

Perceptions of Taste and Knowledge of Sources of Dietary Fiber and How That Relates to Their  
Consumption of Dietary Fiber in Snack Bars

by

Tami R. Stibb

A Research Paper  
Submitted in Partial Fulfillment of the  
Requirements for the  
Master of Science Degree  
in

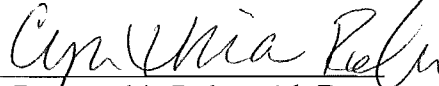
Food and Nutritional Sciences

Approved: 6 Semester Credits

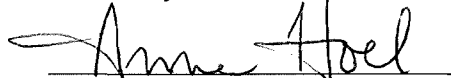


Dr. Charlene Schmidt Ph.D, RD, CD, Thesis Advisor

Thesis Committee Members



Dr. Cynthia Rohrer, Ph.D



Dr. Anne Hoel, Ed

The Graduate School

University of Wisconsin-Stout

May 2011

**The Graduate School  
University of Wisconsin-Stout  
Menomonie, WI**

**Author:** Stibb, Tami R.

**Title:** *Perceptions of Taste and Knowledge of Sources of Dietary Fiber and the Consumption of Dietary Fiber in Snack Bars*

**Graduate Degree/ Major:** MS Food and Nutritional Sciences

**Research Adviser:** Charlene Schmidt, PhD, RD, CD

**Month/Year:** May, 2011

**Number of Pages:** 111

**Style Manual Used:** *American Psychological Association, 6<sup>th</sup> edition*

**Abstract**

Dietary fiber has been an important positive nutrient of the carbohydrate family. The early 1900's were when dietary fiber started to be studied and connected with specific diseases and health problems. Fiber has been fortifying many products today from pancake mix to cottage cheese. Although fiber is more readily available, research shows us that the average American is consuming only 15 grams of dietary fiber per day.

This study investigated the perceptions of dietary fiber among students at University Wisconsin-Stout aged 18 to 30 years old. Data were collected by a sensory evaluation taste testing of snack bars, high and low in dietary fiber. Some of the questions asked included: characteristics about the bars; which bar participants liked most, knowledge regarding sources of fiber, their perceived knowledge, demographical information, as well as how often participants consume fiber products.

The majority of the participants were between 18 and 24 years old and 70% of total participants were female. Results indicated that participants preferred the high fiber snack bar in its texture, appearance and flavor over the low fiber bar. The high fiber snack bar was liked overall, this was not statistically significant at  $p < 0.05$ . Perceptions about their own knowledge regarding dietary fiber, 38.4% of participants indicated having “very much knowledge”. Today’s typical American diet leads to a total daily consumption of dietary fiber much lower than the 25 grams for adult females and 38 grams for adult males, that health officials are currently recommending; thus, researching additional information about dietary fiber can help health officials better educate consumers’ on selecting healthy food options.

The Graduate School  
University of Wisconsin Stout

Menomonie, WI

### Acknowledgments

From the beginning to the end of the thesis process certain people have been very influential in my success. First and for most my thesis advisor Charlene Schmidt has been an amazing mentor and demonstrated great patience and leadership towards me. Without her guidance I would have been lost much of the time. I would also like to thank my other two thesis committee members; Cynthia Rohrer for her statistical, food sensory analyses and helping with the data collection process, and Anne Hoel for her time with revisions and ability to look at my research from a non-nutritional background standpoint. All three of their professional comments and many revisions that were made throughout my development made this research to the professional level that is expected at the University of Wisconsin – Stout. Without these three professors, and now friends, this research would not have been as successful as it was. Additionally, I would like to acknowledge Stephanie Kaltenberg, a dear friend, for helping me assemble, and keep track of participants during the study.

Although not directly involved, my loving parents and close friends supported me through the struggles and long nights with their encouragement and love that they have for me. I thank everyone from the bottom of my heart for being a part of my life and helping to make one more great success happen and come true for me in my overall journey. Thank you everyone! Finally, I would like to dedicate this paper to my loving brother Travis John Stibb who passed away December 19, 2010.

## Table of Contents

	<b>Page</b>
.....	
Abstract .....	2
List of Tables.....	7
List of Figures .....	8
Chapter I: Introduction .....	9
Introduction and Rationale .....	9
Statement of the Problem .....	14
Purpose Statement .....	14
Research Hypotheses.....	16
Definition of Terms .....	17
Assumptions .....	21
Limitations .....	21
Chapter II: Literature Review .....	23
Introduction .....	23
General Knowledge of Dietary Fiber .....	23
Recommendations and Benefits .....	25
Supported Research.....	39
Chapter III: Methodology.....	47
Introduction .....	47
Description of Variables.....	47
Selection of Samples .....	48
Instrumentation.....	49

Data Collection Procedures .....	51
Data Analysis Procedures.....	52
Limitations of Methods, Samples and Procedures .....	53
Chapter IV: Results .....	55
Introduction .....	55
Demographic Data.....	55
Sensory of Snack Bars.....	57
Overall Texture .....	58
Overall Appearance.....	60
Overall Flavor .....	62
Overall Preference.....	64
Perception of Knowledge.....	65
Selecting High Fiber Sources.....	67
How Often Fiber was Consumed .....	73
Reasons for Consumption of High Fiber.....	76
Chapter V: Discussion.....	78
Introduction .....	78
Major Findings .....	78
Conclusions .....	88
Limitations .....	89
Recommendations .....	90
References .....	92
Appendix A: UW-Stout IRB Approval Form .....	103
Appendix B: Paper Copy of Survey Used in Compusense® .....	105
Appendix C: Consent to Participant in UW-Stout Approved Research Project .....	109

## List of Tables

	Page
.....	
Table 1: Percentage of Liking for Overall Texture of the High Fiber and Low Fiber Bars .....	60
Table 2: Percentage of Liking for Overall Appearance of the High Fiber and Low Fiber Bars ...	62
Table 3: Percentage of Liking for Overall Flavor of the High Fiber and Low Fiber Bars .....	64
Table 4: Percentage of Liking Overall Preference of the High Fiber and Low Fiber Bars .....	65
Table 5: Participants Perceptions About Their Dietary Fiber Knowledge .....	66
Table 6: Number of Participants That Selected Particular Items as a High Fiber Source .....	70
Table 7: Percentage of Participants That Selected High Fiber Items Correctly .....	72
Table 8: The Difference Between Nutrition and Non-Nutrition Related Students in Their Selection of High Fiber Items .....	73
Table 9: The Number of Participants That Consumed High Fiber Sources in a Given Time Line .....	73
Table 10: The Number of Participants That Consumed High Fiber Sources in a Given Time Line Between Two Age Range Categories.....	76
Table 11: Top Reasons Why Participants Consumed High Fiber Foods and the Percentage Of Participants That Responded Similarly .....	77

## List of Figures

	<b>Page</b>
Figure 1: Age distribution of participants.....	56
Figure 2: Distributions of students majors.....	57
Figure 3: Overall mean liking scores for texture of two samples of fiber bars .....	59
Figure 4: Overall mean scores for appearance by participants.....	61
Figure 5: Overall mean scores for flavor by participants .....	63
Figure 6: Percentage of participants that correctly selected items as a high fiber source .....	71
Figure 7: Percentage of participants that selected specific time lines for how often they Consume high fiber sources.....	74
Figure 8: Percentage of participants aged 25-30 and how often they consume high fiber items ..	75



## Chapter I: Introduction

### Introduction and Rationale

Dietary fiber is a vital nutrient that needs more attention as it provides tremendous health benefits for the human body. Dietary fiber was first studied in the early 1900's, discovered as a positive nutrient that was associated with specific diseases and health problems (Anderson & Deskins, 1995). Fiber has been an important nutrient of the carbohydrate family since researchers have come to understand the benefits. Dietary fiber is not something new to food markets; it has however, become a new diet trend in society as well as a new marketing tool to get consumers to purchase various food products. Dietary fiber is a nutrient that has accelerated with increased popularity in the last several years. According to Brandt (2003), the Global New Product Database (GNPD) had 29 new products have dietary fiber claims on the packaging in 2002 in the United States and Canada alone; that was up from 24 items in 2001, 21 items in 2000 and only six new items has dietary fiber claims in 1999. Brandt (2003) continues to state that the GNPD tagged a total of 662 new products globally as "added fiber" in 2002. This fiber fascination is likely related to the growing number of people in Western parts of the world that are developing health problems and diseases such as, diabetes mellitus, obesity and cardiovascular diseases that may be prevented if dietary fiber were being consumed more regularly, as Karakaya and Kavas (1999) claim. Manufacturers have caught onto this trend and have developed more food products with added fiber; such as, yogurt, cottage cheese, granola bars and even pancake mix.

Several studies have been designed to assess how dietary fiber affects the human body in many different ways, showing for example, that fiber helps regulate the flow of waste material in the digestive tract, helps with lowering blood cholesterol and glucose levels. Advertisements,

such as Fiber One® cereals market most of their commercials towards adults above the age of thirty. There have been many studies conducted on elderly and various disease states.

According to Sturtzel and Elmadfa (2008), in nursing home facilities, a leading factor related to a poor nutritional status in elderly people is constipation. Most nursing homes use laxatives which can have negative side effects to the residents. Sturtzel and Elmadfa (2008) conducted a study with thirty residents, fifteen in the control group and fifteen ingesting an oat bran product that was either blended into their daily lunch soup or dessert. Results of this study were that the residents in the intervention group accepted the soup and dessert which increased their daily fiber consumption by 5.1 grams per day over 84 total days. This ultimately led to a 59% discontinuation of laxatives in the nursing home facility. Kromhout, Bloemberg, Seidell, Nissinen and Menotti (2001) conducted a seven country study with 12,763 men aged 40-59 years old where they measured height, weight and subscapular skinfold. Information were gathered about job related physical activity, and diet by way of a questionnaire between the years of 1958 to 1964. The results of this study suggested that physical activity and dietary fiber were the most important environmental factors relating to levels of body fat.

There have been much fewer studies conducted on college-aged student's eighteen to thirty years old and how they perceive dietary fiber. This age group should be studied for several important reasons. For instance, college students between the ages of eighteen and thirty may be in impressionable years where they're starting to make their own decisions on many life aspects, including making choices of what foods to purchase and consume. According to Deniz (2004), University students have a lot of problems in daily life and these problems are becoming more complicated; having efficient problem solving skills become very important when dealing with these problems. Deniz (2004) continues to state, "both problem solving and decision making can

be described as a whole complex process” (p. 34). For students that live in campus housing, Kolodinsky, Harvey-Berino, Berlin, Johnson and Reynolds (2007) have stated it very well, “Their decisions about what to eat are currently made in an environment where no nutrition labeling is required” (p. 1409). Another reason that college students were important to study was the types of foods choices this age group tends to make. For example, according to Georgiou, Betts, Hoerr, Keim, Peters, Stewart and Voichick (1997), today’s young people are the first generation to have grown up with the benefits of dietary guidelines to reduce the intake of fat and increase the intake of complex carbohydrates and dietary fiber. Georgiou et al. (1997) continues to states, major contributors to fat intake among young adults aged eighteen to twenty four were ground beef, pizza and cheese for men and ground beef, poultry and salad dressing for women. Items like these are often replacing more nutrient dense food, such as vegetables, fruits and whole grains which are fiber filled. Further discussing college-aged students, Davy, Benes and Driskell (2006) state, “college students’ often do not meet dietary recommendations for the consumption of nutrients” (p. 1673). Davy, Benes and Driskell (2006) continue to discuss, that the typical college student diet consists of high fat and sodium while low in fruits and vegetables. Because of this potential negative impact on their body, it is important to rid the body of waste material and toxins; increasing dietary fiber consumption may help with this issue. Further investigating what dietary fiber is, how it can help the body and the perceptions that this age group has about eating dietary fiber can better equip health professionals regarding what they know and what they still need to learn.

Dietary fiber is a vital nutrient that the body does not absorb; however, it helps to expel toxins in our bodies and rid the body of waste material on a regular basis so it does not lead to detrimental health problems. According to D’inca, Pomerri, Vettorato, Dal Pont, Di Leo,

Ferronato, Medici, & Sturniolo, (2007) some of these health problems would include: irritable bowel syndrome (IBS), colon cancer, diverticulosis, diverticula, and colon tumors. In addition, Karakaya and Kavas (1999) indicate that dietary fiber also helps lower the risk of heart disease, improves blood glucose tolerance and lowers lipid levels. Untreated conditions can also cause painful symptoms such as stomach cramps, intestinal pains, bloating and constipation.

According to Sjóðin, Nyman, Nilsson, and Lagerstad (1985), as stated in Karakaya and Kavas (1999), the health problems previously listed could be prevented or at a minimum be improved with proper dietary modification and lifelong behavior change. Sjodin et al. also stated, as in Karakaya and Kavas (1999) that between 35% and 56% of human cancers could be attributed to dietary habits. This large percentage can be improved by diet alone, especially in the United States. In addition, Karakaya and Kavas (1999), state that, “in western societies, colon cancer is the most common malignancy in both males and females” (p. 319). Colon cancer is rarely seen in places such as Africa, South America and Asia where diets are high in dietary fiber from fruits, vegetables and whole grains and lower in meats and saturated fatty foods such as cheese, as discussed in Karakaya and Kavas (1999). The factors noted above in combination with consumption of healthier whole foods and less fatty highly processed foods are major contributors to having a healthier colon and decreased risk factors. Research has been conducted on colon cancer incidences being associated mainly with environmental factors such as, the foods consumed by different cultures, rather than genetic or racial components.

Protection against these diseases, as Nishiyama, Naga and Yano (1991) and Lapre' & Van der Meer (1992) as discussed in Karakaya and Kavas (1999), “...are related to the physiochemical behaviors of fiber, high water-holding capacity, viscosity enhancing effect, gel-forming properties, high absorption capacity, activation of intestinal enzymes, and alteration of

micro flora of gut” (p. 321). All of those characteristics (high water-holding capacity, gel-forming properties, etc.) are central factors in how dietary fiber affects the body and performs in the body when consumed.

