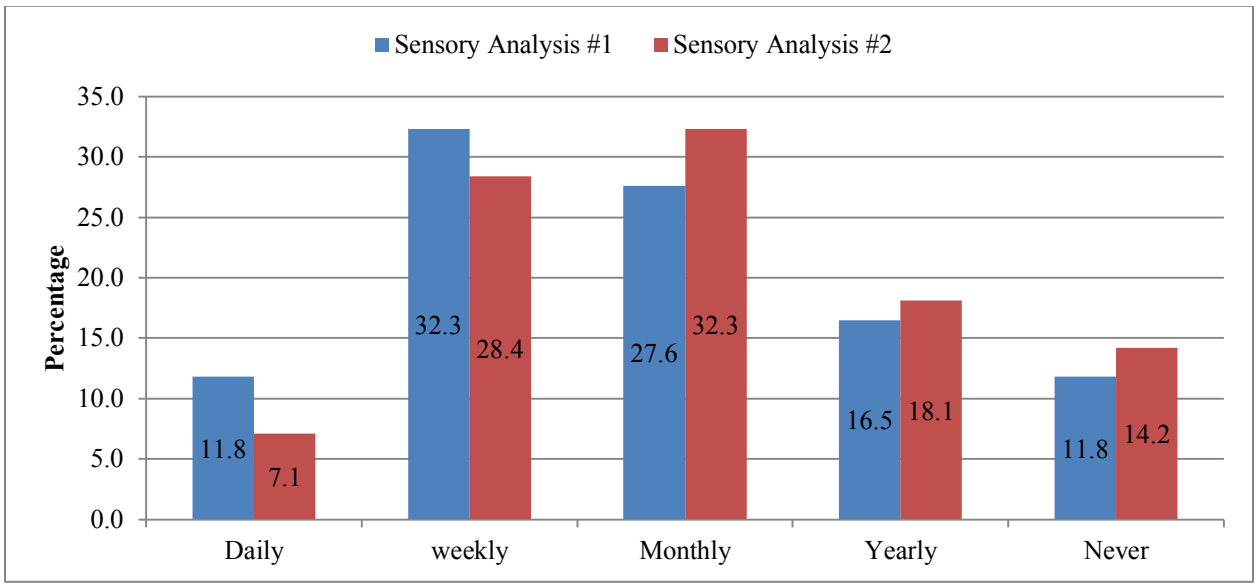


Figure 2. Consumption frequencies of flavored oatmeal. Sensory analysis #1 (apple crisp and blueberry peach cobbler) and sensory analysis #2 (mocha dark chocolate chip).

Sensory analysis #1 - flavor attributes. Table 4 shows the descriptive statistics of the flavor attributes (liking and intensity scores) for the apple crisp and blueberry peach cobbler samples. Analysis of variance at 95% confidence level was conducted using Compusense ® *five* (Compusense Inc, Guelph, ON, Canada).

Table 4

Mean Flavor Attribute Ratings for Apple Crisp and Blueberry Peach Cobbler Oatmeal

Attribute		Descriptive Statistics *M*	*SD*
Tartness - Liking	Apple Crisp	4.45[a]	1.35
	Blueberry Peach Cobbler	4.94[b]	1.44
Tartness - Intensity	Apple Crisp	3.51[a]	1.22
	Blueberry Peach Cobbler	3.82[b]	1.35
Fruit Flavor - Liking	Apple Crisp	4.65[a]	1.43
	Blueberry Peach Cobbler	5.41[b]	1.57
Fruit Flavor - Intensity	Apple Crisp	3.45[a]	1.20
	Blueberry Peach Cobbler	4.45[b]	1.35
Spice Flavor - Liking	Apple Crisp	4.71[a]	1.55
	Blueberry Peach Cobbler	4.67[a]	1.31
Spice Flavor - Intensity	Apple Crisp	4.01[a]	1.31
	Blueberry Peach Cobbler	3.39[b]	1.29

Mean values within the same attribute followed by different letters are significantly different ($p<0.05$).
[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.
[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

Blueberry peach cobbler was significantly liked more for tartness (M = 4.94) than the apple crisp (M = 4.45). Figure 3A shows the percent distribution of panelist's scores; 46.4% of panelists for apple crisp and 63.7% of panelists for blueberry peach cobbler selected liked slightly (5.0), liked moderately (6.0) or liked extremely (7.0) for tartness. Blueberry peach cobbler had significantly stronger intensity for tartness (M = 3.82) than the Apple Crisp (M = 3.51). Figure 3B shows the percent distribution of panelist's scores; 61.4% of panelists for apple

crisp and 49.7% of panelists for blueberry peach cobbler selected slight flavor (3.0) or moderate flavor (4.0) for tartness intensity.

The panelists indicated a significantly greater fruit flavor liking and intensity for blueberry peach cobbler than apple crisp. Figure 4A shows the percent distribution of panelist's scores; 59.1% of panelists for apple crisp and 78% of panelists for blueberry peach cobbler selected liked slightly (5.0), liked moderately (6.0) or liked extremely (7.0) for fruit flavor. Figure 4B shows the percent distribution of panelist's scores; 59.1% of panelists for apple crisp selected slight flavor (3.0) or moderate flavor (4.0) and 56.8% of panelists for blueberry peach cobbler selected moderate flavor (4.0) or strong flavor (5.0) for fruit flavor intensity.

There was no significant difference between blueberry peach cobbler ($M = 4.67$) and apple crisp ($M = 4.71$) for spice flavor liking. Figure 5A shows the percent distribution of panelist's scores; 62.9% of panelists for apple crisp and 55.2% of panelists for blueberry peach cobbler selected liked slightly (5.0), liked moderately (6.0) or liked extremely (7.0) for spice flavor. Apple crisp ($M = 4.01$) had a significantly greater intensity for spice flavor than blueberry peach cobbler ($M = 3.39$). Figure 5B shows the percent distribution of panelist's scores; 59.1% of panelists for apple crisp selected moderate flavor (4.0) or strong flavor (5.0) and 55.2% of panelists for blueberry peach cobbler selected slight flavor (3.0) or moderate flavor (4.0) for spice flavor intensity.

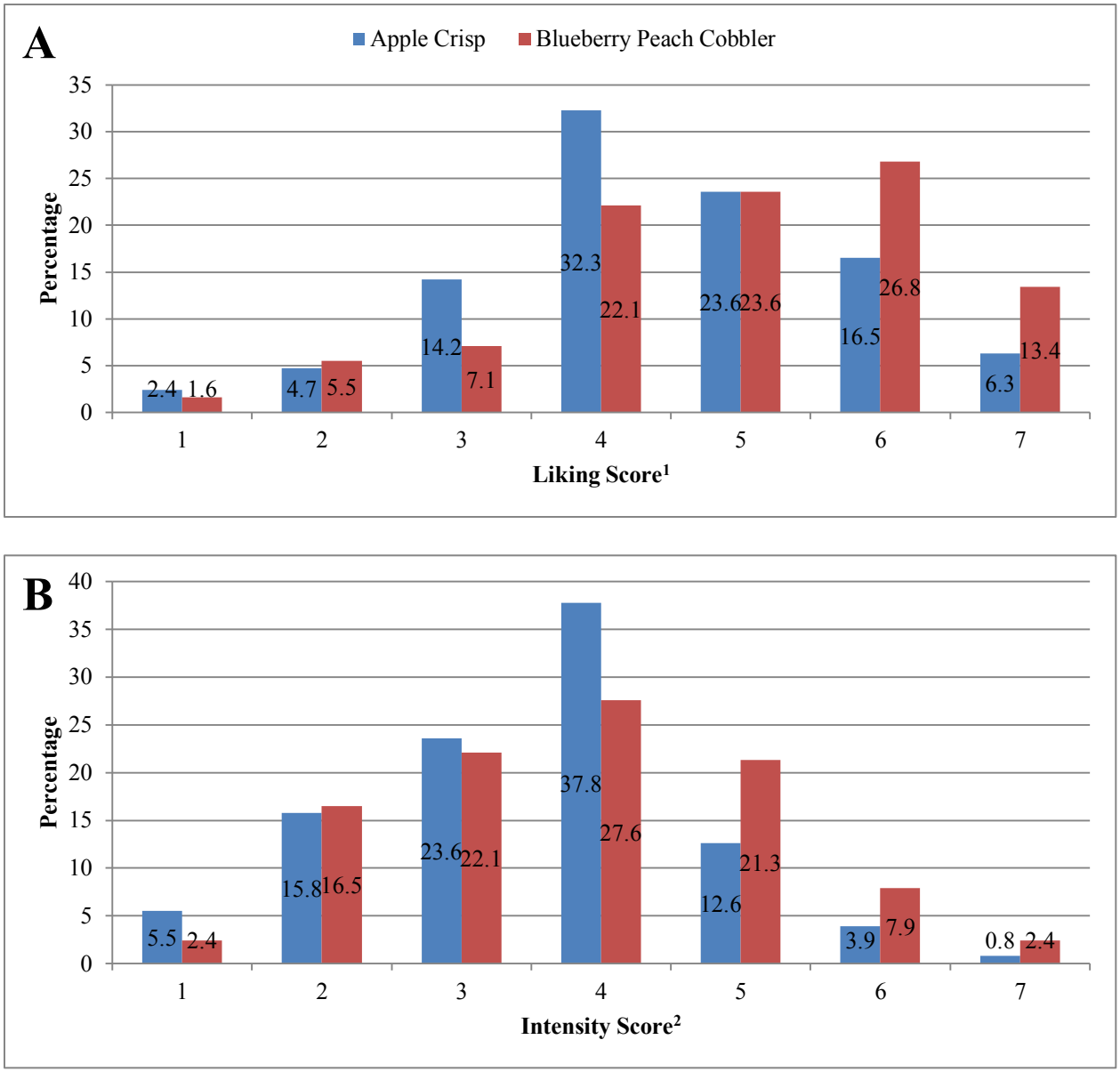


Figure 3. Percentage distribution of tartness liking (**A**) and tartness intensity (**B**) for apple crisp and blueberry peach cobbler.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