Colon cancer, irritable bowel syndrome, heart disease, diverticulitis and other health complications may be attributed from not consuming enough dietary fiber. It was thought that if the proper decisions and eating habits are not well established during childhood, then as young adults they need to be taught the current recommendations for dietary fiber, as well as all health recommendations; as preventative measures need to be the area of focus for health. For example, research has shown that when a family gathers for dinner around the dining table more regularly, many tend to eat additional healthy meals than families that do not. According to Diamond (2010), only one third of families now meet over the dinner table, compared with more than 80% ten years ago. Families eating together can bring up more conversation about healthy eating habits. Diamond (2010) states, “eating together is good for communication... It is also the only way we can watch what everyone is eating” (p. 28). Diamond continues to discuss that family is the key to improved health and families should gather around the dinner table at least five times a week. During childhood years they may not understand the impact of consuming some very vital nutrients may inflict on their bodies, including dietary fiber. And in determining the perceptions that college-aged students have on dietary fiber, the reasons why this age group does not consume enough fiber or know the importance of what dietary fiber can do for them now and what health problems fiber can help prevent can be educated. One factor that may be associated with low fiber consumption was the perceptions of flavor and texture. In addition, the students may not have able to distinguish what foods have fiber in them or may simply not know that a diet high in fiber was important for their health now and later in life. Also, it was

important to study this topic with these specific age groups (college-ages students) because they can start a trend for better colon health and an overall healthy lifestyle for future generations.

### **Statement of the Problem**

The purpose of this study was to determine the 1) perceptions of fiber flavor, 2) knowledge of sources of fiber, and 3) how perception of fiber knowledge related to consumption of dietary fiber. The population was among college students' ages eighteen to thirty years old attending the University of Wisconsin-Stout. The sample was collected during the spring semester of 2009. To measure perceptions, knowledge and reasons for frequency of consumption of these products were investigated; subjects voluntarily participated in a sensory taste testing between a high-fiber snack bar and a low-fiber snack bar. Data were collected through Compusense<sup>®</sup> 5.0, which was the world leader in software applications for sensory evaluation. Compusense<sup>®</sup> promotes sound scientific sensory analysis, was user-friendly and gave immediate data feedback. Therefore, subjects sat down at an individualized computer screen where they selected/filled in their answers as they taste-tested. This study measured the students' ability to identify a whole food, product and/or supplements that are considered a high source of dietary fiber and compare it to their perceptions of appearance, texture and flavor between a low and high-fiber snack bar. This study sought to determine how often participants consume high dietary fiber sources and the reasons that relate to the frequency of consumption.

### **Purpose Statement**

The purpose of this study was to determine attributes on dietary fiber among UW-Stout students aged eighteen to thirty years old. Nutrition is a vital component to survival and fiber is one of those nutrients that are needed to maintain optimal health. Fiber is an extremely important aspect of the human diet; however, it is one of those nutrients that are often

overlooked, especially among young adults. According to a study conducted by Patterson, Kristal, and White (1996), young adults that understand the goals or need for dietary fiber consumption, according to the National Cancer Institute, had an increased awareness to increase their fiber intake and decrease fat intake more than the young adults that did not understand these goals or needs. Although the advocacy for fiber has been on the rise over the last several years, many young adults do not consider it an important factor for them when it comes to a healthy lifestyle, along with many other aspects for optimal health. The question arises about what would influence some young adults that dietary fiber was important for them to consume and not only later in life. College students are in impressionable years where most are transitioning from living with their parents or guardians to living with other college students, on their own or in dormitories. When these young adults enter college they are now responsible for purchasing groceries with many students having financial restrictions and may be uncertain of what foods are healthy selections. The students that live in dormitories have options provided by the cafeteria, and therefore need guidance on making healthful food choices, stated by Peterson, Duncan, Null, Roth and Gill (2010). Students' nevertheless need to make that educated choice between the often not so healthy pizza and the more nutritious option of grilled chicken and broccoli or between the bacon and eggs and the fiber-fortified cereal. This was in addition to possibly having a lack of basic nutrition and fiber knowledge, and possible weight gain. Experts in the field (Peterson et al., 2010) stated that

*Healthy People 2010* aims to increase the proportion of college students who receive information on dietary practices, nutrition, and disease prevention. To meet these national objectives, action must be taken to increase education related to food choice, nutrition, and disease prevention within the college setting. (p.425)

Based off of the researchers past experience, weight gain among first year college students was often called, 'the freshman 15', where weight was gained by many freshmen during their first semester or year of college due to different environmental factors; eating habits, lack of exercise and sudden alcohol consumption. A study conducted by, Gropper, Simmons, Gaines, Drawdy, Saunders, Ulrich and Connell (2009) found that weight gain was a problem among two-thirds of college freshman, although the "the freshman 15" was a myth for most students. Gropper et al. further discussed, "although the average gain was less than 3 lbs, about 9% gained >10 lbs and about one third gained  $\geq 5$  lbs. Only about 5% of students gained the legendary "freshman 15." (p. 228). There was a need to analyze college-aged students so that the information gained by research about dietary fiber can help medical professionals inform the college-aged population on dietary fiber and how it can benefit their health. Testing a high-fiber compared to low-fiber snack bar provided information about perceived flavor, which may change college-aged students perceptions that high-fiber products are acceptable in flavor and are not associated with the negative taste that some advertisements portray. Assessing beliefs about dietary fiber, knowledge and reasons for intake gained by the current study can offer insight to medical professionals to better educate young adults on healthy food consumption.

### **Research Hypotheses**

This study investigated the perceptions of college students on the University of Wisconsin -Stout campus age eighteen to thirty years old about flavor and knowledge of sources of fiber and how that related to their consumption of dietary fiber. Below is a list of research objectives that was under investigation.

1. The participants will prefer the low fiber snack bar over the high fiber snack bar in regards to the overall appearance, flavor and texture.



2. The participants age 25-30 will consume high dietary fiber whole foods, products, and/or fiber supplements more frequently than participants aged 18-24.
3. There will be no difference between genders for selecting at least 50% of high fiber source foods/supplements from a list.
4. Students will be able to select at least 50% of the high fiber source foods/supplements from a list.

### **Definition of Terms**

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

**Cellulose.** According to Merriam-Webster Online Dictionary (2008), cellulose is a polysaccharide of glucose that is the main part of the cell walls of plants. An example of where it is found in nature would be cotton or kapok.

**Chitin.** According to Laguna and Claudio (2004), chitin is an amino-polysaccharide containing beta (1, 4) linkage. This is found in the exoskeleton of arthropods (crabs and lobsters) and the cell walls of most fungi and is also considered a functional fiber.

**Complex Carbohydrates.** According to some experts in the field (Grodner, Long, & DeYoung, 2004) complex carbohydrates are polysaccharides that are bonds of many monosaccharide's that are held together which makes it difficult for the human body to digest properly. Complex carbohydrates would include starch and dietary fiber.

**Dextrins.** According to Merriam-Webster Online Dictionary (2008), dextrins are any of various water-soluble gummy polysaccharides obtained from starch by the action of heat, acids, or enzymes and used as adhesives, as thickening agents like in syrups and in beer.

**Dietary Fiber.** This term can be defined in many different forms but all have similar meanings. According to the American Dietetic Association (2002), as defined by the Institute of Medicine, dietary fiber is primarily the non-digestible carbohydrates and lignin that are intrinsic and intact in plants. Another way of defining dietary fiber could be such as stated by the American Association of Cereal Chemists (Definition of Dietary Fiber, 2008, n.p.), “Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances.”

**Diverticula.** According to Mayo Clinic Staff (2009), are small, bulging pouches that can form anywhere in your digestive system, including your esophagus, stomach and small intestine. However, they're most commonly found in the large intestine.

**Diverticulitis Disease.** According to Mayo Clinic Staff (2009), diverticulitis occurs when one or more diverticula in your digestive tract become inflamed or infected.

**Functional Fiber.** As discussed in the Journal of the American Dietetic Association (2008), the Institute of medicine defined functional fiber in 2002 as, “consisting of the isolated non-digestible carbohydrates that have beneficial physiological effects in the human beings” (p. 1716).

**Gums.** According to Laguna and Claudio (2004), gums are a diverse group of highly viscous polysaccharides usually isolated from the seed group. They are used as food ingredients for their thickening, gelling, and stabilizing properties in recipes. Gums are found in a variety of oats, bran, barley, and legumes, and are classified as dietary or functional fiber.

**Insoluble Fiber.** According to the American Dietetic Association (2009), Insoluble fiber helps to keep toxins moving through the digestive tract. Sources of insoluble fiber include whole-grain breads and cereals; wheat, oat and corn bran; many vegetables, like broccoli, green beans and sweet potatoes. Additionally, some foods, such as oatmeal and beans, have both soluble and insoluble fiber in them.

**Irritable Bowel Syndrome.** According to Mayo Clinic Staff (2009), irritable bowel syndrome (IBS) is a common disorder that affects the large intestine (colon). Irritable bowel syndrome commonly causes cramping, abdominal pain, bloating gas, diarrhea and constipation. Despite these uncomfortable signs and symptoms, IBS doesn't cause permanent damage to your colon.

**Legumes.** Anderson and Deskins (1995), states that peas, beans, lentils, peanuts and other podded plants used as food and are good sources of dietary fiber, carbohydrate, incomplete protein, certain vitamins and minerals. Legumes are a primary source of resistant starch, with as much as 35% passing the digestion process.

**Lignin.** McCrady (2004), states that lignin is found in all vascular plants, mostly between cells, but also within cells, and in cell walls. Lignin is a substance that makes vegetables firm and crunchy. Its function's are to regulate the transport of liquid in the living plant, and it enables trees to grow taller and compete for sunshine.

**Oligosaccharides.** Anderson and Deskins (1995), states that there are three to ten simple sugars (monosaccharide's) bonded into a single molecule or complex sugar; raffinose and stachyose are two oligosaccharides that the body cannot digest, therefore allowing the bacteria in our intestine to produce lots of gas.

**Pectin.** According to Anderson and Deskins (1995), pectin is a complex carbohydrate extracted from apple pulp and citrus rinds that have the capacity to gel. Food processors use pectin to thicken and stabilize candies, syrups and frozen desserts as well as to set jellies, jams and preserves.

**Polydextrose.** Polydextrose is a sugar substitute that is derived from dextrose and is a good source of dietary fiber; it is a food ingredient that can be used as a low calorie substitute in many recipes and can also be used as a thickening agent in foods.

**Polysaccharides.** According to Laguna and Claudio (2004), a carbohydrate containing ten or more monosaccharide units, examples being: glycogen, starch, and dietary fiber.

**Psyllium.** According to Laguna and Claudio (2004), psyllium is a dried ripe seed of *Plantago psyllium* and related species. It is a rich source of dietary fiber, which is effective in regulating the blood sugar levels and in lowering blood cholesterol, especially low-density lipoprotein (LDL).

**RDA.** Also known as Recommended Dietary Allowance is the estimated amount of a nutrient (or calories) per day considered necessary for the maintenance of good health, this is decided by the Food and Nutrition Board of the National Research Council/ National Academy of Sciences. The RDA is updated periodically to reflect new knowledge.

**Resistant Starch.** Resistant starch is the combination of starch and starch-degradation products that cannot be digested in the small intestine. It also contributes to the dietary fiber that is reaching the large intestine. Legumes are the primary source of resistant starch, reaching as much as 35%.

**Simple Carbohydrates.** According to the CDC (2008), Simple carbohydrates include sugars found naturally in foods such as fruits, vegetable milk, and milk products. Simple

carbohydrates also include sugars added during food processing and refining. In general, foods with added sugars have fewer nutrients than foods with naturally-occurring sugars.

**Soluble Fiber.** According to the American Dietetic Association (2009), soluble fiber is in foods such as, oats and oat bran, brown rice and beans, and they may help decrease blood cholesterol levels, reducing your risk of heart disease.

**Total Fiber.** Total fiber is the combination of both dietary fiber and functional fibers.

### **Assumptions**

Assumptions of this study were that the students from the University of Wisconsin – Stout will complete the computerized survey that was presented to them honestly, accurately and to the best of their own knowledge and beliefs. Another assumption may be that a number of international students would participate in this study and therefore add to the variety of the demographics.

### **Limitations**

One limitation of the study was included that only the University of Wisconsin-Stout was being studied and therefore results cannot make a complete conclusion that all college students have the same perspectives on dietary fiber across the population. Another limitation was that participation of the study was voluntary. Although, advertising was done across participation and in a variety of course work, more emphasis for participation will be within the dietetic courses, where they possibly will be rewarded with extra credit points in their courses for participation; thus possibly skewing the data because they possessed a higher level of nutrition knowledge than students from other majors. The snack bars contained milk, soy, almond, peanut, sunflower and wheat ingredients and thus people with allergies were not able to participate. A final limitation may have been if the participants recognized any of the snack bars

by flavor, appearance or texture; this could persuaded them to select the one they are familiar with as the preferred choice and as the high fiber snack bar. Participates may also have selected a certain bar because they may thought that was what the research was seeking.

## **Chapter II: Literature Review**

### **Introduction**

Three different sections are included within this chapter. The first section will include information about dietary fiber. This knowledge will define dietary fiber, the different types of dietary fiber and the roles they play in the body when consumed as well as the sources in which they can be found. The next section will discuss the RDA of dietary fiber to consume and the importance of consuming foods high in dietary fiber for disease prevention and health benefits. The final section will discuss any research that supports or that is related to the perceptions of fiber, whole-grains and college-aged students' eating habits, and other related issues by researchers and accredited health professionals.

### **General Knowledge of Dietary Fiber**

Consumers are even starting to invest in supplements as additional fiber sources, although, according to the American Dietetic Association (2008), few fiber supplements have been studied for physiological effectiveness; therefore, the best advice for consumers was to get their dietary fiber from whole foods when possible. This stirs up confusion with the general public of what fiber is, how much should be consumed and how fiber benefits the body. Fiber is a unique nutrient that is difficult for people to understand since it is not absorbed in the body and/or it does not poses any calories like all other nutrients. The purpose of this current research paper was to understand and help educate college-aged students at UW-Stout, and others, on the topic of dietary fiber and its perceptions.

Dietary fiber is the components of plants that cannot be digested by the human digestive system or absorbed by the small intestine in the human body. According to the American Dietetic Association (2008), there is no biochemical assay that reflects dietary or functional fiber

status, in other words, blood fiber levels cannot be measured because it cannot be absorbed in the body. Other non-digestible carbohydrates that are intrinsic and intact in plants would include: plant non-starch polysaccharides, (such as, cellulose, pectin, gums, hemicelluloses, and other fibers that are within oat and wheat bran), oligosaccharides, lignin, as well as some resistant starch (Koracs, 2000). According to Koracs, functional fiber is a combination of isolated, non-digestible carbohydrates that have physiological health benefits to the human body. Examples of these would include, resistant starch, pectin, gums, chitin, chitosan, or commercially produced such as, polydextrose, inulin, and indigestible dextrins. Koracs adds to the discussion, that the total fiber is what really counts in terms of the human diet. Total fiber would be the sum of dietary fiber and functional fiber.

Dietary fiber comes in the form of complex carbohydrates from fruit, vegetable, whole-grains, legumes (which are beans and peas), seeds and nuts. There is no dietary fiber in simple carbohydrates, for example table sugar. Dietary fiber breaks down into two different types; soluble and insoluble.

Koracs (2000) discusses that soluble dietary fiber is defined by how it functions in the body compared with insoluble fiber. Soluble fiber can be dissolved in water to create a jelly-like substance. This gel-like consistency is formed in the intestine and regulates the flow of waste material in the digestive tract. Soluble dietary fiber helps with lowering blood cholesterol and glucose levels. Another function of soluble fiber is that it helps increase stool volume and stool water content. This is the reason why it is important to increase water consumption when starting to increase fiber more in the daily diet. A rule of thumb is for every gram of fiber that is increased in your diet, one ounce of water should also be increased. According to Koracs, in addition to the above functions, soluble fiber slows stomach emptying time, which delays



absorption of glucose into the blood stream; this has been shown to help regulate diabetes which will be discussed later in this chapter. Soluble fiber can be found in the following sources: oats, legumes (beans, peas and soybeans), apples, bananas, citrus fruits, carrots, berries, barley, and psyllium.

In contrast, insoluble fiber does not dissolve in water. As insoluble fiber's main function is to accelerate intestinal transit or the movement of toxins through the digestive tract, Koracs (2000) states. Another function insoluble fiber has, it can help increase fecal weight, and slow starch hydrolysis, which creates softer and larger feces. As feces move through the intestinal tract, insoluble fiber basically scraps the walls of the intestine to remove waste material. The increased stool bulk, by insoluble fiber, is what will help with constipation and irregular stool complications. Insoluble fiber can be found in whole wheat foods, wheat bran, nuts, seeds, cereals, brown rice, vegetables (eg. celery) and the skins of some fruits (eg. apples) and vegetables (eg. potatoes).

### **Recommendations and Benefits**

The Institute of Medicine (2008) discusses that the Dietary Reference Intake (DRI) recommendations for consumption of dietary fiber is 14 grams for every 1000 kilocalories consumed for an adult. These recommendations are in agreement with the American Dietetic Association (2008). Further, these recommendations translate to 25 grams of fiber for adult females and 38 grams for adult males. The Mayo Clinic Staff (2007) enhance these recommendations with specificity, 25 grams of fiber for females when 50 years old or younger, 21 grams of fiber for females when 51 years or older. Recommendations for males are also more specific, 38 grams of fiber when 50 years old or younger, 30 grams of fiber for males when 51 years or older. There has been conflicting recommendations of fiber for children and the elderly,

and values are based on the consumption of 14 grams of fiber per 1000 kilocalories consumed. The American Dietetic Association (2008) indicates that limited research has shown previous fiber recommendations for children older than two years were to take their age and add five grams of fiber. For example, if the child was six years old they should consume eleven grams of fiber daily. This estimation would continue until they have reached the age of twenty.

According to the American Dietetic Association (2008), “no published studies have defined desirable fiber intakes for infants and children younger than age two years. Until there is more information about the effects of dietary fiber in the very young, a rational approach would be to introduce a variety of fruits, vegetables, and easily digestible cereals as solid foods are brought into the diet”. According to Ruottinen, Lagström, Niinikoski, Rönnemaa, Saarinen, Pakkala, Hakanen, Viikari, and Simell (2010), they considered recommendations controversial for children aged thirteen months to nine years old because it may displace energy. Ruottinen et al. (2010) studied 543 children, and discovered the opposite to be true; they divided the children into three separate groups, all ingesting different amounts of fiber, fiber did not displace energy and children with a high fiber diet received more vitamins and minerals than children with lower fiber intakes.

Therefore, there is no adequate intake for healthy infants zero to six months old who are feeding from breast milk, because human milk does not contain dietary fiber. Based on general observations, typically infants seven to twelve months old once introduced to solid foods, the fiber intake increases.

Although these are the recommendations, the American Dietetic Association (2008) remarks, that the usual intake in the United States is averaging around only 15 grams per day which is much less than the above mentioned levels. When the American Dietetic Association

(2008) asked average United States citizens about their fiber intake, 73% of individuals think they are consuming, “about right” amounts of fiber, although their mean was less than 20 grams per day. The most popular foods in the United States generally contain very little dietary fiber. For example, the American Dietetic Association (2008) states that, “white flour and white potatoes provide most of the Americas fiber intake, being 16% and 9% respectively” (percentages were based off the American population) (p. 1717). These products are not high sources of fiber, however, they are consumed on a more regular basis than for instance, legumes, which are a very high source of fiber, but because they are consumed in low amounts, they only provide about 6% of the average Americans daily fiber intake. Another example is fruit, fruit has a high amount of fiber content and they are consumed in low amounts in America, thus providing only 10% of the RDA for fiber in the American diet, as stated by the American Dietetic Association (2008).

There are many important benefits of consuming dietary fiber on a daily basis in regards to its function in the human body and how it can prevent and help treat disease. The main topics included in evidence-based analysis for dietary fiber include: cardiovascular disease, gastrointestinal health and disease, weight control, and diabetes mellitus. Other topics, although not any less important, that dietary fiber are associated with colon and rectal cancer, breast cancer, diverticulitis, and irritable bowel syndrome (IBS).

According to the American Heart Association (2009), estimates in 2006 suggest that 80,000,000 people in the United States alone have at least one form of cardiovascular disease (CVD). High blood pressure consumes 73,600,000 peoples’ lives, coronary heart disease (CHD) 16,800,000 people, and myocardial infarction or acute heart attack 7,900,000 lives in the year 2006. In addition to those figures, angina pectoris, chest pain or discomfort caused by

reduced blood supply to the heart muscle affected 9,800,000 people, 6,500,000 people had a stroke and finally, 5,700,000 people had heart failure, all in that same year. In addition to the above statistics, the American Heart Association (2009) indicates that in 2005, 35.3% of all deaths were related to some form of cardiovascular disease. Dietary fiber intake may lower blood pressure, improve lipid serum levels, and reduce indicators of inflammation. The American Dietetic Association (2008), states that benefits can occur with intakes of 12 to 33 grams of fiber per day from whole foods or up to 42 grams of fiber per day from supplements. Bazzano, He, Ogden, Loria, and Whelton, (2003), conducted a study with 9,776 subjects that participated in the National Health and Nutrition Examination Survey Epidemiologic study, where they analyzed a 24-hour dietary recall and found that a higher diet in dietary fiber, particularly soluble fiber, reduced the risk of coronary heart disease. During another study that analyzed dietary fiber and coronary heart disease, Pereira, O'Reilly, Augustsson, Fraser, Goldbourt, Heitmann, Hallmans, Knekt, Liu, Pietinen, Spiegelman, Stevens, Virtamo, Willett and Ascherio (2004) found that each ten grams per day increment of energy adjusted total dietary fiber was associated with a 14% decrease in risk of all coronary events and a 27% decrease in risk of coronary death. Additionally, only fiber from cereals and fruits were found to be inversely associated with the risk of coronary heart disease. Finally, Pereira and colleagues (2004) indicate that cereal fiber consumption later in life was associated with a lower risk of incident cardiovascular disease, thus supporting recommendations for older adults to increase consumption of dietary cereal fiber.

The American Journal of Clinical Nutrition (1999) indicates that dietary fiber lowers blood cholesterol levels, specifically low-density lipoproteins (LDL). The American Dietetic Association (2008) indicated that in the American Journal of Clinical Nutrition (1999), daily

intake of two to ten grams of soluble fiber significantly lowered total cholesterol and LDL concentrations. The majority of the studies discussed by, Brown, Rosner, Willett, and Sacks (1999) show no change in high-density lipoprotein (HDL) cholesterol or triglycerides in relation to daily fiber intake. The US Food and Drug Administration (2008) have authorized a health claim that foods meeting specific compositional requirements and containing 0.75 grams to 1.7 grams of soluble fiber per serving can reduce the risk of heart disease based on studies they conducted.

Fiber can also affect blood pressure and the C-reactive protein (CRP), which if elevated are risks for developing cardiovascular disease. The American Heart Association (2010) states that C-reactive protein is an acute phase protein that increases during systemic inflammation. It is a level in the blood that can be tested to determine cardiovascular risk. The American Dietetic Association (2008) states that, dietary fiber intake inversely associated with C-reactive protein in the National Health and Nutrition Examination Survey 1999-2000, with a fiber intake of about 30 grams per day from a diet naturally rich in fiber reduced levels of C-reactive protein and blood pressure. Reductions in blood pressure tended to be greater in older adults and populations with existing hypertension. The studies discussed above done by, Whelton, Hyre, Pedersen, Yi, Whelton and He (2005) support the idea that for maximum cardiovascular disease prevention and protection, following a 14 gram per 1000 kilocalories intake of dietary fiber per day is best.

Stated in the American Dietetic Association position paper in 2008, many fiber sources help increase stool weight which promotes regular laxation. Stool weight will increase as dietary fiber in the diet increases. The American Dietetic Association (2008) states that, “stool weight is caused by the presence of the fiber, by the water that the fiber holds and by the fermentation of the fiber, which increases bacteria in the stool” (p. 1720). Moisture content of human stool is 70

to 75% water and an increase of dietary fiber does not change this amount. Although, one known exception is psyllium seed husk, which does increase the water concentration to about 80%. Meaning, that as fiber is increased in the diet, stool weight is increased and an increased amount of water is recommended as discussed earlier.

Cummings, Bingham, Heaton, and Eastwood (1993) conducted a meta-analysis of eleven studies in which daily fecal weight was measured, while on controlled diets with known fiber intake. Fiber intake was significantly related to stool weight. Stool weight was related to colon cancer risk within this study. Spiller (2001) conducted a study by measuring subjects stool weight with their typical diet, which indicated there was a critical weight of 160 to 200 grams per day for healthy adults in their stool weight. Western populations have a much lower range of 80 to 120 grams per day in stool weight. According to the American Dietetic Association (2008), constipation and diarrhea are two extremes for abnormal bowel function. In addition, they noted that constipation was three or fewer bowel movements per week. Constipation is a condition where the rectum becomes distended, which can cause uncomfortable abdominal discomfort, headaches, loss of appetite and nausea. Diarrhea is classified as excess stool output, watery, difficult to control bowel movements and having more than three movements per day. Laxation is the preferred terminology by health professionals, and most individuals for comfort, and it refers to a slight increase in bowel frequency and softer consistency of stools. According to the American Dietetic Association (2008),

Many foods are natural laxatives because they contain indigestible carbohydrates and other compounds with natural laxative properties. Cabbage, brown bread, oatmeal porridge, fruits with rough seeds, vegetable acids, aloe, rhubarb, cascara, senna, castor

oil, honey, tamarinds, figs, prunes, raspberries, strawberries, and stewed apples all have natural laxative abilities. (p. 1721)

Another main topic that has recently been a highlight for dietary fiber was the evidence that supports weight control. Dietary fiber intake may have benefit to those individuals trying to lose or maintain weight. These benefits can occur with intakes between 20 to 27 grams of fiber daily from either whole foods or supplements. According to Heaton in the American Dietetic Association Journal (2008),

Fiber acts as a physiological obstacle to energy intake by at least three mechanisms: fiber displaces available energy and nutrients from the diet; fiber increases chewing, which limits intake by promoting the secretion of saliva and gastric juice, resulting in an expansion of the stomach and increased satiety; and fiber reduces the absorption efficiency of the small intestine. (p. 1722)

When consuming a high fiber diet, the bulk properties of dietary fiber are predominately responsible for both satiety and satiation. The American Dietetic Association (2008) has defined satiation as the satisfaction of appetite that occurs while eating and signals your brain that you can stop eating. Satiety has been defined as the state in which you feel after having already eaten.

Dietary fiber can also help decrease gastric emptying and/or slow energy and other nutrient absorption leading to lower postprandial glucose and lipid levels. Glucose is a type of sugar in the body made from primarily carbohydrates and is used for energy. Postprandial glucose is a type of test to determine the amount of glucose in the blood. The American Dietetic Association (2008) discussed that when studies are conducted on dietary fiber and weight control, a common agreement was found that an additional 14 grams of dietary fiber per day

resulted in a 10% decrease in energy intake and 10% decrease in total weight loss. This effect can even have greater results in obese individuals. A high fiber, low fat diet can result in greater weight loss and greatest decrease in risk of being overweight or obese when compared to a low fiber, high fat diet.

In one study conducted by Mattes (2007), a control breakfast cereal bar was compared with a breakfast bar containing alginate and guar gum in obese subjects. The bars were 0.6 grams of dietary fiber versus 4.5 grams of fiber. No significance was found for the satiety levels of the individuals. Another study conducted by Haber, Heaton, Murphy, and Burroughs (1977) examined satiety levels of subjects drinking apple juice, eating applesauce, and the whole apple itself; all three contained the same amount of energy and fiber. Respectively, the individuals that consumed the juice continued to eat more than the individuals that ate the whole apple as discussed by Haber and colleagues. This may be related to the evidence that increasing consumption of high fiber whole foods may decrease feelings of hunger by inducing satiation and satiety. It also may be related to the gut having to break down the apple which takes longer than passing the apple juice through the digestive tract, thus creating longer satiety.