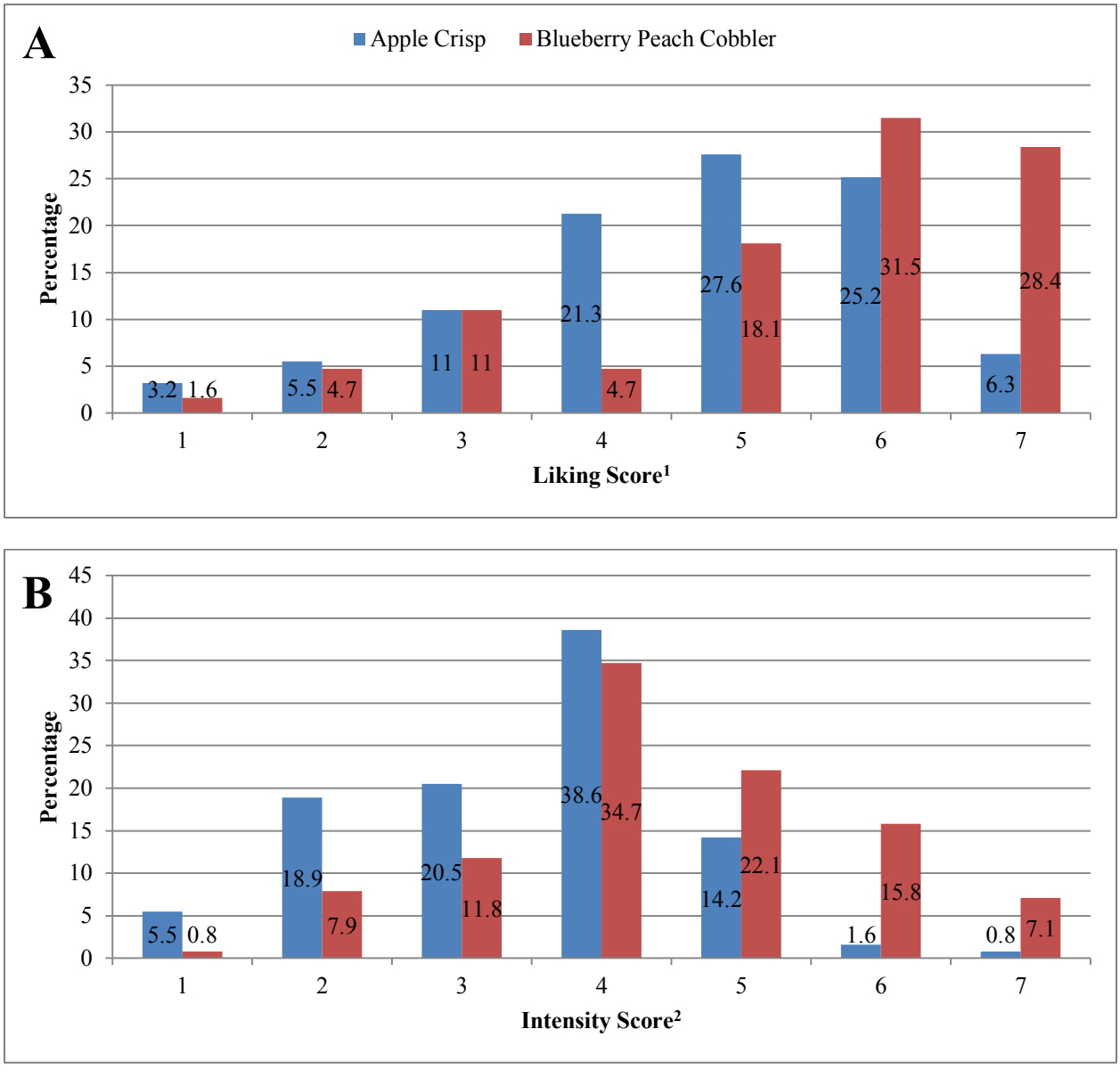


Figure 4. Percentage distribution of fruit flavor liking (**A**) and fruit flavor intensity (**B**) for apple crisp and blueberry peach cobbler.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor.* (n=127).

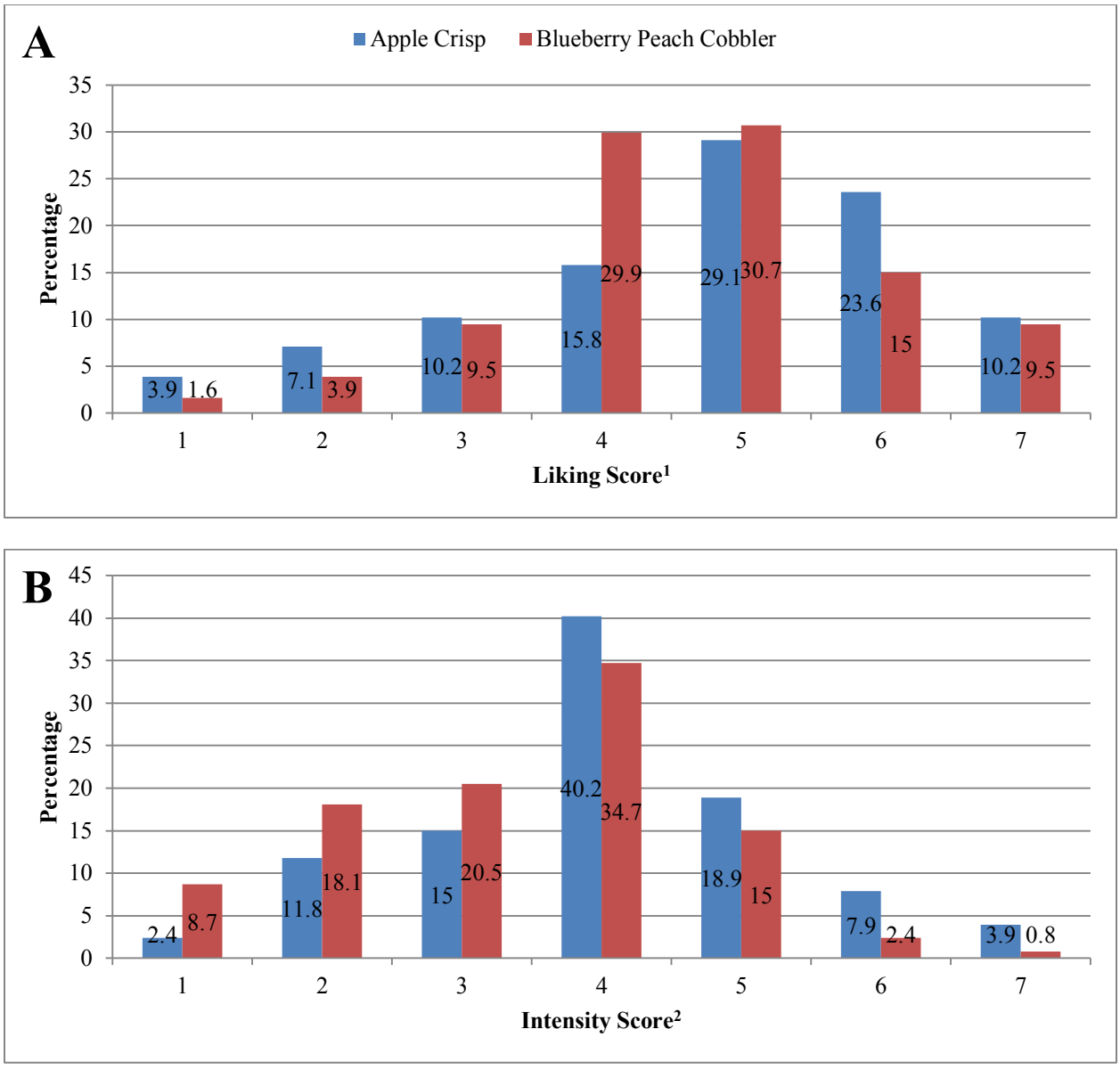


Figure 5. Percentage distribution of spice flavor liking (**A**) and spice flavor intensity (**B**) for apple crisp and blueberry peach cobbler.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

Sensory analysis #2 - flavor attributes. Table 5 shows the descriptive statistics of the flavor attributes (liking and intensity scores) for the mocha dark chocolate chip sample and it was noted that bitterness was liked above the midpoint (*M* = 4.74) and had a moderate intensity (*M* =3.69). Figure 6A show the percent distribution of panelist's scores with 61.5 % of panelists selected like slightly or greater for bitterness. Figure 6B show the percent distribution of panelist's scores with 63.8% of panelists felt this sample had moderate (4.0) or strong (5.0) bitterness intensity.

Table 5

Mean Flavor Attribute Ratings for Mocha Dark Chocolate Chip Oatmeal

	Descriptive Statistics	
Attribute	*M*	*SD*
Bitterness – Liking[1]	4.74	1.45
Bitterness – Intensity[2]	3.96	1.13
Coffee Flavor - Liking	5.07	1.72
Coffee Flavor - Intensity	3.99	1.27
Chocolate Flavor - Liking	5.72	1.33
Chocolate Flavor - Intensity	4.64	1.21

Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor.* (n=127).

Coffee flavor was liked slightly (*M* = 5.07) and had a moderate intensity (*M* =3.99) with 66.2 % of panelists liking slightly or greater for coffee flavor (Figure 7A) and 59.8% of panelists felt this sample had moderate (4.0) or strong (5.0) coffee flavor intensity (Figure 7B).

Chocolate flavor was liked slightly to liked moderately (*M* =5.72) and had a moderate to strong intensity (*M* =4.64) with 87.4 % of panelists selected like slightly or greater for chocolate flavor (Figure 8A) and 63% of panelists felt this sample had moderate (4.0) or strong (5.0) chocolate flavor intensity (Figure 8B).