Kaufman (2002) indicates Type 2 Diabetes mellitus (non-insulin dependent Diabetes mellitus) was ever increasing in incidences across the United States. She continues to express that it is America's "new epidemic". Type 2 Diabetes mellitus was formerly termed, "Adult onset diabetes," however; cannot be called this anymore due to the massive number of overweight children that were developing Type 2 Diabetes mellitus. According to Nuttall (1993), the ingestion of a highly viscous fiber such as guar would reduce the rate at which glucose was absorbed in the body. However, ingestion of very large quantities of fiber was required for a significant effect to be seen by individuals. Based on current data, the American



Dietetic Association (2008) indicates that diets containing 30 to 50 grams of dietary fiber per day from whole food sources produce lower serum glucose levels compared to low-fiber diets. Supplements containing 10 to 29 grams per day may have some benefit in terms of glycemic control. Additionally, a high fiber meal was processed and absorbed more slowly and usually was richer in micronutrients than a lower fiber meal. Considering the overall benefits, when fiber was added to the diet, the rate of glucose in the blood was slowed and insulin secretion was subsequently reduced. These effects were seen predominately in individuals with diabetes mellitus. A long term study discussed by Giacco, Parillo, Rivellese, Lasorella, Giacco, D'Episcopo and Riccardi (2000) suggested that an intake of 50 grams of fiber per day for 24 weeks significantly improved glycemic control and reduced the number of hypo-glycemic episodes in individuals with Type 1 diabetes mellitus. Simpson, Simpson, Lously, Carter, Geekie, and Hockaday (1981) also indicated from some other studies that diets high in dietary fiber can diminish insulin demand in non-insulin dependent diabetes mellitus. In prevention of this disease, the American Dietetic Association (2008) suggests two servings per day of whole grains can be associated with a 21% decrease in risk of non-insulin dependent diabetes mellitus. Although diabetes mellitus was increasing in the number of cases throughout the United States, cancer was of major health concern as well.

The American Dietetic Association (2008) discusses several cancers that show evidence dietary fiber may help prevent and/or treat. Although studies on fiber and cancers were inconsistent they are important to research. The most important cancer associated with dietary fiber was large-bowel (colon and rectal) cancers. Howe, Benito, Castelleto, Cornee, Esteve, Gallagher, Isovich, Deng-ao, Kaaks and Kune (1990) indicate great evidence supports that eating a diet that was high in dietary fiber foods may protect against these types of cancers. Howe and

colleagues (1992) estimates that the risk of colon and rectal cancers in the United States could be decreased by 31% with a national average increase of thirteen grams of dietary fiber per day in the form of whole food sources. According to Bingham, Day, Luben, Ferrari, Slimani, Norat, Clavel-Chapelon, Kesse, Nieters, Boeing, Tjonneland, Overvad, Martinez, Dorronsoro, Gonzalez, Key, Trichopoulou, Naska, Vineis, Tumino, Krogh, Bueno-de-Masquita, Peeters, Berglund, Hallmans, Lund, Skele, Kaaks and Riboll (2003) after conducting a study in Europe they found, people that ate an average of 33 grams of fiber daily had 25% lower incidence of colorectal cancer than those that ate an average of twelve grams of dietary fiber daily. Despite that there was inconsistency in the results regarding studies with fiber and colon cancers; there was clearly enough evidence to have health professionals promoting an increase in dietary fiber consumption among all age ranges. The American Dietetic Association Position Paper (2008) discusses how breast cancer has been associated with high fiber and high fat diets. Women with diets that have increased excess fat intake and diets lower in fiber consumption have an elevated risk of developing breast cancer. Additionally Howe, Hirohata, Hislop, Iscovich, Katsouyanni, Lubin, Marubini, Modan and Rohan (1990) state that, a diet increased in dietary fiber consumption has been associated with reduced risks of breast cancer and other benign proliferative epithelial disorders of the breast. Dietary fiber had many beneficial factors to fight off diseases and disorders; more specifically, fiber was known for its digestive and intestinal health benefits.

According to some experts in the field (D'inca et al., 2007) one of the more severe diseases was diverticular disease, which has a significant mortality and morbidity rate in the western part of the world and has increased greatly over the last 100 years. Diverticular disease has been known to develop within persons that tend to have deficiency in fiber intake in the

Western part of the world. This disease was extremely uncommon to developing countries and Africa where dietary fiber intake was very high (above 40 grams per day). There were two main reasons why diverticular disease could exist; one was from an abnormal colonic motility and the second was from not consuming enough dietary fiber. According to the experts from the National Digestive Diseases Information Clearinghouse (NDDIC),

Diverticulosis occurs when small pouches, called diverticula, bulge outward in weak spots in the colon (large intestine). The pouches form when the pressure inside the colon builds, usually because of constipation. About 10% of Americans of the age of forty have Diverticulosis and about half of all people over the age of sixty have the disease. (Diverticulosis and Diverticulitis, 2006, para. 1163)

According to the American Dietetic Association (2008), about 10 to 25% of individuals with diverticular disease will develop diverticulitis. To distinguish between diverticular and diverticulitis, the National Digestive Diseases Information Clearinghouse (NDDIC) (2008) indicates,

Many people have small pouches in the lining of the colon, or large intestine that bulge outward through weak spots in the lining. Each pouch is called a diverticulum. Multiple pouches are called diverticula. The condition of having diverticula is called diverticulosis. (para. 1163)

The condition becomes more common as people age, about half of all people older than 60 have diverticulosis. When the pouches become inflamed, the condition was called diverticulitis. The NDDIC (2008) states, 10 to 25% of people that get diverticulosis get diverticulitis. Diverticulosis and diverticulitis together are called diverticular disease. Most people with this disease don't ever feel any pain or discomfort, thus making it hard to diagnose.

However, if discomfort does exist they may experience mild cramps, bloating or constipation. These symptoms are very similar to another disorder called Irritable Bowel Syndrome (IBS), so these symptoms do not always mean they have diverticulosis. Some complications can develop when not treated properly, such as bleeding, infections or blockages of the intestinal tract. According to Eglash, Lane, and Schneider (2006), a diet high in fiber was a standard therapy for this disease, increasing the intake of fiber to the recommended daily allowance of 14 grams per 1000 calories through vegetables, fruits and whole-grains would be ideal forms.

According to Rose, DeMeo, Keshavarzian and Hamaker (2007), Inflammatory Bowel Disease (IBD) has increased steadily over the last forty years in particular parts of the world. Inflammatory Bowel Disease includes two separate types of conditions, which include both ulcerative colitis and Crohn's disease; these were both characterized by chronic inflammation of the gut. Ulcerative colitis and Crohn's disease were characterized by diarrhea and abdominal pain. Ulcerative colitis generally affects just the innermost lining of the colon and rectum and only occurs through continuous stretches of the colon. Whereas Crohn's disease, affects the lining in general and occurs in patches within the digestive tract and generally spreads deep into the layers of affected tissues. With Crohn's disease or ulcerative colitis high fiber diets may make symptoms worse. Although this does not mean to eliminate high fiber foods from the diet, but rather experiment with what foods cause the least amount of problems. This varies from person to person and different high fiber foods may be better tolerated than others.

Rose, DeMeo, Keshavarzian and Hamaker (2007), indicates the benefits of dietary fiber greatly influence over all human health. These benefits can be separated into two different categories; non-fermentative and fermentative. The effects of non-fermentative are directly correlated with dietary fiber by itself. An example, stated by Rose, DeMeo, Keshavarzian and

Hamaker (2007) that “many dietary fibers can bind bile acids and increase their excretion in the feces” (p. 57). This was a direct result of an increasing amount of cholesterol that the body must dedicate to the production of bile acid. This process may be just one way that dietary fiber aids in the protection against cardiovascular disease.

Rose, DeMeo, Keshavarzian and Hamaker (2007), continue to discuss the different non-fermentative and fermentative mechanisms, their physiological response and their effect on the body. Mechanisms of non-fermentative benefits of dietary fiber would include; increased fecal bulk, decreased feces transit time, carcinogen binding, bile salt binding, and increased digestive viscosity. Some of the physiological responses would include; increased fecal excretion and frequency, the release of carcinogens, decreased re-absorption of bile salts, and decreased rate of glucose absorption into the small intestine. All of these physiological responses will affect the body in a positive way, such as diluting toxins and ridding them in the colon at a much quicker rate. However, an increased cholesterol requirement decreases blood cholesterol which can be related to cardiovascular disease. Decreased blood glucose response was also another physiological effect.

In addition to the non-fermentative benefits, Rose, DeMeo, Keshavarzian and Hamaker (2007) also state that some mechanisms of fermentative, which would include; production of short chain fatty acids, and production of butyrate (a salt or ester of butyric acid). These two mechanisms create several physiological responses; a decreased pH level in the colon, and decreased production of pro-inflammatory cytokines (proteins and peptides). These have a physiological effect of decreasing the inflammatory response system in the colon which may decrease the chance of developing inflammatory bowel disease (IBD). Inflammatory bowel disease was a condition where fiber intake needs to be consumed with caution and amounts vary

depending on how the individual is tolerating the food. Rose, DeMeo, Keshavarzian and Hamaker (2007) continue to discuss when IBD was under control, then a high dietary fiber diet was recommended, however when a flare up of the condition was present then lower amounts of fiber should be consumed (as low as 10 grams per day).

Inflammatory bowel disease was related to the production of butyrate (helps control the good bacteria in the gut) from bacteria build up in the colon. This research plays a very important role in the alleviation of Crohn's disease. Butyrate has been shown to be beneficial in alleviating chronic inflammation, which Crohn's disease is caused from. Crohn's disease was caused by the immune system having an abnormal reaction to the normal bacteria in the intestine. As previously discussed, dietary fiber can play an important role in helping with inflammation symptoms; however these symptoms differ from person to person. According to the Mayo Clinic (2008) inflammatory bowel disease can be treated in several different ways, including, dietary changes, and medications and in some cases, surgery. These options all depend on the individual with the disease and the severity of that particular person's condition. The Mayo Clinic (2008) also discusses some different types of drug therapies, such as, antibiotics, immunosuppressive, and biological therapy. Although drug therapies are a common solution, controlling dietary fiber intake is the best way nutritionally to control the condition.

Inflammatory bowel disease (IBD) should not be confused with irritable bowel syndrome (IBS). Unlike IBD, IBS does not cause inflammation, ulcers or other damage to the bowel. Instead, IBS was a much less serious problem. This means that the digestive system looks normal but doesn't work as it should. Irritable bowel syndrome affects about 20% of adults in the United States and Europe. Since this was a condition that was so prevalent, it was important to understand it. The Mayo Clinic (2008) discusses, IBS disturbs gastrointestinal motility and

reduces the small intestines absorption, which results in an increase of water that reaches the large intestine which results in diarrhea if the large intestine lumen cannot absorb the excess water. Other symptoms of IBS may include cramping, bloating, gas, mucus in the stool, and constipation. IBS has also been called spastic colon or spastic bowel. Studies indicate that IBS may be relieved by increased fiber intake.

### **Supported Research**

Limited research has been conducted on the perceptions of dietary fiber among college students but, there was research that supports aspects of perceptions of dietary fiber in adult populations. Kolodinsky, Harvey-Berino, Berlin, Johnson, and Reynolds (2007) believes that there was a gap in the literature concerning college students and their knowledge of the dietary guidelines and how that translates to better eating behaviors among this age group. According to Kolodinsky et al. (2007) nutrition knowledge was related to making healthful food choices among college aged students in every case. Kolodinsky et al. (2007) conducted an Internet-based survey with 200 first year college students that were on the universities meal plan to find the relationship between self-reported eating behaviors and nutrition knowledge. Results of the study conducted by Kolodinsky et al. (2007) showed only one statistically significant difference in the knowledge scores and that difference was with whole-grains. The results indicate that the students who consumed the recommended amounts of whole-grains also had greater whole-grain knowledge than the students who consumed less than the recommended amounts. This finding indicates that there was some evidence that consumer-education campaigns have helped contribute to the increase in whole-grains and knowledge from the recent increase in whole-grain food sales since the release of the revised *Dietary Guidelines for Americans 2005*.

Now that it was possible for educational campaigns on foods to impact food sales, it would seem that it could change the amount of dietary fiber people are consuming. Some experts in the field (Miller, Gabbay, Dillion, Apgar & Miller, 2006) have discussed that snack foods provide approximately 20% of all daily intake for people in the United States, which was an increase from 11% in 1977. Also, Miller, et al. (2006) states that perceived healthy snack-foods, such as snack bars, increased in consumption by consumers in 2002. Piernas and Popkin (2010) further thought by stating, that snacking prevalence increased significantly from 71% to 97% between the years 2003–2006. This implied that consumers are consuming more snack foods, such as snack bars, as companies are producing them. More education needed to be conducted on foods, labels and advertising so consumers are aware of what foods are the more healthy options. Snack food consumption is increasing and the variety of snack bars being produced has been increasing; recently Fiber One<sup>®</sup> has produced a high fiber snack bar which could be a positive impact on food sales and health. This snack bar has nine grams of dietary fiber for one bar, which equals 45% of the daily value consumers should have. By consumers eating this high fiber snack bar it would increase the total daily amount of dietary fiber they consume, which would have positive impacts on their health. There have been other studies conducted regarding whole grains in association with likeability and texture or with dietary fiber and amount of consumption for instance but not perceptions of dietary fiber.

Nicklas, Farris, Myers and Berenson (1995) conducted a study analyzing children (one group of ten year olds and one group of thirteen year olds) and young adults (19 to 28 year olds) to find out how much dietary fiber they consumed. Duplicate 24-hour recalls were collected from 1976 to 1988 every three years. Results of this study demonstrate that across all age groups, total dietary fiber intake was the same, averaging 12 grams or 5 grams per 1000 kcal.



Boys did consume more fiber than girls (13.7 vs. 10.7 grams) and blacks consumed more than whites (13.2 vs. 11.8 grams). However, when fiber intake was adjusted for energy consumed, there was no significance between races. Boys consumed more fiber than girls due to consuming more energy intake overall. Although this study was conducted twenty years ago, notice should be taken to the mean dietary fiber intake at 12 grams per day, where the average American today consumes similarly 15 grams of fiber daily as stated by the American Dietetic Association (2008). Additionally, snacks and lunch contributed for approximately one-fourth each of total dietary fiber intake. Nicklas, Farris, Myers and Berenson (1995) indicated that these results were similar to the NHANES data collected at that time. If snacks contribute one-fourth of total fiber, then recent new high fiber snack bars could possibly increase the national average if these were consumed more frequently as snacks than typical fat-containing snacks.

A more closely related study conducted by Burgess-Champoux, Marquart, Vickers and Reicks (2006) discussed how healthful eating habits as a child may translate into healthful eating habits as an adult. Also discussed was that the average American child and adult are only consuming one serving of whole-grains versus the recommended three servings by Healthy People 2010 objectives. Marquart, Pham, Lautenschlager, Croy and Sobal (2006) added by stating that only 8% of adults are consuming the recommended three or more servings of whole-grains per day; this was found in the National Health and Nutrition Examination Survey (NHANES) 1999-2002. Burgess-Champoux, Marquart, Vickers and Reicks (2006) had children taste test whole-grain cereal and cheese bread that had been modified with half whole-grains. The cereal samples were distributed in small bags and the bread was warmed and served on plates in small samples during focus group sessions with the children, their parents and their teachers to determine the children's and parents' perceptions of whole-grain foods. The children

were asked to rate the products according to their liking for taste, texture and appearance on a three point scale (like, okay, dislike). The parents also were asked to rate a sandwich made with whole-grain bread on flavor, texture, appearance and overall liking according to a 9-point hedonic scale. Burgess-Champoux, Marquart, Vickers and Reicks (2006) discussed that for each of these characteristics, the range was 7.2 and 7.7 (like moderately and like very much). For both the children and adults, the majority liked flavor or taste, texture and appearance, yet most Americans are still only consuming one serving of whole-grains versus the three that are recommended. Therefore the perceptions must be based on more than flavor, texture and appearance.

When participants were asked about their perceptions and knowledge of grain-based foods (Burgess-Champoux, Marquart, Vickers & Reicks, 2006), “Adults believed whole-grains were more satiating and contained more nutrients compared to refined grains, which were considered less healthful. Most indicated they read labels and looked for fiber and the word “whole-grain” when identifying whole-grain foods, but they gave an overall impression that they lacked confidence in their ability to correctly identify whole-grain foods” (p. 234). Therefore, a clear and consistent definition of whole-grain foods and labeling standards was needed to improve consumers’ knowledge about whole-grain products (Burgess-Champoux, Rosen, Marquart & Reicks, 2008). This seems to be a reoccurring statement among the literature; one reason may be that consumers know that whole grains are good for them. It seems as though consumers know that whole-grains are good for them yet there was much confusion of what whole-grains were and what the difference was between whole-grains and dietary fiber. Marquart, Pham, Lautenschlager, Croy and Sobal (2006) stated, that consumer beliefs influence the consumption of whole-grains and it was still poorly understood. Discussing this topic more

in-depth may break the gap in the literature; according to the nonprofit consumer advocacy group, Whole Grains Council (2004),

Whole-grains or foods made from them contain all the essential parts and naturally-occurring nutrients of the entire grain seed. If the grain has been processed (e.g., cracked, crushed, rolled, extruded, and/or cooked), the food product should deliver approximately the same rich balance of nutrients that are found in the original grain seed. (para. n.p.)

Knowing how many whole-grains to have each day was also confusing. A product may advertise that it has five servings of whole-grains, but understanding how that translates to the general population was a key factor for consumers to understand the amount of whole-grains they were consuming. The Whole Grains Council (2004) discusses that if the food was entirely a whole-grain, then it was consider one serving of whole-grains. For example,  $\frac{1}{2}$  cup cooked brown rice was one serving of whole-grains or one slice of 100% whole-grain bread. The Whole Grains Council (2004) on the other hand states if the food was not entirely a whole-grain, like granola bars or waffles, then six-teen grams equals' one serving. According to the *Dietary Guidelines for Americans 2005*, adults should consume at least three servings of whole-grains, or 48 grams daily. The *Dietary Guidelines for Americans (2005)* continues to state there will not be a product endorsed by the American Heart Association or the Whole Grain Council unless the product contains at least half a serving of whole-grains per product serving or eight grams.

Now battling the confusion of whole-grains versus dietary fiber; some people mistakenly think that if a food does not have high fiber content then it was not really made with whole-grains. Marquart, Pham, Lautenschlager, Croy and Sobal (2006) state that consumers perceive the major benefits of eating whole-grains was the fiber content. Fiber in itself was not a good gauge of if a product was in fact a whole-grain food. According to the Whole Grain Council

(2004), for every 16 grams of whole-grain (one serving), brown rice only has 0.6 grams of dietary fiber, wheat has two grams of fiber and oats has 1.7 grams of fiber to name some of the most commonly eaten grains. So this demonstrates that although most whole-grain foods contain some level of dietary fiber, the fiber content was not high fiber.

Determining reasons for low consumption of dietary fiber will add to the body of consumer knowledge. The main goal of all health professionals could be investigating new ways to educate children and adults of increasing consumption of dietary fiber, whole-grain products, fruits, vegetables and legumes to reach the necessary goals for optimal fiber intake and decrease the risk for all of the problems and diseases that were discussed previously.

Research has determined that knowledge of health benefits of dietary fiber influence families to purchase whole-grain products, especially if sensory attributes were to consumer standards and this idea was confirmed by LeBlanc, Ostteen and Gerald (2005). Literature contributed by Schnoll and Zimmerman (2001) suggest that setting goals, self monitoring, and self reward should be used to increase self efficacy and improve motivation to implement and maintain any dietary changes. According to the social cognitive theory, self regulation can be broken down into self observation, self judgment and self reaction. Schnoll and Zimmerman (2001) noticed that goal setting had a significant effect on self efficacy and dietary fiber consumption. Schnoll and Zimmerman (2001) had subjects that were college students in an introductory nutrition course and were randomly assigned to four different treatment groups: goal setting, self monitoring, goal setting and self monitoring and no goal setting and no self monitoring. Subjects who set goals consumed 91% or 22 grams more dietary fiber compared to 11.5% for subjects that did not set any goals. Students were also asked to complete a dietary fiber self efficacy questionnaire; an example question was, “please indicate your confidence that

you can do the following...(eg, read labels for fiber content; choose high fiber snacks such as whole grain pretzels, fruits, and vegetables)” (p. 1007). Schnoll and Zimmerman (2001) concluded results with subjects who set goals had a mean fiber self efficacy score of 71.8 compared to 62.7 for the subjects that did not set any goals. Additionally, there was a dietary fiber knowledge questionnaire that asked questions such as, “The average intake of dietary fiber for Americans is approximately \_\_\_”. This question in that study was asking participants to identify the numerical amount of dietary fiber they believe Americans intake daily. This research clearly demonstrates that knowledge from an introductory nutrition course; setting goals and self monitoring all have a positive change on dietary behavior change. Leefeldt and Fang (2007) conducted a similar study, in which students randomly selected across the entire campus and conducted over the internet. Leefeldt and Fang (2007) wanted to help improve dietary intake among college students. The web-based educational module included information about dietary fiber, recommendation intake levels, and how to incorporate fruits, vegetables, legumes and whole-grains into the diet of a college student. According to Leefeldt and Fang (2007), the treatment groups significantly increased their dietary fiber intake from 19.6 grams per day to 21.5 grams per day and compared to the control group. This intervention shows once again that knowledge about the importance of dietary fiber consumption helps increase dietary behavior changes. One gap in this literature was noted, although the students increased their overall dietary fiber intake and their consumption of whole-grains, the increase of fruits and vegetables was not as high, which demonstrated that whole-grains are continually being promoted as high fiber sources over fruits and vegetables and as discussed earlier, whole-grains are not a high source (5 grams per serving or more) of dietary fiber. Nutritional knowledge can be taught from various sources which can be different for males and females.

Davy, Benes and Driskell (2006) found that there were some differences between genders on their source of nutritional knowledge with students at a Midwestern university. Davy, Benes and Driskell (2006) stated that females reported obtaining most of their nutritional knowledge in the order that follows: family members, classes, magazines/newspapers, friends, instinct, television, physicians, books, health professionals, Registered Dietitians and other. Males were slightly different in their order of where they obtain their nutritional knowledge from; classes, family members, friends, magazines/newspapers, television, instinct, physicians, books, other, other health professionals and lastly Registered Dietitians. Other studies explored the beliefs and understanding about whole-grains.

Marquart , Pham, Lautenschlager, Croy and Sobal (2006) examined the perceptions, understanding, beliefs, and knowledge about whole-grain foods among food and nutrition professionals, health club members, and individuals from the general population. Health benefits of eating whole-grain foods were primarily reported as fiber among all groups studied; 21% of food and nutrition professionals, 16% of the health club members and 18% of the general population. This research further demonstrates the gap of what whole-grain foods are and the content of foods that contain high fiber. The study that the author of this research paper conducted tries to represent these gaps in the literature related to knowledge about whole-grain foods and dietary fiber.

## **Chapter III: Methodology**

### **Introduction**

This chapter will discuss the methodology of the study on the perceptions of flavor and knowledge of sources of fiber and how that relates to college-aged students consumption of dietary fiber. Participants were college students at the University of Wisconsin-Stout. It includes the data collection procedures which covers data entry, data analysis and data interpretation. In addition to this, a description of the variables are discussed, how the subjects were selected, instrumentation used throughout the study and limitations of methods, samples and procedures.

### **Description of Variables**

University of Wisconsin-Stout was chosen for the study for several reasons, although the demographic was predominately Caucasian, there was some international students participating. This university had subjects ranging from 18 to 30 years old and from varying majors which allow students with different knowledge base and backgrounds to participate. Additionally, many students were from all over the Midwest area of the country. All students that participated volunteered their own time to taste test the two different fiber snack bars (one containing high fiber and one containing low fiber). They filled out the informed consent form (see Appendix C) that was placed in front of them on paper and then they filled out the survey on the computer screen. One variable was the fiber snack bars themselves, if the product was consumed by the participants on a regular basis, they may be able to identify which one was the high fiber bar and which one was the low fiber bar.

## **Selection of Samples**

A small pilot study was conducted with approximately 15-20 subjects. This was to clarify language and response options on the Compusense<sup>®</sup> survey. The selection for the pilot subjects were workers at the UW-Stout Health and Fitness Center who were all registered UW-Stout students. Subjects varied in age, gender and majors they are studying. For convenience and time purposes, a hard copy was administered of the survey that had the exact same questions that were on the Compusense<sup>®</sup> 5.0 program in the computer during the actual consumer study. Subjects that participated in the pilot study also were invited to participate in the actual consumer study later. It was observed that several pilot study subjects participated in the consumer study.

Participants for data collection were selected in several different ways. Advertisement for participation was posted to the *Campus Today* (campus wide email that is sent out daily to all students, faculty and staff) email that was administered to all students. This included information about the study; what, where, when, who and why participants were needed and general information on the study. In addition, signage was placed at the Health and Fitness Center, and other buildings throughout campus to advertise participation that was needed for the study. General, non-specific snack bars were promoted and a small treat that was rewarded for attending the study, in hopes that this would draw in more subjects. Another way participants were selected was by announcing the need for participants in all of the courses the researcher was currently enrolled in. Finally, the study's three committee members announced the study in all courses that they taught. Extra credit points were given to students that participated in the study. Participation was strictly on a voluntary basis.



## **Instrumentation**

In April 2009, permission to conduct this study was obtained through the University of Wisconsin-Stout Institutional Review Board (see Appendix A). A variety of tools were employed in this study. The questionnaire on Compusense<sup>®</sup> 5.0, which is the world leader in software applications for sensory evaluation, was used to collect data from the participants. The same questionnaire was available on hard copy (see Appendix B) for the pilot study. Other materials that were used for the pilot study were small plastic bags that the sample products were placed in and they were labeled with a random three-digit code so the subjects were unaware of the samples and unbiased. The high fiber and low fiber snack bars, specifically, General Mills<sup>®</sup> Fiber One Oats and Chocolate which was the high fiber bar and General Mills<sup>®</sup> Nature Valley Chewy Trail Mix Dark Chocolate & Nut bars as the low fiber bar. The high fiber bar was selected based on nutritional content of the highest fiber content snack bar in supermarkets. The low fiber bar was selected on specific attributes such as, texture, appearance and fiber content. The texture and appearance closely resembles the high fiber bar in color, chocolate pieces and chewiness, however was low in fiber content. Mahanna, Moskowitz and Lee (2009) conducted a study to analyze different elements of food bar products on purchase intent, including types of bar, ingredients, macro-nutrients, health claims, calories and sensory characteristics. Mahanna, Moskowitz and Lee (2009) discovered that, “consumers wanted a food bar to be less than 150 kcal, made with whole grains and higher in protein. Consumers divided into four mind-set segments were characterized as “Label Readers” (n =213), “Calorie Health Nuts” (n = 90), “Flavor Energy Seekers” (n = 79) and “Chocolate Lovers” (n = 44)” (p.851). Sensory characteristics such as, chewy, crunchy and crispy were not as important to consumers, where calorie content was.

As earlier discussed in an additional similar study conducted by, Burgess-Champoux, Marquart, Vickers and Reicks (2006), children taste tested whole-grain cereal and cheese bread that had been modified with half whole-grains. The children were asked to rate the products according to their liking for taste, texture and appearance on a three point scale (like, okay, dislike).

A fifteen item list of foods, products and fiber supplements was developed to examine the knowledge of participants. Kristal, Abrams, Thornquist, Disogra, Croyle, Shattuck and Henry (1990) developed a new dietary food behavior checklist that would relate to a lower fat and higher fiber diet. This food list was developed to increase high fiber containing products, fruits and vegetables and to decrease full fat dairy products and fried foods. Some foods on the food behavior checklist included high fiber cereal, fruit, vegetable, dark bread, muffins, and cakes to list several. Although this list of foods was different from the list of foods, products and fiber supplements in this study, it helps demonstrate knowledge of selecting high fiber items on the list provided to the participants. Another study conducted by Berg, Jonsson, Conner and Lissner (2002) investigated dietary knowledge of adolescence. Food choice and perceptions were studied by the participants selecting food items among photographs of breakfast foods that they believe were a healthy breakfast. These foods were selected based on low fat and high fiber content.

Other materials that were used during the data collection process were small plastic cups that contained the high fiber and the low fiber snack bar. Trays were used to slide the samples, napkins, and spring water through the sensory windows to the participants on the other side of the wall by their computers.

## **Data Collection Procedures**

A pilot study was conducted to determine validity of the survey tool. Participants were selected by asking all Co-workers to attend a meeting at the UW-Stout Health and Fitness Center. Participation was on a voluntary basis only and/or participants were exempt if they had certain food allergies. Participants were asked to review the initial paper survey for clarity and understanding, upon this, revisions were made as necessary. Participants reviewed questions about overall texture, overall appearance and overall flavor of both snack bars. Participants were asked which snack bar they preferred best after tasting both products. Questions were asked about their gender, age range (18-24 or 25-30 or 30+) and how often they consume sources that are high in dietary fiber. Additionally, they were asked to select items from a given list of foods, products and supplements that they believe to be considered sources high in dietary fiber. Finally, the questionnaire asked them to list as many reasons as they could that related to the frequency about their consumption of high fiber sources. This survey was administered through hard copy format, which directly simulated the computer screen that was used during the consumer study.