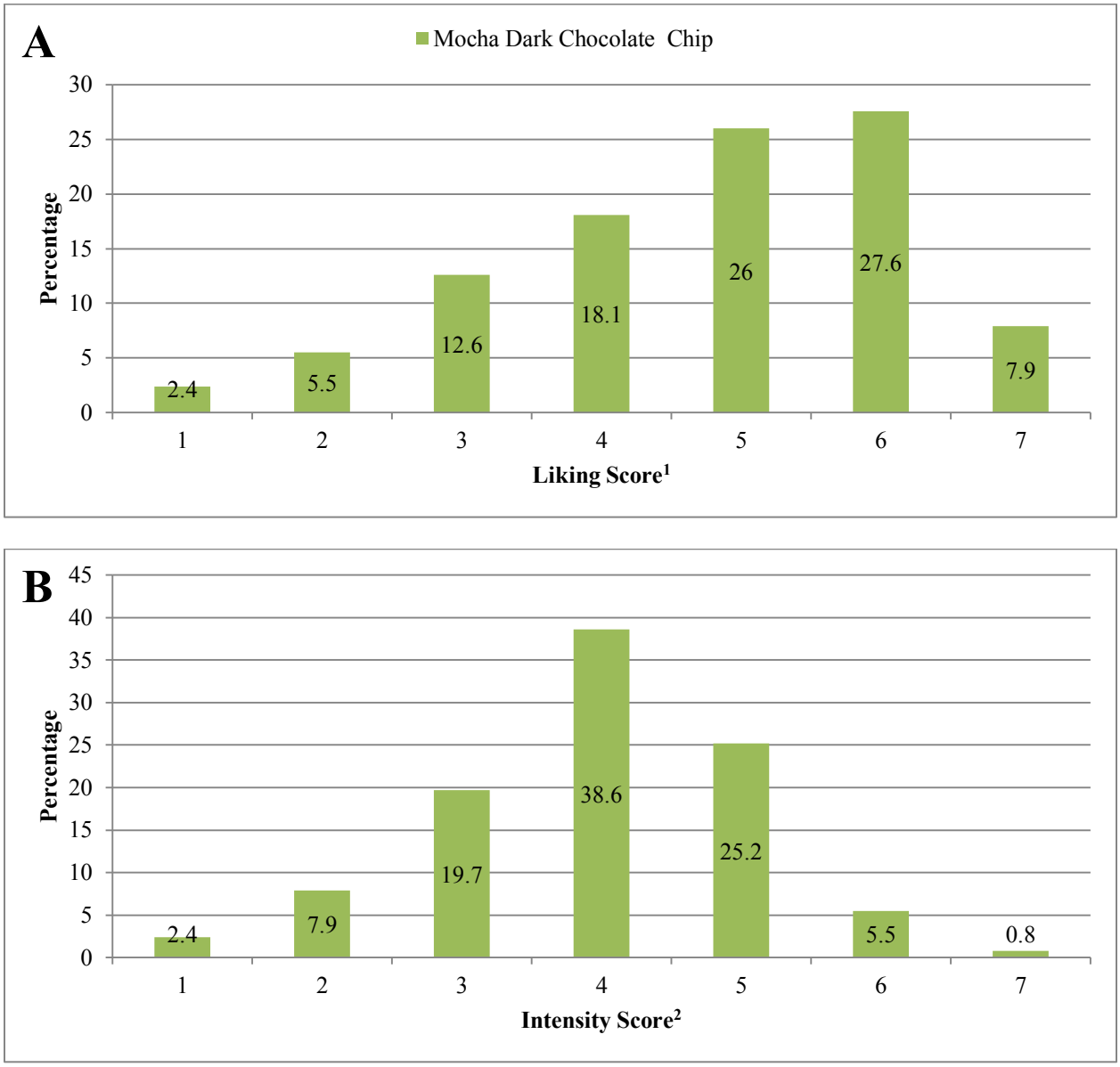


Figure 6. Percentage distribution of bitterness liking (**A**) and bitterness intensity (**B**) for mocha dark chocolate chip.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

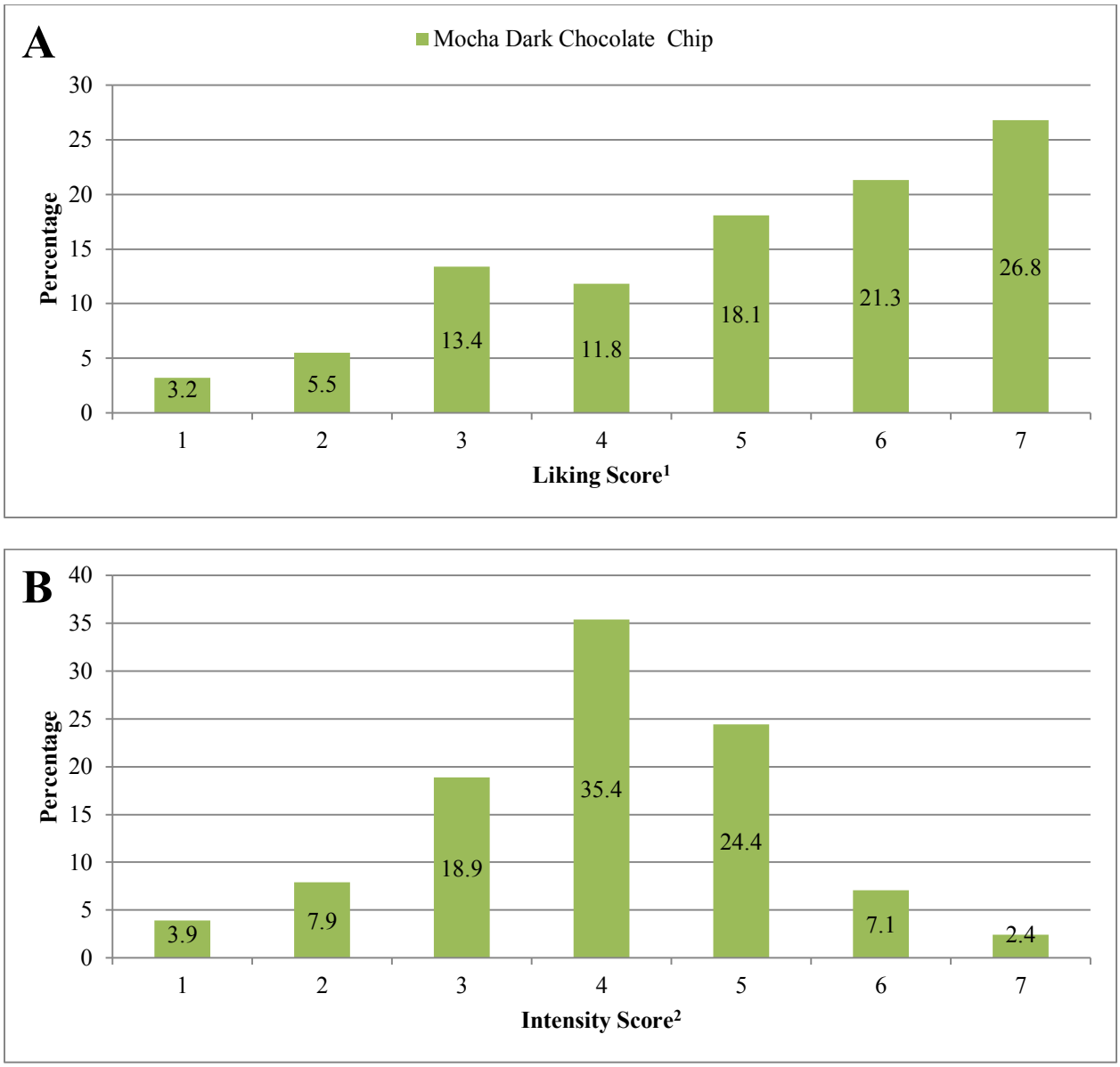


Figure 7. Percentage distribution of coffee flavor liking (**A**) and coffee flavor intensity (**B**) for mocha dark chocolate chip.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

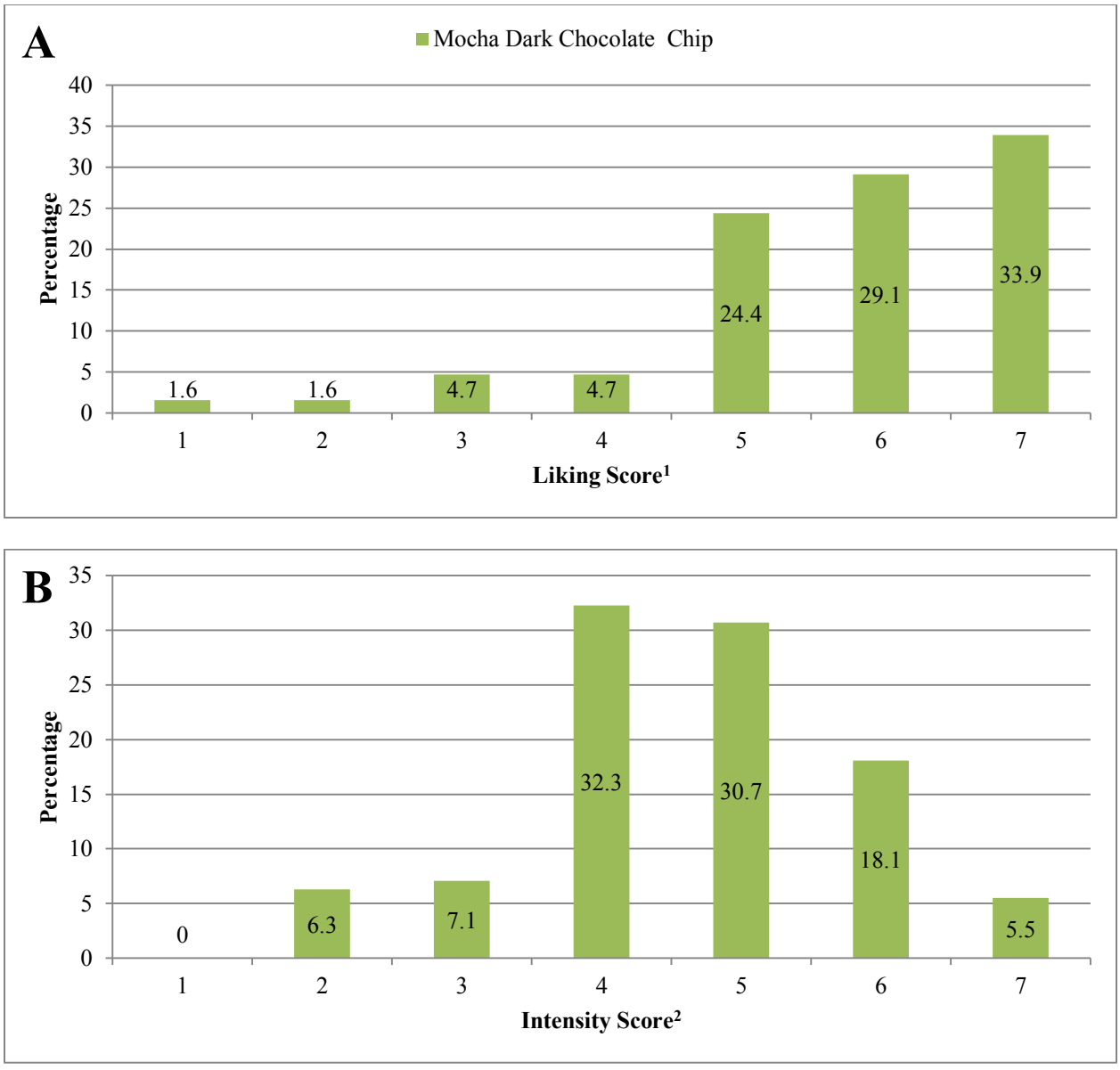


Figure 8. Percentage distribution of chocolate flavor liking (**A**) and chocolate flavor intensity (**B**) for mocha dark chocolate chip.