During data collections in the consumer study, the products were prepared in the sensory evaluation laboratory at the University of Wisconsin-Stout. After the researcher properly washed their hands, put on a clean lab coat, hair net and gloves, the products were taken directly from the manufacturers' packaging to a clean cutting board and cut with a clean knife into thirds. This was done to ensure that taste-size samples were presented in equal portions to all participants and that no bias was introduced. Products were directly placed in the coded plastic cups and placed on the tray with the other materials the participants utilized then passed through the window for their testing to begin. Participants reported to the sensory evaluation laboratory

on May 6, 2009 between the hours of 10:00 a.m. and 2:00 p.m. After signing their name to any papers for their professors (if extra credit points are given for participation) they sat down at an individual, private booth. They indicated that they were there by turning the green light on; they were given the informed consent form to sign that indicates testing procedures, confidentiality, benefits and potential risks of the research. Once they had completed the consent form, they turned the red light on indicating that they were finished and were ready for their samples from the other side of the wall. The researcher then delivered the snack bar samples, napkins and spring water on a tray through the sensory windows. Participants completed the thirteen question survey on the computer screen. When finished, participants turned on the red light again and were free to leave, and upon their way out, they may have selected a treat (variety of small candy bars, pretzels or pudding) for a reward for participating in the study.

### **Data Analysis Procedures**

Analysis of the data was conducted through Compusense<sup>®</sup> 5.0 which is a sensory computerized data program. This program instantaneously produced statistics that were needed for analysis regarding any variables. The study included a qualitative component which consisted of asking the participants, via the computer, about the texture, appearance, flavor and overall preference of the bars. Specifically, these questions regarding the above listed attributes were on a five point hedonic scale; 1 = dislike very much, 2 = moderately dislike, 3 = neither like nor dislike, 4 = moderately like and 5 = like extremely. Other qualitative components included, demographical questions, selecting their perception of knowledge of fiber, selecting items they believed to be high fiber sources and indicating how often they consume and reasons why they eat dietary fiber. Selection of the individuals demographics were as follows: gender selection (male or female) and age category the participant fit within (18-24, 25-30 or 30+). The question

regarding the frequency of consuming high fiber items was on a six point hedonic scale; 1 = daily, 2 = 3 times/week, 3 = once per week, 4 = once every two weeks, 5 = once a month and 6 = never consume. Participants selected their perception of how much knowledge they had regarding dietary fiber, this question was also asked on a five point hedonic scale; 1 = not knowledgeable, 2 = somewhat knowledgeable, 3 = moderately knowledgeable, 4 = very much knowledgeable and 5 = extremely knowledgeable. The study asked participants to select items from a given list that they believe to be sources high in dietary fiber, participants made a check to these items. Finally, participants were free to type in their major and their reasoning for consuming or not consuming dietary fiber sources.

Data were calculated in numerical terms in order to understand the percentages of participants that selected similar items. Other reasons quantitative measures were used were because the study was objective and used a questionnaire on the computer.

Means, standard deviations and analysis of variance for overall texture, overall flavor and overall appearance were calculated. Demographics (age and gender), participants' perception of knowledge about dietary fiber, items participant believed to be high fiber sources and how often the participant consumed foods, products or supplements high in dietary fiber were all analyzed by cross-tabulation. Tukey's HSD (Honestly Significant Differences) was the test used for testing the significance of unplanned pair wise comparisons and cross-tabulation was calculated for overall preference of snack bars. Why fiber was consumed and by what major participants reported as their course of study were also analyzed.

### **Limitations of Methods, Samples, and Procedures**

Limitations included: the participants themselves may be a limitation, since many of the announcements were made in nutrition and food science courses, the study may collect data from

a majority of these majors rather than a wide variety of students that cover all areas of education. This may reflect the final results, because these students may consume high fiber foods on a more regular basis or are more familiar with the products being tested than students from other majors due to their increased knowledge about nutrition, dietary fiber included.

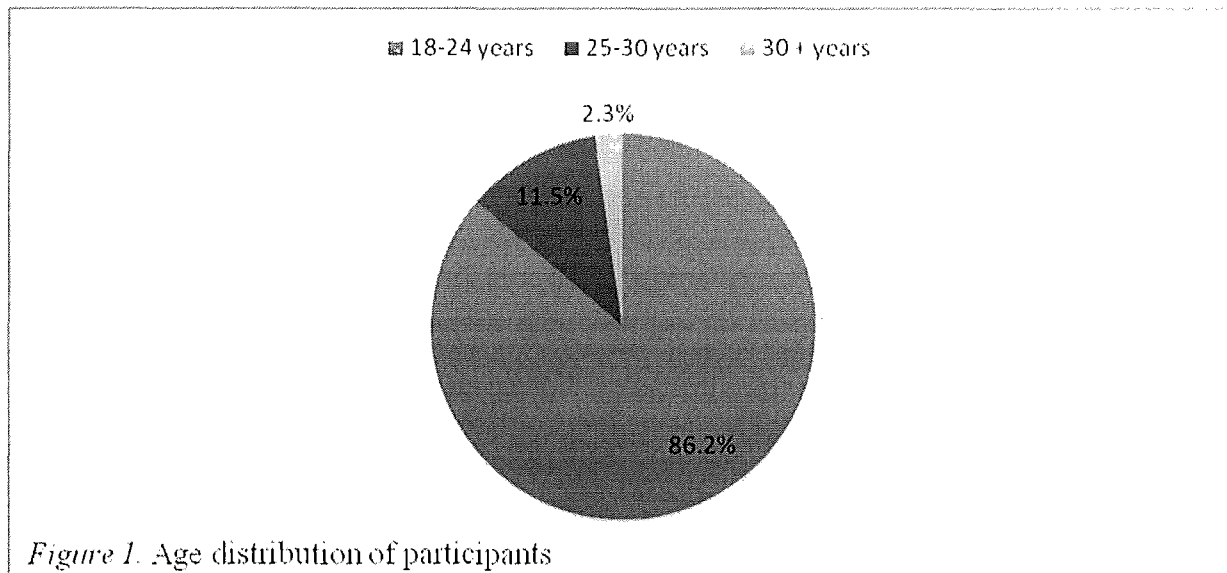
## Chapter IV: Results

### Introduction

The purpose of this study was to determine: 1) perceptions of taste, 2) knowledge about sources of fiber, and 3) how perception of knowledge related to consumption of dietary fiber. The population included males and females ages eighteen to thirty years old attending the University of Wisconsin-Stout. This chapter contains all statistical data on demographics, perceptions of knowledge about dietary fiber, frequency of consumptions, and about the texture, appearance and flavor of the high and low fiber bars. The statistical information was obtained through the software Compusense<sup>®</sup> upon data collection of the survey.

### Demographic Data

Compusense<sup>®</sup> was used to collect data and collection stopped once 127 participants were surveyed. The population included ages 18 to 30 years old. There were a total of 127 participants used. Out of the 127, the age group 18-24 years made up the majority of the study including 112 participants (86.2%) and the age group 25-30 years had a total of 15 participants (11.5%) and three participants (2.7%) were over the age of 30 (these participants were excluded). Figure 1 demonstrates the percent distribution of the age groups where a total of 91 participants were female (70%) and 39 were males (30%).



The majority, 53 of the participants were from the dietetics or food and nutritional sciences major, (40.7%) of total participants. Food science and technology major was the next largest group at 23 participants or 17.6% of total participants. A combined total of 58.3% of total participants came from the food and nutrition related majors. Participants from these majors were expected to attend as flyers were posted in the building where those courses were held and it was also the major housed in the building where testing was held. Hotel, restaurant and tourism management major accounted for 15 participants (11.4%) and family and consumer science major contributed seven participants (5.3%). Three participants were not counted as they were over the age of 30. Figure 2 demonstrates the distribution of the various majors among the participants, there were 13 additional various majors combined together among 29 (22.3%) of total participants.



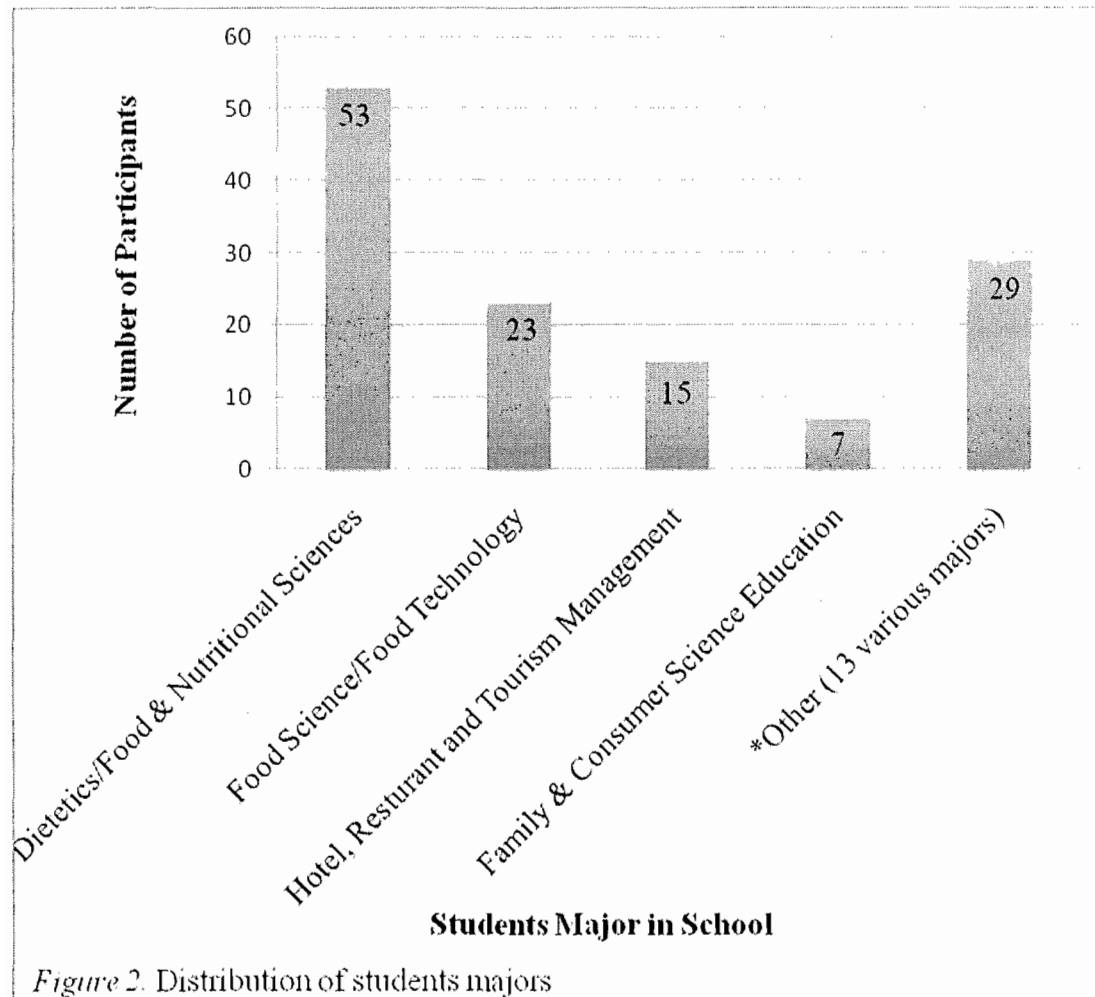


Figure 2. Distribution of students majors

\*Business Administration (5), Human Development (3), Industrial Design (5), Early Childhood Education (3), Special Education (2), Retail Management (2), Psychology (1), Engineering Technology (2), Construction (1), Golf Enterprise Management (1), Graphic Design (2), Voc. Rehab (1), No Major (1)

### Sensory of Snack Bars

A total of 13 questions were asked on the survey which included: overall texture (two questions), appearance (two questions) and flavor (two questions) of the two snack bars. After taste testing both products and answering the first six questions, participants were asked to select the product that they most preferred (one question) (see Appendix B). Additionally, participants

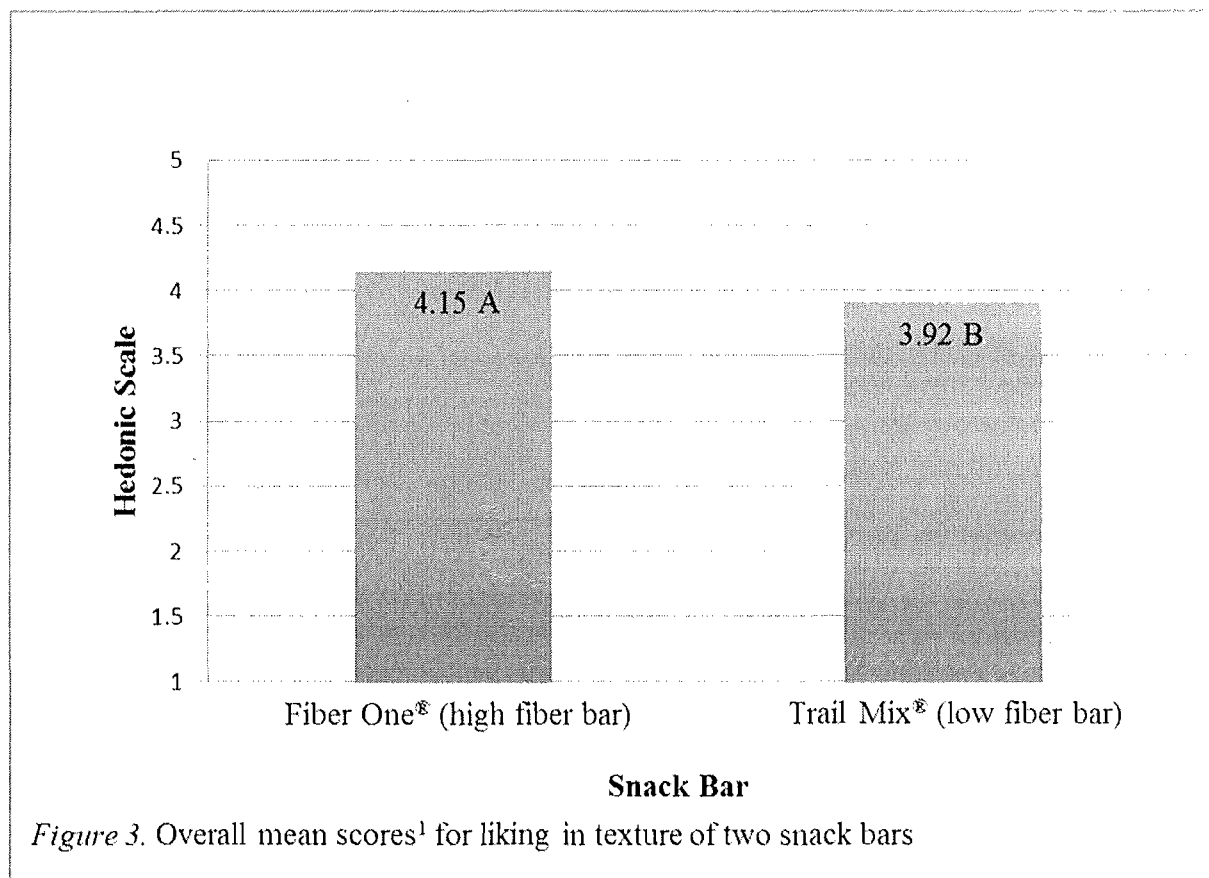
were asked several demographical questions (three questions) regarding gender, age group and current major. The survey concluded with three questions about perceptions of dietary fiber; their own knowledge regarding dietary fiber, ability to select foods or supplements that are a high source of fiber and reasons that relate to the frequency about their consumption of fiber. Products were by number designations: 845 and 932. Product coded 845 was the high fiber bar with nine grams per bar (General Mills, Fiber One<sup>®</sup> Oats and Chocolate). The product that was coded 932 was the low fiber bar with one gram per bar (General Mills, Nature Valley<sup>®</sup> Chewy Trail Mix Dark Chocolate & Nut). Participants were offered 1/3 bar from the high and low fiber sample which consisted of 3.33 grams of fiber total. Three grams came from the high fiber bar and .33 grams came from the low fiber bar.