[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.

[2] Scale for intensity: 1 = *No flavor*, 2= *Weak flavor*, 3 = *Slight flavor*, 4 = *Moderate flavor*, 5= *Strong flavor*, 6 = *Very strong flavor*, 7 = *Extremely strong flavor*. (n=127).

Multiple Comparisons. Data were analyzed by ANOVA ($p<0.05$) and Tukey's HSD where appropriate (IMB SPSS Statistics). Table 6 shows the mean ratings of the liking for appearance, convenience, granola flavor, aftertaste and intent to purchase for apple crisp, blueberry peach cobbler and mocha dark chocolate chip oatmeal samples.

Table 6

Mean Rating Comparisons of the Difference Oatmeal Samples for Appearance, Convenience, Granola Flavor, Aftertaste and Intent to Purchase

Attribute		Descriptive Statistics *M*	*SD*
Appearance – Liking[1]	Apple Crisp	4.66[a]	1.71
	Blueberry Peach Cobbler	3.94[b]	1.77
	Mocha Dark Chocolate Chip	4.83[a]	1.62
Convenience– Liking	Apple Crisp	5.35[a]	1.38
	Blueberry Peach Cobbler	5.23[a]	1.39
	Mocha Dark Chocolate Chip	5.12[a]	1.27
Granola Flavor – Liking	Apple Crisp	4.77[a]	1.45
	Blueberry Peach Cobbler	5.41[b]	1.64
	Mocha Dark Chocolate Chip	5.46[b]	1.48
Aftertaste– Liking	Apple Crisp	4.59[a]	1.43
	Blueberry Peach Cobbler	4.94[a]	1.36
	Mocha Dark Chocolate Chip	4.98[a]	1.38
Intent to Purchase[2]	Apple Crisp	2.92[a]	1.08
	Blueberry Peach Cobbler	3.29[b]	1.16
	Mocha Dark Chocolate Chip	3.41[b]	1.08

Mean values within the same attribute followed by different letters are significantly different ($p<0.05$).
[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*.
[2]Scale for intent to purchase: 1= *Definitely would not buy it*, 2= *Probably would not buy it*, 3= *Might or might not buy it*, 4= *Probably would buy it*, 5= *Definitely would buy it*. (n=127).

A one-way ANOVA revealed that there was a significant difference in the liking scores for appearance, $F(2, 378) = 9.759$, $p<0.05$ noting that both apple crisp (4.66) and mocha dark chocolate chip (4.83) were significantly liked more for appearance than blueberry peach cobbler (3.94) (Figure 9). The results for percent distribution was 58.3 % for apple crisp, 44.9 % for blueberry peach cobbler and 61.5% for mocha dark chocolate chip of ratings greater than 5.

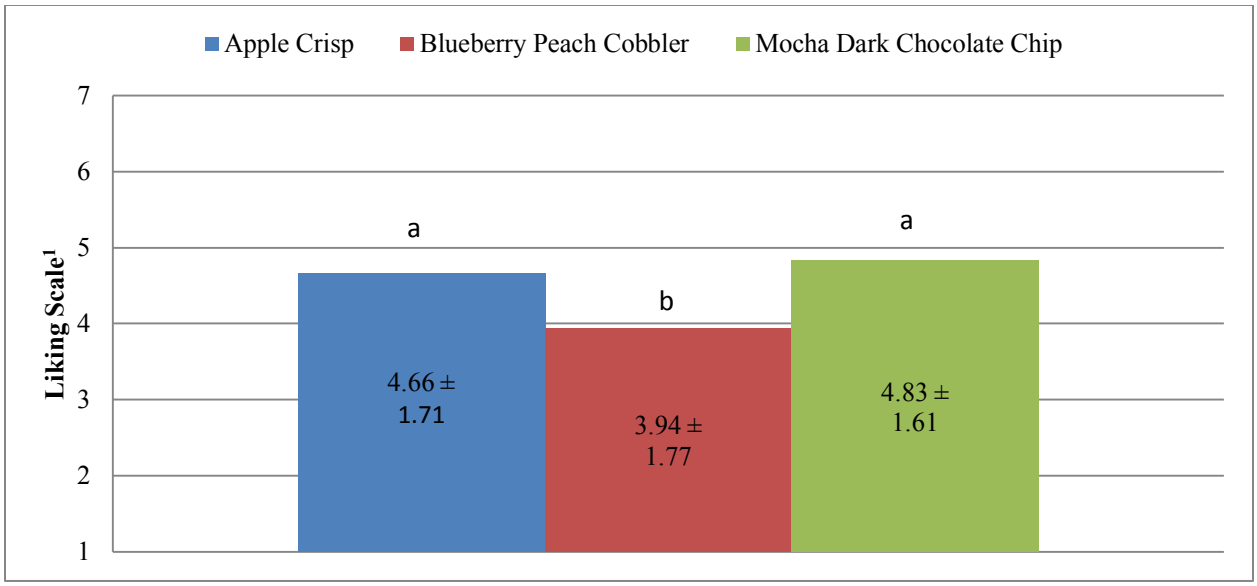


Figure 9. Mean liking scores for appearance of apple crisp, blueberry peach cobbler and mocha dark chocolate chip.
Mean bars having different letters are significantly different ($p<0.05$).
[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*. (n=127).

The convenience of all three oatmeal samples were comparable with ranges of 5.12 + 5.35, indicating like slightly with a distributions of 73.3 % for apple crisp, 68.6 % for blueberry peach cobbler and 66.2% for mocha dark chocolate chip having ratings of liking (5 or greater) for the convenience of granola mix in.

Panelists liked both blueberry peach cobbler (5.41) and mocha dark chocolate chip (5.46) significantly more for granola mix in flavor than apple crisp (4.77) (Figure 10). The percent distribution showed that 66.2 % liked apple crisp, 78.8 % liked blueberry peach cobbler and

81.9% liked mocha dark chocolate chip slightly or greater for granola flavor.

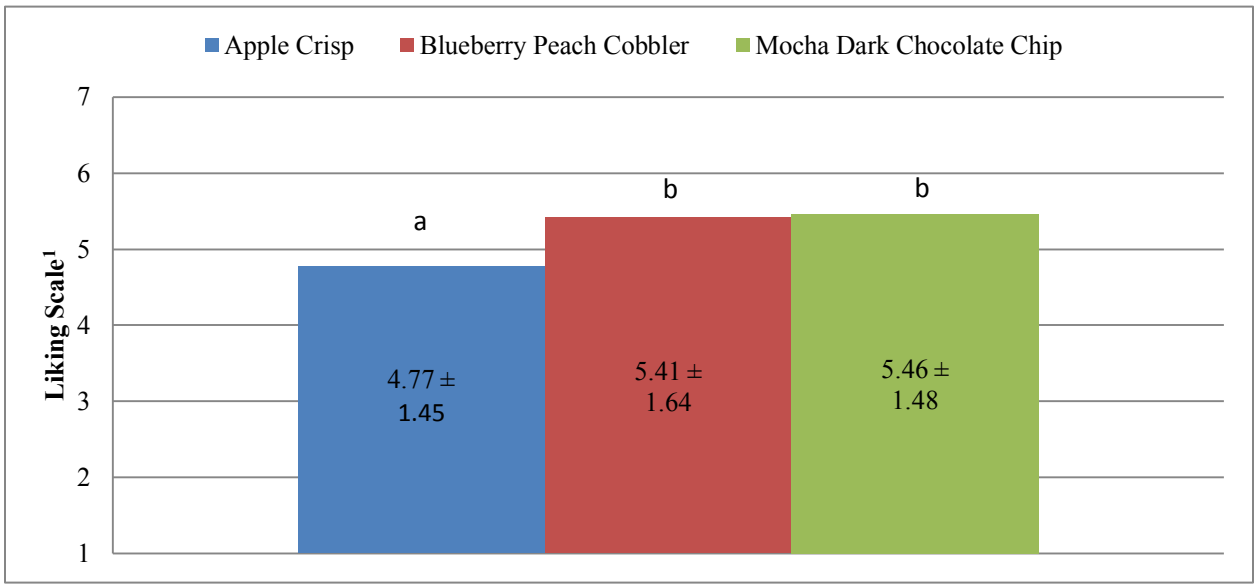


Figure 10. Mean liking scores for granola flavor of apple crisp, blueberry peach cobbler and mocha dark chocolate chip.
Mean bars having different letters are significantly different ($p<0.05$).
[1]Scale for liking: 1= *Dislike extremely*, 2= *Dislike moderately*, 3= *Dislike slightly*, 4= *Neither like nor dislike*, 5= *Like slightly*, 6= *Like moderately*, 7= *Like extremely*. (n=127).

The aftertaste of all three oatmeal samples were not statistically different with more panelists (64.6%) liked the aftertaste of the blueberry peach cobbler than apple crisp (58.2%) or mocha dark chocolate chip (62.3%).

Panelists indicated a greater intent to purchase both blueberry peach cobbler (3.29) and mocha dark chocolate chip (3.41) compared to apple crisp (2.92) (Figure 11). The percent distribution of panelist's scores noted more panelists (51.2%) would probably or definitely buy blueberry peach cobbler, while only 30.7 % probably or definitely would purchase apple crisp), 51.2 % (blueberry peach cobbler) and 47.2% (mocha dark chocolate chip) of panelists selected probably would buy it (4.0) or definitely would buy it (5.0) for intent to purchase.

Discussion. From the first sensory evaluation, the blueberry peach cobbler samples had a greater intensity and greater liking for tartness and fruit flavor compare to the apple crisp sample. Although, apple crisp sample was still liked slightly above the midpoint with liking ranging from 4.45 to 4.71, on the 7-point hedonic scale. These results are comparable with the sensory evaluation (n=89) of bagels prepared with flaxseed (Aliani, Ryland & Pierce, 2012), in which the cinnamon-raisin bagel containing flaxseed was liked slight above the midpoint on the 9-point hedonic scale, when compared with plain and sunflower sesame flaxseed bagels. When flaxseed and non-flaxseed bagels were compared, results (Aliani, Ryland & Pierce, 2012) showed that overall consumer acceptance of non-flaxseed were greater that the flaxseed samples, which had greater bitterness ($M = 2.1 > 0.9$), grain/flax aroma ($M = 5.0 < 1.5$) and grain/flax flavor ($M = 5.5 < 1.2$) and lower sweet taste ($M = 1.9 < 3.0$). The current oatmeal study did not have non-flaxseed oatmeal samples to compare with for consumer acceptance, but if included, may have supported the overall findings of this study.

From the second sensory evaluation, mocha dark chocolate chip was liked the most for its strong chocolate flavor followed the sample's moderate coffee flavor and liked the least for its moderate bitterness intensity. These results are in contrast to the results found within a study comparing chocolate (mint, milk and dark chocolate) using a panel of 46 students, 37% of which were female within the age range of 26-36 years (Ngo & Spence, 2011). These researchers noted that the dark chocolate and solid mint were rated as *neither pleasant nor unpleasant* while mint fondant and milk chocolate were rated at *pleasant*. This study (Ngo & Spence, 2011), along with a previous study (Crisinel & Spence, 2011) suggests that consumers have a "lack of consensus regarding the pleasantness of dark chocolate" (pg. 424). The current oatmeal evaluation

consisted of panelists who slightly to moderately liked the chocolate flavor within the mocha dark chocolate chip samples.

Multiple comparison of the three oatmeal flavors revealed that, there was no difference among samples for the convenience of the granola mix in and the aftertaste. The granola flavor for the mocha dark chocolate chip and blueberry peach cobbler was preferred over the apple crisp granola flavor. The appearance of the mocha dark chocolate chip and apple crisp was preferred over the blueberry peach cobbler appearance. Overall, the mocha dark chocolate was liked the greatest by the panel, followed by blueberry peach cobbler and apple crisp.

According to this study, an acceptable oatmeal breakfast can be made with the addition of flaxseed and chia seed due to mean scores slightly above the midpoint. These results are similar to previous sensory studies; Rendón-Villalobos, Ortíz-Sánchez, Solorza-Feria, & Trujillo-Hernández (2012) in which it was reported that acceptable corn tortillas can be made with the addition of chia seed. Additionally, Girma, Bultosa, & Bussa (2013) reported that with increasing flour substitutes of ground flaxseed in injera (Ethiopian fermented bread) there is an increase in sensory acceptance scores, and Aliani, Ryland & Pierce (2012) reported acceptable bagels can be prepared with the addition of ground flaxseed.

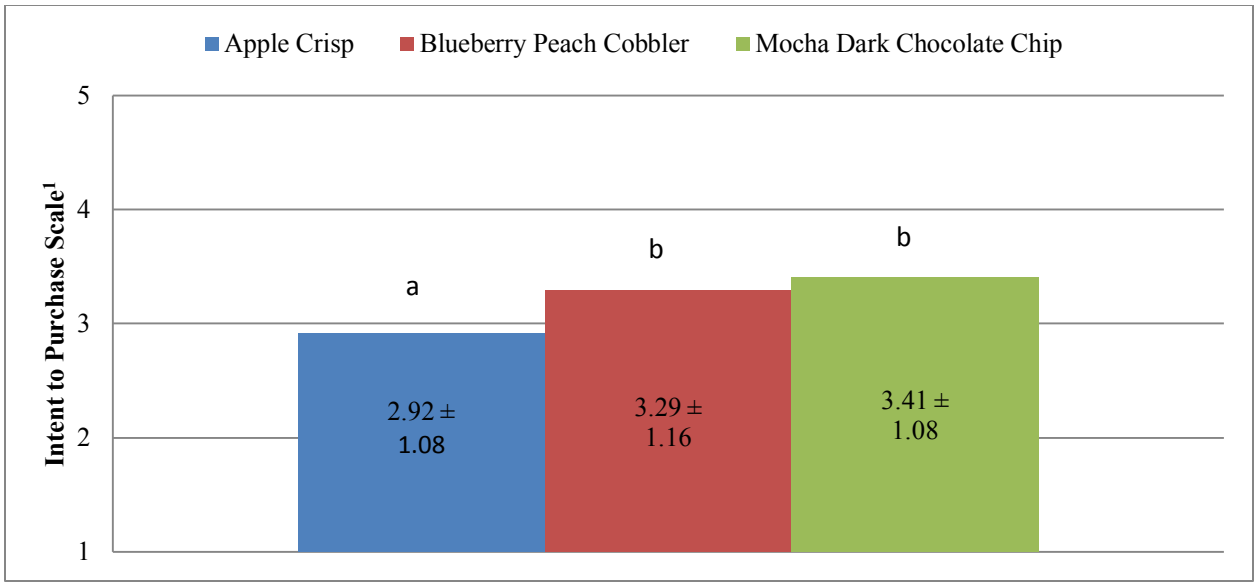
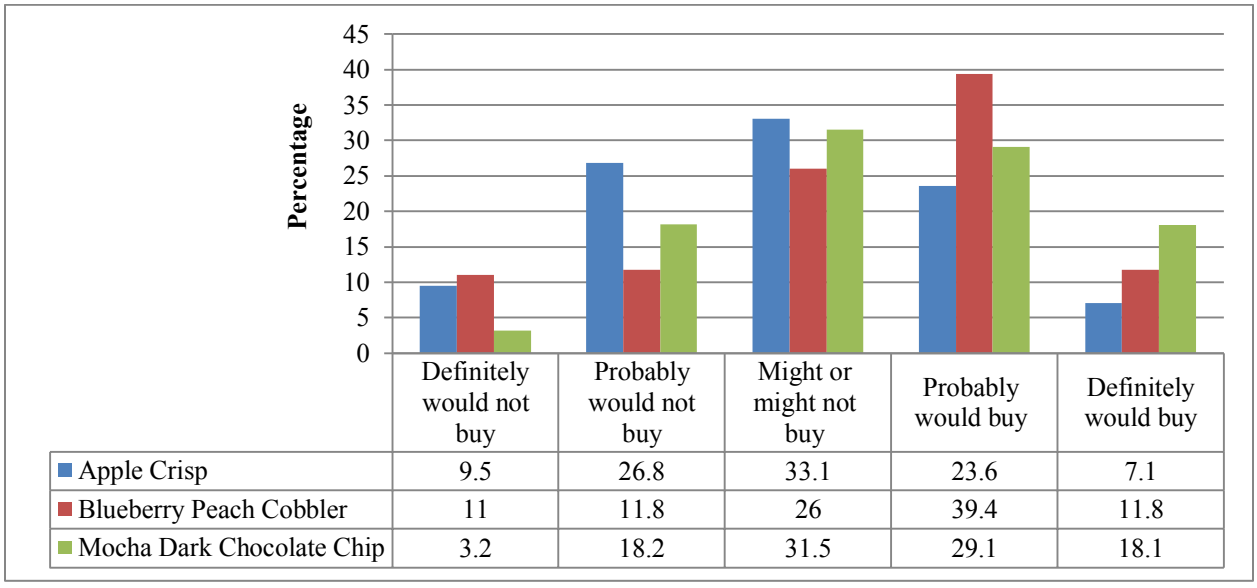


Figure 11. Mean intent to purchase scores for granola flavor of apple crisp, blueberry peach cobbler and mocha dark chocolate chip.

Mean bars having different letters are significantly different ($p<0.05$).

[1]Scale for intent to purchase: 1= *Definitely would not buy it*, 2= *Probably would not buy it*, 3= *Might or might not buy it*, 4= *Probably would buy it*, 5= *Definitely would buy it*,



	Definitely would not buy	Probably would not buy	Might or might not buy	Probably would buy	Definitely would buy
Apple Crisp	9.5	26.8	33.1	23.6	7.1
Blueberry Peach Cobbler	11	11.8	26	39.4	11.8
Mocha Dark Chocolate Chip	3.2	18.2	31.5	29.1	18.1

Figure 12. Percentage distributions of intent to purchase scores for apple crisp, blueberry peach cobbler and mocha dark chocolate chip.

Shelf Life Studies

The water activity for the oatmeal samples were 0.343 ± 0.032 (apple crisp), 0.299 ± 0.022 (blueberry peach cobbler) and 0.320 ± 0.009 (mocha dark chocolate chip) (Table 7). The water activity for the granola samples were 0.148 ± 0.020 (cinnamon), 0.169 ± 0.018 (vanilla) and 0.231 ± 0.008 (mocha dark chocolate). The moisture content for the oatmeal samples were 9.34% (apple crisp), 8.55% (blueberry peach cobbler) and 7.88% (mocha dark chocolate chip). The moisture content for the granola samples were 3.52% (cinnamon), 4.22 % (vanilla) and 4.60 % (mocha dark chocolate).

A critical step is product development is determining the safety and shelf life of the product by measuring the moisture content and water activity. Moisture content measures the amount of free water within a system and indicates the perishability of the food (Ward, 2007). Dried food, such as dried fruit, has a longer shelf life than fresh and has only 1.0% to 15% water (Ward, 2007). The moisture content for the newly developed oatmeal flavors and granola flavors are within this range, which implies that the ingredients are dehydrated and will perish more slowly. Water activity measures the energy state of water within the system that contributes to microbial growth, enzymatic and chemical reactions and is used to predict the growth rates of microorganisms (Anon, 2012). Microbial growth occurs in water activity 0.85-1.00 and is inhibited within the range of 0.70-0.85. Developed oatmeal and granola are below water activity of 0.40 which deem the products as safe and shelf life stable. Results are similar to another study (Kane, Swanson, Lyon & Savage, 2011) which reported oatmeal cookies having a water activity of 0.56.

Table 7

Average Water Activity (a_w) and Moisture Content (%)

	Water Activity	% Moisture Content
Apple Crisp - Oatmeal	0.343 ± 0.032	9.34
Cinnamon Granola	0.148 ± 0.020	3.52
Blueberry Peach Cobbler - Oatmeal	0.299 ± 0.022	8.55
Vanilla Granola	0.169 ± 0.018	4.22
Mocha Dark Chocolate Chip - Oatmeal	0.320 ± 0.009	7.88
Mocha Dark Chocolate Granola	0.231 ± 0.008	4.60

Chapter V: Conclusion

Three naturally flavored oatmeal breakfast cereals were developed with flaxseed and chia seed. The oatmeal was developed as a dry blend to be prepared in the microwave, for convenience, that had a granola mix in developed to be added to the oatmeal after heating. The flavor combinations of products were apple crisp oatmeal with cinnamon granola mix in, blueberry peach cobbler oatmeal with vanilla granola mix in and mocha dark chocolate chip oatmeal with mocha dark chocolate granola and mini dark chocolate chips. Flaxseed and chia seeds were added to the formula in order to increase the omega 3 fatty acids, fiber and protein content. Each serving of oatmeal contained 1.26 grams of omega 3fatty acids with at least 5 grams of fiber and 5 grams of protein. The developed oatmeal products were also low in sodium (< 140 mg sodium) and at 200 calories or less. Samples were measured for both nutritional content and water content. Water activity levels and moisture content were within the accepted range (a_w <0.85 and moisture content within 1% - 15% range). Dry oatmeal blend and granola mix in are shelf life stable and safe for consumption.