### **Overall Texture**

Texture was one attribute that was measured in this study. Observed during distribution of the bars, that the high fiber bar was a slightly more structured and held together, where as the low fiber bar fell apart more easily while they were prepared prior to sensory analysis.

Means and standard deviations were calculated for overall texture on the high fiber bar and the low fiber bar, and the results of the mean were 4.15 (SD±0.881) and 3.92 (SD±0.961), respectively, on a scale of 1 to 5; with 1 = extremely dislike and 5 = extremely like. This indicated that participants significantly liked the high fiber bar texture more than the low fiber bar (Figure 3). It was noted that fifty-one participants (39.2%) selected “extremely like” for the high fiber bar while 38 participants (29.2%) selected, “extremely like” for the low fiber bar (Table 1). Both bars were taste tested and scored by the participants, 10% more participants selected “extremely like” for the high fiber bar versus the low fiber bar, which demonstrates that

the high fiber bar was more liked in texture more than the low fiber bar. Analysis of variance was determined at  $p = 0.0287$ .



<sup>1</sup>Where on the hedonic scale 1 = "Dislike extremely", 2 = "Moderately dislike", 3 = "Neither like or dislike", 4 = "Moderately like", 5 = "Like extremely"; Bars having means followed by different uppercase letters are significantly different ( $p = 0.0287$ )

Table 1

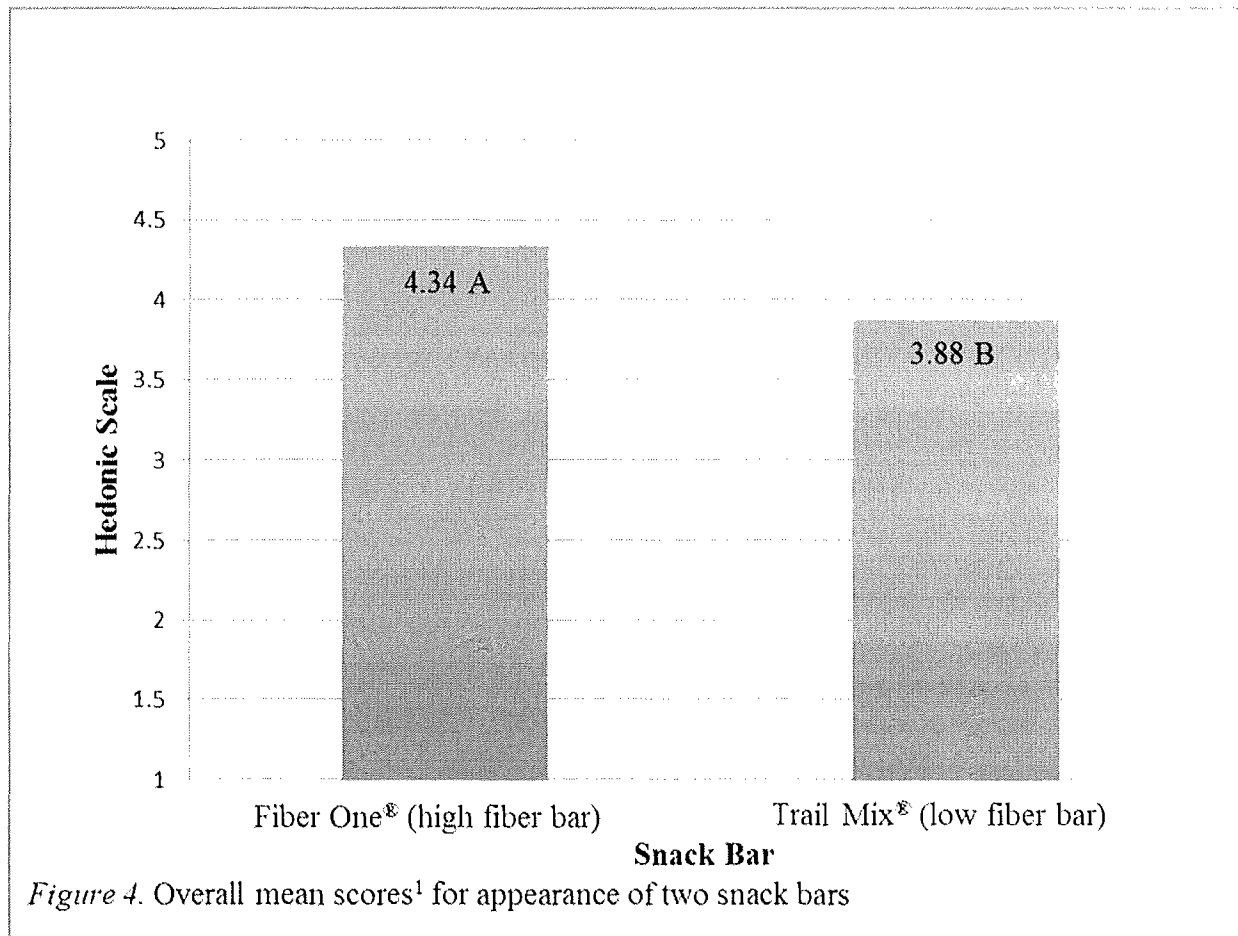
*Percentage of Liking for Overall Texture of the High Fiber and Low Fiber Bars*

Product	Level of liking in terms of texture <sup>1</sup>					Total
	1	2	3	4	5	
High fiber bar	0	7.7	9.2	43.9	39.2	100%
Low fiber bar	0.8	10.8	13.1	46.2	29.2	100%

<sup>1</sup>Where on the hedonic scale 1 = "Dislike extremely", 2 = "Moderately dislike", 3 = "Neither like or dislike", 4 = "Moderately like", 5 = "Like extremely"

### **Overall Appearance**

The purpose of analyzing the appearance in these bars was to determine what snack bar college aged students preferred between the bar high in fiber or low in fiber. Means and standard deviations were calculated for overall appearance on the high fiber bar and low fiber bar, and the results of the mean indicated hedonics scores of 4.34 (SD±0.803) and 3.88 (SD±0.835) respectively, on a scale of 1 to 5 with 1 = extremely dislike and 5 = extremely like (Figure 4). This demonstrated that participants significantly liked the high fiber bar in overall appearance over the low fiber bar; 62 participants (47.6%) selected "extremely like" for the high fiber bar and 28 participants (21.5%) selected "extremely like" for the low fiber bar (Table 2), which demonstrated that the participants liked the appearance more in the high fiber bar than the low fiber bar. Analysis of variance was determined at  $p = 0.0287$ .



<sup>1</sup>Where on the hedonic scale 1 = “Dislike extremely”, 2 = “Moderately dislike”, 3 = “Neither like or dislike”, 4 = “Moderately like”, 5 = “Like extremely”; Bars having means followed by different uppercase letters are significantly different  $p = 0.0287$

Table 2

*Percentage of Liking Overall Appearance of the High Fiber and Low Fiber Bars*

Product	Level of liking in terms of appearance <sup>1</sup>					Total
	1	2	3	4	5	
High fiber bar	1.5	2.3	4.6	43.9	47.7	100%
Low fiber bar	0	7.7	18.5	52.3	21.5	100%

<sup>1</sup>Where on the hedonic scale 1 = "Dislike extremely", 2 = "Moderately dislike", 3 = "Neither like or dislike", 4 = "Moderately like", 5 = "Like extremely"

### **Overall Flavor**

By asking the participants to taste the products the researcher was also able to examine whether fiber alone was a determining factor in what products they preferred.

Means and standard deviation were calculated for overall flavor on the high fiber bar and low fiber bar and it was determined that, the hedonic mean for the high fiber bar was 4.14 (SD±0.842) and 3.88 (SD±0.962) for the low fiber bar (Figure 5). The high fiber bar (Fiber One<sup>®</sup>) was liked significantly more than the low fiber bar (Trail Mix<sup>®</sup>) in terms of flavor. Table 3 demonstrates the cross-tabulation percentages flavor preference on a range of how well they liked each product. Participants liked the high fiber bar in overall flavor more than the low fiber bar. Of the 127 participants, 47 participants (36.2%) selected "extremely like" for the flavor of the high fiber bar and 33 participants (25.3%) selected "extremely like" for the low fiber bar. Analysis of variance was determined at  $p = 0.0187$ .

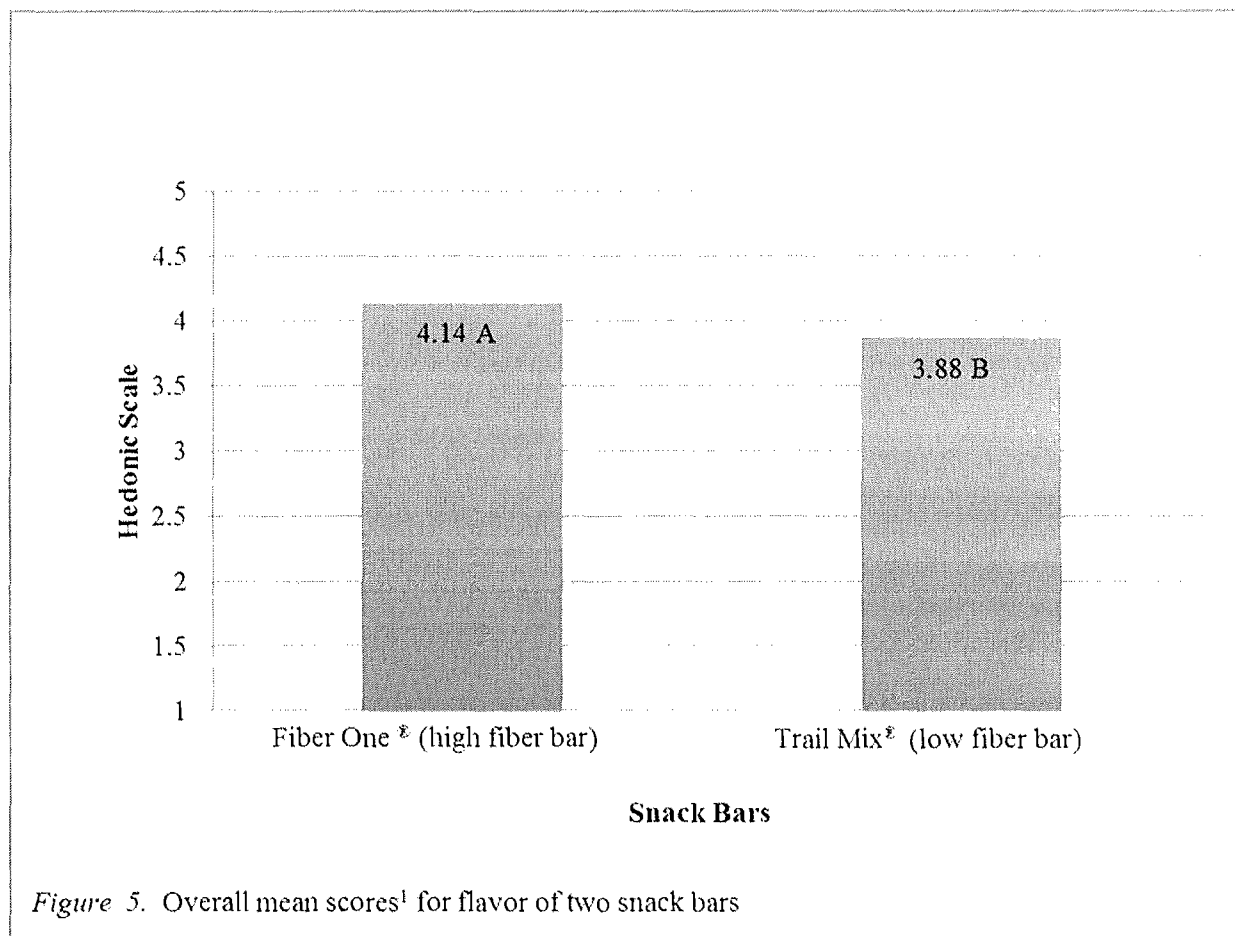


Figure 5. Overall mean scores<sup>1</sup> for flavor of two snack bars

<sup>1</sup>Where on the hedonic scale 1 = "Dislike extremely", 2 = "Moderately dislike", 3 = "Neither like or dislike", 4 = "Moderately like", 5 = "Like extremely"; Bars having means followed by different uppercase letters are significantly different  $p = 0.0187$

Table 3

*Percentage of Liking Overall Flavor of the High Fiber and Low Fiber Bars*

Product	Level of liking in terms of flavor <sup>1</sup>					Total
	1	2	3	4	5	
High fiber bar	0.8	4.6	10.8	47.7	36.2	100%
Low fiber bar	1.5	10.8	10.8	51.5	25.4	100%

<sup>1</sup>Where on the hedonic scale 1 = "Dislike extremely", 2 = "Moderately dislike", 3 = "Neither like or dislike", 4 = "Moderately like", 5 = "Like extremely"

### **Overall Preference**

It was evident that 76 participants (58.5%) selected the high fiber bar as the selection they preferred overall; that means that only 54 participants (41.5%) preferred the low fiber bar over the high fiber bar in overall acceptance. This was not statistically significant at  $p < 0.05$ . The majority of participants selected the high fiber bar as what they preferred overall; this was not surprising since the high fiber bar was significantly preferred in individual characteristics of flavor, appearance and texture. Table 4 shows the percentage of participants that selected each snack bar.