Oatmeal and granola mix in products were presented to a focus group of six panelists. The study investigated consumers' thoughts on definition of a healthy breakfast, packaging labels, ingredients, health claims, pricing and informal sensory evaluation of oatmeal prototypes. Overall, college-aged consumers expect a healthy breakfast to be high in fiber and protein. Consumers want to feel satisfied and full after consuming one to two servings and prefer the packaging and label to be simple. College-aged consumers are willing to pay $0.50 per packet of naturally flavored oatmeal ($2.50/box of five packets).

The informal sensory results showed that attributes of appearance, convenience, granola flavor and aftertaste were liked moderately (6.0) for apple crisp, blueberry peach cobbler and

mocha dark chocolate chip. Tartness, fruit flavor and spice flavor of apple crisp and blueberry peach cobbler were liked slightly (5.0) or liked moderately (6.0). Bitterness, coffee flavor and chocolate flavor of mocha dark chocolate chip were liked moderately (6.0) or liked extremely (7.0). Overall, samples were liked well above average and would probably or most- likely be purchased by the focus group panelists. Positive feedback was received on oatmeal prototypes, so no further alterations were made.

Two sensory evaluations were conducted; first evaluating apple crisp and blueberry peach cobbler samples and second evaluating mocha dark chocolate chip sample. Out of the 127 panelists (73% female) that participated in the first sensory analysis, 44.1 % consumed flavored oatmeal daily or weekly and 76% were 18-23 years old. Results indicated that blueberry peach cobbler was significantly liked more for tartness and fruit flavor than apple crisp. Spice flavor was liked slightly more for apple crisp than blueberry peach cobbler, but not significantly greater. Blueberry peach cobbler had a significantly greater intensity for tartness and fruit flavor. Apple crisp had significantly greater spice flavor intensity. Overall, both samples were liked above the midpoint on the 7 point hedonic scale and the 127 panelists preferred blueberry peach cobbler sample over the apple crisp sample.

Out of the 127 panelists (69% female) that participated in the second sensory analysis, 35.1% consumed flavor oatmeal daily or weekly and 69% were 18-23 years old. Three flavor attributes were evaluated for liking and intensity. Chocolate flavor was liked the most, followed by coffee flavor and bitterness. All flavors were liked well above the midpoint on the 7 point hedonic scale. Chocolate flavor had the greatest intensity, followed by coffee flavor and bitterness.

Appearance, convenience, granola flavor, aftertaste and intent to purchase was asked for all three samples; apple crisp, blueberry peach cobbler and mocha dark chocolate chip. Overall, the panelists slightly liked the convenience of the granola mix in and the aftertaste of each sample. The panelists preferred the appearance of the apple crisp and mocha dark chocolate chip over the blueberry peach cobbler. The granola flavor for mocha dark chocolate chip and blueberry peach cobbler was liked significantly more than the apple crisp granola flavor. Mocha dark chocolate chip and blueberry peach cobbler had a significantly greater intent to purchase than the apple crisp.

Overall, the mocha dark chocolate chip received the greater scores of liking for flavor attributes (chocolate, coffee and bitterness), appearance, granola flavor, aftertaste and intent to purchase. Blueberry peach cobbler came in second for liking scores for flavor attributes (fruit flavor and tartness), granola flavor, aftertaste and intent to purchase. Apple crisp received scores above the midpoint on the 7 point hedonic scale and was preferred least of the three samples.

Summary

Three naturally flavor oatmeal samples were successfully developed with the addition of flaxseed and chia seeds. Nutritional content was enhanced (omega 3 fatty acids, fiber and protein) and samples were shelf life stable. Focus group results concluded that samples should be have a simple package and label. College-aged consumers felt that one packet of oatmeal should cost around $0.50. Sensory analysis results showed that samples received ratings above the midpoint on the 7 point hedonic scale for liking of flavor attributes, appearance, convenience, granola flavor and aftertaste. Samples received ratings slightly above the midpoint on the 5 point hedonic scale for intent to purchase. From the two sensory analyses, mocha dark chocolate chip received the greatest intent to purchase, followed by blueberry peach cobbler and apple crisp.

Limitations

The demographics of the panelists were one limitation to this study. There was an unequal distribution of males (~30) and females (~70%) and majority of the panelists were 18-27 years old (~ 85 %). Younger (<18) and older population (>30) was not properly represented in this study. Demographic of current oatmeal consumers' should be researched and another sensory analysis could be conducted to better represent these demographics.

Second limitation to the study was that the panelists were untrained. Some of the panelists showed difficulty in following directions of the taste test. Some panelists did not pour granola mix in onto oatmeal sample or did not flip green light in sensory booth to receive the second sample. Panelists may have been unfamiliar with identifying sensory attributes of samples.

The third limitation to the study was that samples could not be tasted by the same panelists. Apple crisp and blueberry peach cobbler samples were tasted on the same day by the same 127 panelists, while the mocha dark chocolate sample was tasted by some of the same panelists and new panelists. The same 127 panelists did not taste all three samples, but it was not possible to recruit the same panelists or administer all three samples during the same taste test (due to sensory/mental fatigue and carryover effects).

Another limitation to the study was that collected results were not comparable to other products. For example, two sets of sample could have been prepared, flaxseed and chia seed vs. non-flaxseed and non-chia seed, to determine the consumer acceptance for addition the flaxseed and chia seed. New developed oatmeal sample could have also been compared with similar-like oatmeal product currently on the market.

Recommendations

Based on data collected and limitations that occurred, further studies are recommended:

1. To conduct another sensory analysis with participants younger than 18 years old and older than 30 years old. This data could be compared to the current study found with college-aged students.
2. To conduct paired preference sensory analysis with newly developed oatmeal flavors and current market sample (if possible - the current market sells apple crisp flavored oatmeal, but blueberry peach cobbler or mocha dark chocolate chip oatmeal have not been found on the market).
3. To conduct acceptance test for flaxseed and chia seed oatmeal vs. non-flaxseed and non-chia seed oatmeal.

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Appendix A: Nutrition Fact Panels

Apple Crisp Oatmeal

Nutrition Facts

Serving Size (35g)
Servings Per Container

Amount Per Serving

Calories 130	Calories from Fat 30
	% Daily Value*
Total Fat 3g *	**5%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 100mg	**4%**
Total Carbohydrate 23g	**8%**
Dietary Fiber 5g	**20%**
Sugars 10g	
Protein 4g	

Vitamin A 0%	• Vitamin C 8%
Calcium 4%	• Iron 8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Apple Crisp Oatmeal with Granola

Nutrition Facts

Serving Size (51g)
Servings Per Container

Amount Per Serving

Calories 180	Calories from Fat 45
	% Daily Value*
Total Fat 5g *	**8%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 5mg	**2%**
Sodium 115mg	**5%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 6g	**24%**
Sugars 13g	
Protein 5g	

Vitamin A 2%	• Vitamin C 8%
Calcium 4%	• Iron 10%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Blueberry Peach Cobbler Oatmeal

Nutrition Facts

Serving Size (35g)
Servings Per Container

Amount Per Serving

Calories 140	Calories from Fat 30
	% Daily Value*
Total Fat 3.5g *	**5%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 80mg	**3%**
Total Carbohydrate 23g	**8%**
Dietary Fiber 4g	**16%**
Sugars 8g	
Protein 4g	

Vitamin A 0% • Vitamin C 0%

Calcium 4% • Iron 8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Blueberry Peach Cobbler Oatmeal with Granola

Nutrition Facts

Serving Size (51g)
Servings Per Container

Amount Per Serving

Calories 190	Calories from Fat 45
	% Daily Value*
Total Fat 5g *	**8%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 5mg	**2%**
Sodium 90mg	**4%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 5g	**20%**
Sugars 11g	
Protein 6g	

Vitamin A 0% • Vitamin C 0%

Calcium 4% • Iron 10%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Mocha Dark Chocolate Chip Oatmeal

Nutrition Facts

Serving Size (35g)
Servings Per Container

Amount Per Serving

Calories 140	Calories from Fat 35
	% Daily Value*
Total Fat 3.5g *	**5%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 80mg	**3%**
Total Carbohydrate 22g	**7%**
Dietary Fiber 4g	**16%**
Sugars 7g	
Protein 5g	

Vitamin A 0% • Vitamin C 0%

Calcium 4% • Iron 8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Mocha Dark Chocolate Chip Oatmeal with Granola & Mini Dark Chocolate Chips

Nutrition Facts

Serving Size (51g)
Servings Per Container

Amount Per Serving

Calories 200	Calories from Fat 60
	% Daily Value*
Total Fat 6g *	**9%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 85mg	**4%**
Total Carbohydrate 32g	**11%**
Dietary Fiber 5g	**20%**
Sugars 13g	
Protein 6g	

Vitamin A 0% • Vitamin C 0%

Calcium 4% • Iron 10%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300 mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

*1.26 g omega 3 fatty acid

Appendix B: Focus Group Prescreening Questionnaire

Volunteer for a Paid Focus Group

Naturally Flavored Oatmeal

Name_____ Email_____

Please answer the following questions to see if you qualify for this focus group.

1. How often do you consume **flavored oatmeal** breakfast cereal?
   1 = Never
   2 = Yearly
   3 = Monthly
   4 = Weekly
   5 = Daily

2. How often do you consume **flaxseed**?
   1 = Never
   2 = Yearly
   3 = Monthly
   4 = Weekly
   5 = Daily

3. How often do you consume **chia seed**?
   1 = Never
   2 = Yearly
   3 = Monthly
   4 = Weekly
   5 = Daily

4. Please indicate either you AGREE or DISAGREE with this statement - Consuming products with **natural** ingredients is important to me.
   1 = Strongly disagree
   2 = Somewhat disagree
   3 = Neither disagree nor agree
   4 = Somewhat agree
   5 = Strongly agree

5. Please indicate either you AGREE or DISAGREE with this statement – I am interested in **learning** about new naturally flavored oatmeal products.
   1 = Strongly disagree
   2 = Somewhat disagree
   3 = Neither disagree nor agree
   4 = Somewhat agree
   5 = Strongly agree

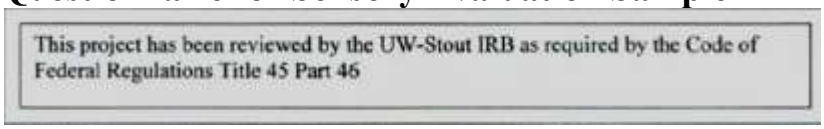
6. Please indicate either you AGREE or DISAGREE with this statement – I am interested in **tasting** new naturally flavored oatmeal products.
   1 = Strongly disagree
   2 = Somewhat disagree
   3 = Neither disagree nor agree
   4 = Somewhat agree
   5 = Strongly agree

7. If you are interested in participating in this Focus Group, please **check all** of the time slots you would be available to participate.

   □ Tuesday, February 26th 9:00 am – 10:00 am
   □ Tuesday, February 26th 10:00 am – 11:00 am
   □ Thursday, February 28th 9:00 am – 10:00 am
   □ Thursday, February 28th 10:00 am – 11:00 am
   □ I am not available during these time slots
   □ I am not interested in participating

Appendix C: Focus Group Informal Sensory Questionnaire

Questionnaire for Sensory Evaluation Sample 1



Instructions: Please pour sample cup labeled TOPPING into sample cup labeled **756** Use the spoon to stir and answer the following question BEFORE tasting the sample.

1. How much do you LIKE or DISLIKE the APPEARANCE of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

2. How much do you LIKE or DISLIKE the CONVENIENCE of adding the TOPPING of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

Instructions: Now you can taste your sample. Please answer the following questions.

3. How much do you LIKE or DISLIKE the FLAVOR of the TOPPING?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

4. How much do you LIKE or DISLIKE the TARTNESS of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

5. How would you rate the INTENSITY of the TARTNESS?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

6. How much do you LIKE or DISLIKE the FRUIT FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

7. How would you rate the INTENSITY of the FRUIT FLAVOR in the sample?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

8. How much do you LIKE or DISLIKE the SPICE FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

9. How would you rate the INTENSITY of the SPICE FLAVOR in the sample?

1 = No flavor
2= Weak flavor
3 = Slight flavor
4 = Moderate flavor
5= Strong flavor
6 = Very strong flavor
7 = Extremely strong flavor

Instructions: Please wait 30 seconds after tasting the sample to answer the following question.

10. How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

1= Dislike extremely
2= Dislike moderately
3= Dislike slightly
4= Neither like nor dislike
5= Like slightly
6= Like moderately
7= Like extremely

---

11. How likely would you be to purchase this oatmeal product if it were available at your local grocer?

1 = Definitely would not buy it
2= Most-likely not buy it
3 = Probably would not buy it
4 = Might or might not buy it
5 = Probably would buy it
6= Most-likely buy it
7 = Definitely would buy it

Questionnaire for Sensory Evaluation Sample 2

Instructions: Please pour sample cup labeled TOPPING into sample cup labeled **984** Use the spoon to stir and answer the following question BEFORE tasting the sample.

1. How much do you LIKE or DISLIKE the APPEARANCE of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

2. How much do you LIKE or DISLIKE the CONVENIENCE of adding the TOPPING of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

Instructions: Now you can taste your sample. Please answer the following questions.

3. How much do you LIKE or DISLIKE the FLAVOR of the TOPPING?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

4. How much do you LIKE or DISLIKE the TARTNESS of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

5. How would you rate the INTENSITY of the TARTNESS?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

6. How much do you LIKE or DISLIKE the FRUIT FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

7. How would you rate the INTENSITY of the FRUIT FLAVOR in the sample?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

8. How much do you LIKE or DISLIKE the SPICE FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

9. How would you rate the INTENSITY of the SPICE FLAVOR in the sample?

1 = No flavor
2= Weak flavor
3 = Slight flavor
4 = Moderate flavor
5= Strong flavor
6 = Very strong flavor
7 = Extremely strong flavor
6 = Extremely strong flavor

Instructions: Please wait 30 seconds after tasting the sample to answer the following question.

10. How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

1= Dislike extremely
2= Dislike moderately
3= Dislike slightly
4= Neither like nor dislike
5= Like slightly
6= Like moderately
7= Like extremely

---

11. How likely would you be to purchase this oatmeal product if it were available at your local grocer?

1 = Definitely would not buy it
2= Most-likely not buy it
3 = Probably would not buy it
4 = Might or might not buy it
5 = Probably would buy it
6= Most-likely buy it
7 = Definitely would buy it

Questionnaire for Sensory Evaluation Sample 3

Instructions: Please pour sample cup labeled TOPPING into sample cup labeled **235** Use the spoon to stir and answer the following question BEFORE tasting the sample.

1. How much do you LIKE or DISLIKE the APPEARANCE of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

2. How much do you LIKE or DISLIKE the CONVENIENCE of adding the TOPPING of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

Instructions: Now you can taste your sample. Please answer the following questions.

3. How much do you LIKE or DISLIKE the FLAVOR of the TOPPING?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

4. How much do you LIKE or DISLIKE the COFFEE FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

5. How would you rate the INTENSITY of the COFFEE FLAVOR?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

6. How much do you LIKE or DISLIKE the CHOCOLATE FLAVOR of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

7. How would you rate the INTENSITY of the CHOCOLATE FLAVOR in the sample?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

---

8. How much do you LIKE or DISLIKE the BITTERNESS of this sample?
   1= Dislike extremely
   2= Dislike moderately
   3= Dislike slightly
   4= Neither like nor dislike
   5= Like slightly
   6= Like moderately
   7= Like extremely

9. How would you rate the INTENSITY of the BITTERNESS in the sample?
   1 = No flavor
   2= Weak flavor
   3 = Slight flavor
   4 = Moderate flavor
   5= Strong flavor
   6 = Very strong flavor
   7 = Extremely strong flavor

Instructions: Please wait 30 seconds after tasting the sample to answer the following question.

10. How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

1= Dislike extremely
2= Dislike moderately
3= Dislike slightly
4= Neither like nor dislike
5= Like slightly
6= Like moderately
7= Like extremely

11. How likely would you be to purchase this oatmeal product if it were available at your local grocer?

1 = Definitely would not buy it
2= Most-likely not buy it
3 = Probably would not buy it
4 = Might or might not buy it
5 = Probably would buy it
6= Most-likely buy it
7 = Definitely would buy it

13. How often do you consume flavored oatmeal?

1 = Daily
2 = Weekly
3 = Monthly
4 = Yearly
5 = Never

14. Please indicate your gender.

1 = Female
2 = Male

15. Please indicate your age.

1 = 18-20
2 = 21-23
3 = 24-27
4 = 28+

Appendix D: Sensory Questionnaire: Apple Crisp & Blueberry Peach Cobbler

WELCOME to COMPUSENSE *five*

To start the test, click on the Continue button below and Switch Light To GREEN:

Panelist Code: _____

Today, you will be tasting two samples of flavored oatmeal with a granola mix-in (GM).

Please turn on the green light in front of you to receive your first oatmeal sample. Please pour sample cup labed GM (granola mix-in) into oatmeal sample cup. Use the spoon to stir and answer a series of questions about the appearance, flavor, and texture. Once you are finished with your first sample, Please Drink water before going on to the next sample, and then Please turn on the green light again to receive your second oatmeal sample.

Please eat as much as needed to form an opinion. Please give one response per question. There is no right or wrong answer to each of these questions; we are only interested in your opinions.

Thank you and let's begin!

Please look at the sample in front of you and answer the following questions.

DO NOT eat the sample yet.

Question # 1 - Sample _____

Reminder: Please pour sample cup labeled GM into oatmeal sample cup. Use the spoon to stir the mixture and answer the following question.

How much do you LIKE or DISLIKE the APPEARANCE of this sample?

Appearance

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 2 - Sample _____

How much do you LIKE or DISLIKE the CONVENIENCE of adding the GRANOLA MIX-IN (GM) into this sample?

CONVENIENCE

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

Now please taste this sample and answer the following questions:

Question # 3 - Sample _____

How much do you LIKE or DISLIKE the FLAVOR of the GM (granola mix-in) ?

Flavor

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 4 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the TARTNESS of this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

How would you rate the INTENSITY of the TARTNESS of this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 5 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the FRUIT FLAVOR of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the FRUIT FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Question # 6 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the SPICE of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the SPICE FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Please wait 30 seconds after the sample has been swallowed to rate the aftertaste.

Question # 7 - Sample _____

How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

Aftertaste

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 8 - Sample _____

How likely would you be to purchase this oatmeal product if it were available at your local grocer?

- ☐ Definitely would not buy it
- ☐ Probably would not buy it
- ☐ Might or might not buy it
- ☐ Probably would buy it
- ☐ Definitely would buy it

Please look at the sample in front of you and answer the following questions.

DO NOT eat the sample yet.

Question # 1 - Sample _____

Reminder: Please pour sample cup labeled GM into oatmeal sample cup. Use the spoon to stir the mixture and answer the following question.

How much do you LIKE or DISLIKE the APPEARANCE of this sample?

Appearance

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 2 - Sample _____

How much do you LIKE or DISLIKE the CONVENIENCE of adding the GRANOLA MIX-IN (GM) into this sample?

CONVENIENCE

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

Now please taste this sample and answer the following questions:

Question # 3 - Sample _____

How much do you LIKE or DISLIKE the FLAVOR of the GM (granola mix-in) ?

Flavor

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 4 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the TARTNESS of this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

How would you rate the INTENSITY of the TARTNESS of this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 5 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the FRUIT FLAVOR of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the FRUIT FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Question # 6 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the SPICE of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the SPICE FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Please wait 30 seconds after the sample has been swallowed to rate the aftertaste.

Question # 7 - Sample _____

How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

Aftertaste

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 8 - Sample _____

How likely would you be to purchase this oatmeal product if it were available at your local grocer?

- ☐ Definitely would not buy it
- ☐ Probably would not buy it
- ☐ Might or might not buy it
- ☐ Probably would buy it
- ☐ Definitely would buy it

Question # 9.

How often do you consume flavored oatmeal?

- ❍ Daily
- ❍ Weekly
- ❍ Monthly
- ❍ Yearly
- ❍ Never

Question # 10.

Please indicate your gender.

- ❍ Female
- ❍ Male

Question # 11.

Please indicate your age.

- ❍ 18-20
- ❍ 21-23
- ❍ 24-27
- ❍ 28+

THANK YOU and Enjoy a treat as you exit!

Appendix E: Sensory Analysis Questionnaire: Mocha Dark Chocolate Chip

WELCOME to COMPUSENSE *five*

To start the test, click on the Continue button below and Switch Light To GREEN:

Panelist Code: _____

Today, you will be tasting one sample of flavored oatmeal with a granola mix-in (GM).

Please turn on the green light in front of you to receive your oatmeal sample. Please pour sample cup labed GM into oatmeal sample cup. Use the spoon to stir and answer a series of questions about the appearance, flavor, and texture.

Please eat as much as needed to form an opinion. If you need more water knock on the metal window. Please give one response per question. There is no right or wrong answer to each of these questions; we are only interested in your opinions.

Thank you and let's begin!

Please look at the sample in front of you and answer the following questions.

DO NOT eat the sample yet.

Question # 1 - Sample _____

Reminder: Please pour sample cup labeled GM into oatmeal sample cup. Use the spoon to stir the mixture and answer the following question.

How much do you LIKE or DISLIKE the APPEARANCE of this sample?

Appearance

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 2 - Sample _____

How much do you LIKE or DISLIKE the CONVENIENCE of adding the GRANOLA MIX IN (GM) into this sample?

CONVENIENCE

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

Now please taste this sample and answer the following questions:

Question # 3 - Sample _____

How much do you LIKE or DISLIKE the FLAVOR of the GM (granola mix in) ?

Flavor

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 4 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the BITTERNESS of this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

How would you rate the INTENSITY of the BITTERNESS in this sample?

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 5 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the COFFEE FLAVOR of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the COFFEE FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Question # 6 - Sample _____

Please answer the following questions:

How much do you LIKE or DISLIKE the CHOCOLATE FLAVOR of this sample?

- ☐ Dislike extremely
- ☐ Dislike moderately
- ☐ Dislike slightly
- ☐ Neither like nor dislike
- ☐ Like slightly
- ☐ Like moderately
- ☐ Like extremely

How would you rate the INTENSITY of the CHOCOLATE FLAVOR in the sample?

- ☐ No flavor
- ☐ Weak flavor
- ☐ Slight flavor
- ☐ Moderate flavor
- ☐ Strong flavor
- ☐ Very strong flavor
- ☐ Extremely strong flavor

Please wait 30 seconds after the sample has been swallowed to rate the aftertaste.

Question # 7 - Sample _____

How much do you LIKE or DISLIKE the AFTERTASTE of this sample?

Aftertaste

- ☐ like very much
- ☐ like moderately
- ☐ like slightly
- ☐ neither like nor dislike
- ☐ dislike slightly
- ☐ dislike moderately
- ☐ dislike very much

Question # 8 - Sample _____

How likely would you be to purchase this oatmeal product if it were available at your local grocer?

- ☐ Definitely would not buy it
- ☐ Probably would not buy it
- ☐ Might or might not buy it
- ☐ Probably would buy it
- ☐ Definitely would buy it

Question # 9.

How often do you consume flavored oatmeal?

- ❍ Daily
- ❍ Weekly
- ❍ Monthly
- ❍ Yearly
- ❍ Never

Question # 10.

Please indicate your gender.

- ❍ Female
- ❍ Male

Question # 11.

Please indicate your age.

- ❍ 18-20
- ❍ 21-23
- ❍ 24-27
- ❍ 28+

THANK YOU and Enjoy a treat as you exit!

Compusense *five*

Appendix F: UW-Stout IRB Approval

January 31, 2013

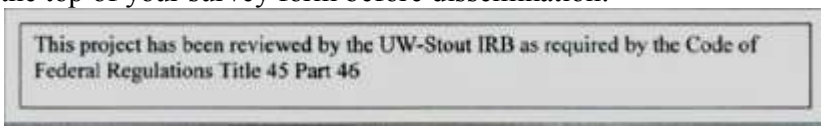
Courtney Mendini, Cynthia Rohrer, Renee Surdick
Food & Nutrition
UW-Stout

RE: Consumer Acceptance of Flavored Oatmeal Prepared with Flaxseed and Chia Seeds

Dear Courtney, Cynthia, Renee,

The IRB has determined your project, "*Consumer Acceptance of Flavored Oatmeal Prepared with Flaxseed and Chia Seeds"* is **Exempt** from review by the Institutional Review Board for the Protection of Human Subjects. The project is exempt under **Category # 6** of the Federal Exempt Guidelines and holds for 5 years. Your project is approved from **1/31/2013**, through **1/30/2018**. Should you need to make modifications to your protocol or informed consent forms that do not fall within the exemption categories, you will need to reapply to the IRB for review of your modified study.

If your project involved administration of a survey, please copy and paste the following message to the top of your survey form before dissemination:



If you are conducting an **online** survey/interview, please copy and paste the following message to the top of the form:
"This research has been reviewed by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46."

Informed Consent: All UW-Stout faculty, staff, and students conducting human subjects research under an approved "exempt" category are still ethically bound to follow the basic ethical principles of the Belmont Report: 1) respect for persons; 2) beneficence; and 3) justice. These three principles are best reflected in the practice of obtaining informed consent from participants.

If you have questions, please contact Research Services at 715-232-1126, or foxwells@uwstout.edu, and your question will be directed to the appropriate person. I wish you well in completing your study.

Sincerely,

Susan Foxwell

Susan Foxwell
Research Administrator and Human Protections Administrator,
UW-Stout Institutional Review Board for the Protection of Human Subjects in Research (IRB)

Appendix G: Consent Form: Sensory Analysis Apple Crisp & Blueberry Peach Cobbler

Consent to Participate In UW-Stout Approved Research

Title: Consumer Acceptance of Flavored Oatmeal

Investigators: Courtney Mendini, graduate student, Dr. Cynthia Rohrer, x-2088, room 368 HEC, Renee Surdick Renee Surdick, EdD, Program Coordinator, University of Wisconsin-Stout, Stout Technology Transfer Institute.

Description: You will be taking part in a sensory evaluation of a sample of flavored oatmeal used with natural ingredients. If you have any dietary restrictions that would make you unable to eat these food items, then you should not take part in the evaluation.

Risks and Benefits: Care has been taken so that all risks associated with food products have been reduced. Samples of flavored oatmeal have remained sealed and freshly prepared just prior to evaluation.

Time Commitment and Payment: Each subject will receive compensation for their participation. Each evaluation should require no more than 15 min.

Confidentiality: Your name will not be included on any documents. We do not believe that you can be identified from any of this information. This informed consent will not be kept with any of the other documents completed with this project.

Right to Withdraw: Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to participate and later wish to withdraw from the study, you may discontinue your participation at this time without incurring adverse consequences.

IRB Approval: This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator: Dr. Cynthia Rohrer
715-232-2088
rohrerc@uwstout.edu

Courtney Mendini
262-271-6321
mendinic6065@uwstout.edu

IRB Administrator:
Sue Foxwell, Director, Research Services
152 Vocational Rehabilitation Building
UW-Stout
Menomonie, WI 54751
715-232-2477
foxwells@uwstout.edu

Statement of Consent:

By signing this consent form you agree to participate in the project entitled, "Consumer Acceptance of Flavored Oatmeal"

_____ _____

Signature Date

Appendix H: Consent Form: Sensory Analysis Mocha Dark Chocolate Chip

Consent to Participate In UW-Stout Approved Research

Title: Consumer Acceptance of Flavored Oatmeal

Investigators: Courtney Mendini, graduate student, Dr. Cynthia Rohrer, x-2088, room 368 HEC, Renee Surdick Renee Surdick, EdD, Program Coordinator, University of Wisconsin-Stout, Stout Technology Transfer Institute.

Description: You will be taking part in a sensory evaluation of a sample of flavored oatmeal used with natural ingredients. If you have any dietary restrictions that would make you unable to eat these food items, then you should not take part in the evaluation.

Risks and Benefits: Care has been taken so that all risks associated with food products have been reduced. Samples of flavored oatmeal have remained sealed and freshly prepared just prior to evaluation.

Time Commitment and Payment: Each subject will receive compensation for their participation. Each evaluation should require no more than 15 min.

Confidentiality: Your name will not be included on any documents. We do not believe that you can be identified from any of this information. This informed consent will not be kept with any of the other documents completed with this project.

Right to Withdraw: Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to participate and later wish to withdraw from the study, you may discontinue your participation at this time without incurring adverse consequences.

IRB Approval: This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator: Dr. Cynthia Rohrer
715-232-2088
rohrerc@uwstout.edu

Courtney Mendini
262-271-6321
mendinic6065@uwstout.edu

IRB Administrator:
Sue Foxwell, Director, Research Services
152 Vocational Rehabilitation Building
UW-Stout
Menomonie, WI 54751
715-232-2477
foxwells@uwstout.edu

Statement of Consent:

By signing this consent form you agree to participate in the project entitled, "Consumer Acceptance of Flavored Oatmeal"

_____ _____

Signature Date

Appendix I: Consent Form: Focus Group

Consent to Participate in Focus Group

You have been asked to participate in a focus group sponsored by the Graduate students of Food Science and Technology of University of Wisconsin Stout for a Thesis Project. The purpose of the group is to obtain consumer feedback and recommendations of new naturally flavored oatmeal products. The information learned in the focus groups will be used to optimize oatmeal prototypes and to optimize the Compusense® survey being issued for in future sensory evaluations. You can choose whether or not to participate in the focus group and stop at any time. Although the focus group will be tape recorded, your responses will remain anonymous and no names will be mentioned in the report. There is no right or wrong answers to the focus group questions. We want to hear many different viewpoints and would like to hear from everyone. We hope you can be honest even when your responses may not be in agreement with the rest of the group. In respect for each other, we ask that only one individual speak at a time in the group and that responses made by all participants be kept confidential.

I understand this information and agree to participate fully under the conditions stated above:

Signed:_____ Date:_____

Appendix J: Focus Group Discussion Guideline

Focus Group Guideline

Introduction

1. Introduce self
   a) Fill out consent form
2. Ground rules:
   a) Free to participate or not participate at any time
   b) No right or wrong answers
   c) One person talking at a time
   d) Respect others' opinions
   e) Video recording of the focus group; destroyed upon completion of the study
   f) May leave at anytime

Ice breakers

3. State your name
4. Briefly describe the breakfast you had this morning

Discussion Questions

5. What factors were involved in selecting that breakfast?
6. What is your definition of a "Healthy breakfast cereal"?
7. What do the words "natural" and "organic" mean to you when you see it on a food item?
8. What are some benefits/disadvantages of labels?
9. How do you feel when your see that omego-3 is advertised on the label?
10. How do you feel when your see that high-fiber is advertised on the label?
11. What is the "best" way to grab your attention when purchasing a food product?
12. How much would you be willing to pay for a prepackaged oatmeal product?

Sensory Evaluation

13. Hand out fruit flavored samples (apple crisp and blueberry peach cobbler) and granola toppings (cinnamon topping and vanilla topping) with questionnaire.
14. Hand out mocha dark chocolate chip sample with granola topping with questionnaire.
15. Go over thoughts and opinions of the samples

Closing

Any last comments?
Thank you for your time.