Table 4

*Percentage Liking Overall Preference of the High Fiber and Low Fiber Bars*

<b>High fiber bar</b>	<b>Low fiber bar</b>
58.5% (76)	41.5% (54)

Research objective one stated the participants will prefer the low fiber snack bar over the high fiber snack bar in regards to the texture, appearance and flavor. This objective was not met, the opposite occurred with the participants preferring the high fiber snack bar over the low fiber snack bar in regards to texture, appearance and flavor.

Participants significantly preferred ( $p < 0.05$ ) the high fiber snack bar over the low fiber snack bar in all three characteristics of overall texture, appearance and flavor. Although the research objective was disproven and the participants preferred the high fiber bar in texture, appearance and flavor, more participants also selected the high fiber bar as the preferred choice in overall acceptance, although not significantly. A total of 58.5% of participants chose the high fiber bar over the low fiber bar. Reasons for the 41.5% of participants that selected the low fiber snack bar could have been because it had larger chocolate chunks in it and thus became more appealing overall. Another reason could be that they were familiar with that taste of bar and selected the one that was most familiar to their palates. A final theory could be that they simply selected the opposite one that they had been selecting throughout the survey for a change in answers.

### **Perception of Knowledge**

Participants were asked to select what they believe their perception of their own knowledge was regarding dietary fiber. Answers that could be selected were, “not

knowledgeable”, “somewhat knowledgeable”, “moderately knowledgeable”, “very much knowledgeable” and “extremely knowledgeable”. Table 5 represents the percentage of each answer selected by the participants in terms of their beliefs of their knowledge about dietary fiber. Most (76.8%) of the participants believe that they have moderate to very much knowledge regarding dietary fiber. A small percentage (7.6%) of responses was at the extremes of the hedonic scale selecting either extremely knowledgeable or not knowledgeable at all. This is remarkable due to the fact that 58.3% of total participants are in either a food and/or nutritional related major where knowledge about fiber might be expected to be higher and one would predict the percentage for extremely knowledgeable would be higher than the 3.8%. Additionally, the same number of participants selected moderately knowledgeable and very much knowledgeable.

Table 5

*Participants Perceptions About Their Dietary Fiber Knowledge*

<b>Answer</b>	<b>Percent of participants</b>
Not knowledgeable	(5) <sup>1</sup> 3.8%
Somewhat knowledgeable	(20) 15.6%
Moderately knowledgeable	(50) 38.4%
Very much knowledgeable	(50) 38.4%
Extremely knowledgeable	(5) 3.8%

<sup>1</sup>Numbers in the parentheses indicate the actual number of participants that selected that response

This question can be dissected further by determining if the participants' perception of their knowledge about dietary fiber matched what they actually selected for the high fiber items. Research objective four was anticipating that participants would select at least 50% of all dietary fiber foods, products and supplements as a high fiber item. Ninety-five (75%) total participant's selection of their own perception was accurate to what they actually achieved when selecting high fiber items. Thirty-two (25%) total participants selection of their own perception was not accurate to what they actually achieved when selecting high fiber items. This demonstrates that some participants thought that they were somewhat, moderately or extremely knowledgeable when they may not have been. Additionally, some participants may not have had as much confidence and selected that they were not knowledgeable when in fact they were, by selecting at least 50% or more high fiber items correctly.

### **Selecting High Fiber Sources**

Participants were asked to select high fiber sources in foods, supplements and products from a list that was provided to them and a statement as follows, "According to the Food and Drug Administration (FDA), a food, product or supplement is considered a high source of dietary fiber if it contains at least 5 grams of fiber per serving or more" (FDA, 1993, n.p.). Table 6 shows the list of foods, supplements and products that were given and the number of participants that selected it as a high fiber source. Also is shown the actual amount of fiber in each of the items with the given serving amount, for example, 5 grams of fiber per serving is considered a high source. Table 6 further illustrates the level of knowledge that participants had about dietary fiber content. In Table 6, fifteen foods, products and supplements were listed; seven of the 15 are high fiber items.

Research objective four stated students will be able to select at least 50% of the high fiber source foods/supplements from a list. Most participants (77.6%) selected any products that had the word fiber appeared in the items name as being a high fiber source. For example, 77.6% of participants selected Fiber Choice<sup>®</sup> as being a high fiber source and although it is a fiber supplement, there are only 4 grams of fiber in two tablets which was close to being considered a high source of dietary fiber.

Raspberries are one the highest sources of fiber among fruits and only 26.2% of participants selected it as a high fiber source. This was speculated to be due to a lack of knowledge about whole food fiber content. Nabisco<sup>®</sup> Wheat Thin crackers had a total of 22.3% of participants reporting that they were thinking that they are a high fiber source; this may have been due to heightened advertising and packaging on products, causing consumers to incorrectly identify a product is healthy or is a good source of a specific nutrient when it is not. Wheat Thins<sup>®</sup> product advertises itself as having 5 grams of whole grain, when the typical consumers may not know the recommendation amounts 16 grams of whole grains for it to be considered one serving of whole grains (Whole Grain Council, 2004). As stated above, a little over three servings would have to be consumed in order to be equivalent to one serving of whole grains.

The lowest percentage, 6.9% of participants selected the white bread as high fiber. Once again this demonstrates a lack of knowledge about what sources are high in dietary fiber. Out of the fifteen items that were given to the participants, seven of them were selected as being high fiber by percent. Metamucil<sup>®</sup> was only 1% away from having 50% of total participants selecting it as a high fiber source which was significant. Overall this research objective was met by participants' ability to select about 50% of the food items as being a high fiber source, whether these were guesses or not, some knowledge of fiber sources was shown. Items that were high

fiber and more than 50% of participants selected them as high fiber items were, kidney beans, whole wheat pasta, Kellogg's®, All bran cereal, General Mills®, Fiber One Granola bars and Metamucil®. However there is still a lack of knowledge regarding fiber content in foods, products and supplements with some participants. For example, 22.3% of participant's selected Wheat Thin® crackers as a high fiber source, which confirms that there was a need to be clearer and more consistent in labeling standards and advertising on whole grains, dietary fiber and wheat products. Raspberries and Citrucel® were the only two high fiber sources on the list in which less than 50% of participants selected as a high fiber source. Only 34 (26%) participants selected raspberries as a high fiber item and 50 (38.5%) participants selected Citrucel® as a high fiber item.

Although 6.9% was a low percentage, this was a substantial number of participants that believed two slices of white bread were a high source of dietary fiber. In addition, supplements may claim to help with digestion, even though the fiber content may not be high enough to qualify as a high fiber source (5 grams). Figure 6 represents the percentages that these items were selected by the participants as shown below. Each participant selected all items that they thought was a high fiber source and therefore they could have selected zero to fifteen items, making all of the items not totaling 100%.

Table 6

*Number of Participants That Selected Particular Items as a High Fiber Source*

<b>Food</b>	<b>Number selected item</b>	<b>High fiber source</b>
Kidney beans, 1 cup	70	6 grams <sup>1</sup>
Whole wheat pasta, 1 cup	81	6 grams <sup>1</sup>
White bread, 2 slices	9	1 gram
Nabisco®, Wheat thin crackers, 12 crackers	29	1 gram
Raspberries, 1 cup	34	8 grams <sup>1</sup>
<b>Products</b>		
Kellogg's®, All bran cereal, 1/2 cup	89	10 grams <sup>1</sup>
General Mills®, Fiber One Granola bars, 1 bar	92	9 grams <sup>1</sup>
Oatmeal, instant, 1 cup	82	3 grams
Low fat plain yogurt, 6 oz cup	12	0 grams
General Mills®, Cheerios, 3/4 cup	38	3 grams
<b>Supplements</b>		
Activia®, 4 oz	48	0 grams
Citrucel®, 2 teaspoons	50	6 grams <sup>1</sup>
Metamucil®, 2 teaspoons	64	10 grams <sup>1</sup>
Benefiber®, 2 tablets	98	4 grams
Fiber Choice®, 2 tablets	101	4 grams

<sup>1</sup> Indicates whether the item is considered a high fiber source according to FDA standards  
N=130 total participants

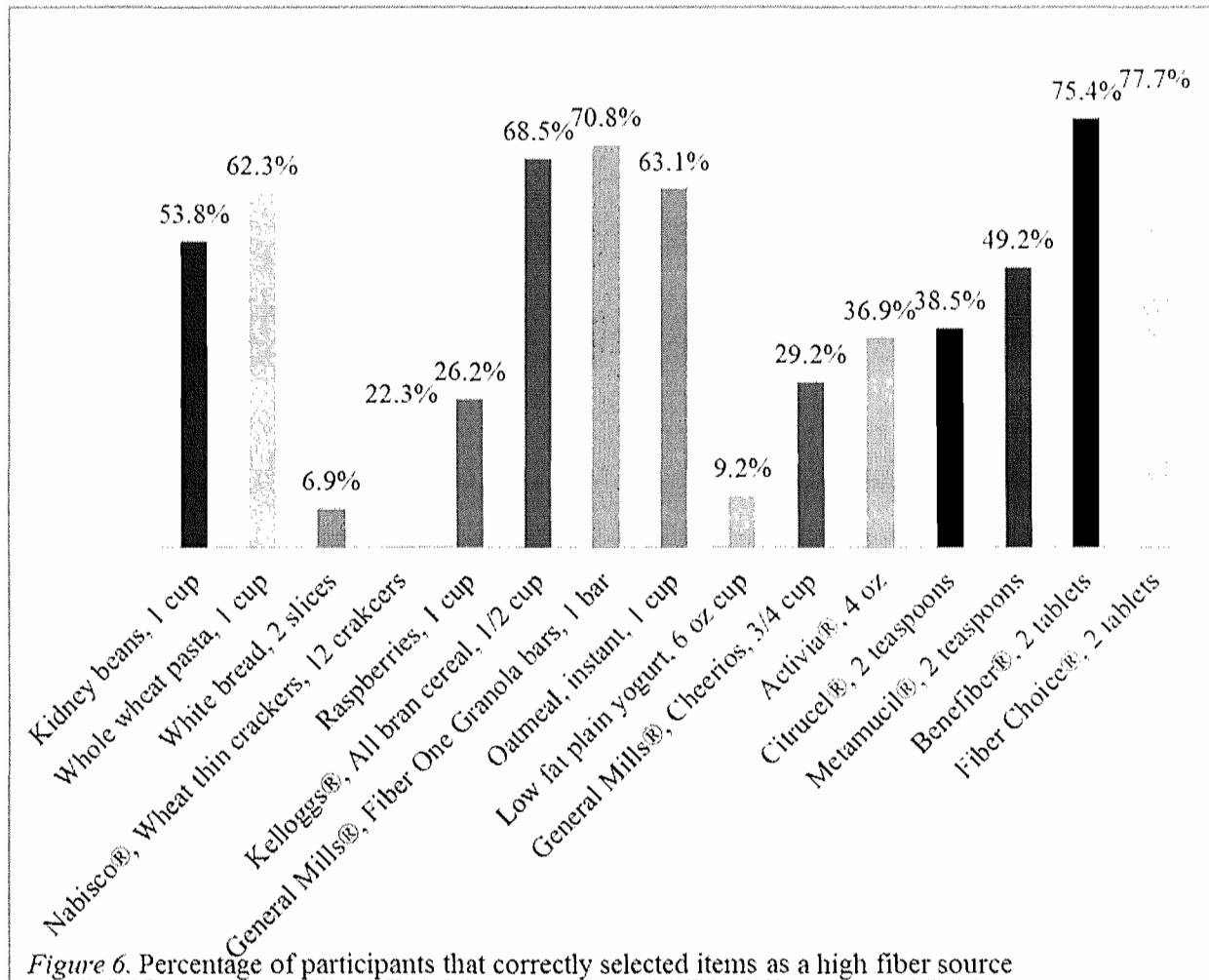


Table 7 illustrates there was a small percentage in difference between males and females and how many fiber items they correctly selected as high fiber. Thirty-one of the 40 total males selected at least 50% of the high fiber items correctly; which represents 77.5% of males selected at least 50% of the items correctly. Comparing to females, 62 of the 87 total females selected at least 50% of the high fiber items correctly; which represents 71.2% of all females selected at least 50% of the high items correctly; Table 7 represents this difference. Research objective three states there will be no difference between genders for selecting at least 50% of high fiber source foods/supplements from a list. There was a small percentage in difference between males and females and how many fiber items they correctly selected as high fiber. The majority of the

total participants were females, at 70%. Ninety-three (71.5%) total participants correctly selected at least 50% of high fiber source foods/supplements from a list; 33.33% (31) were male participants and 66.66% (62) were female participants. There were a greater number of females that participated in the study; therefore the total number of each gender that correctly selected at least 50% of high fiber source foods/supplements from a list was divided by the total number of participants from that gender. The participants that selected less than 50% of the high fiber items correct were; 22.5% males and 28.8% of the females, which resulted in having the males significantly scoring more items correct than females. This objective was not met; however, the percentages were very close with only a 6.3% margin between the genders. This objective may have been met if the gender distribution was equal with 50% males and 50% females.

Table 7

*Percentage of Participants That Selected High Fiber Items Correctly*

	<b>&gt; 50% selected correctly</b>	<b>&lt; 50% selected correctly</b>
<b>Males</b>	77.50%	22.50%
<b>Females</b>	71.20%	28.80%

Table 8 further demonstrates the knowledge of dietary fiber sources between nutrition related majors and non-nutritional majors. Nutrition related majors include, Dietetics, Food Science, Food Systems and Technology and Food and Nutritional Sciences. Fifty-nine out of the total 76 nutrition related students selected at least 50% or more of the high fiber items correctly, which is equivalent to 77.6% of nutrition related students. Thirty-one out of the total 51 non-nutrition related students selected at least 50% or more of the high fiber items correctly, which is equivalent to 60.7% of non-nutrition related students.



Table 8

*The Difference Between Nutrition and Non-Nutrition Related Students in Their Correct Selection of High Fiber Items (5 grams or more per serving)*

<b>Nutrition related majors</b>	<b>Non-Nutrition related majors</b>
59/76 (77.6%)	31/51 (60.7%)

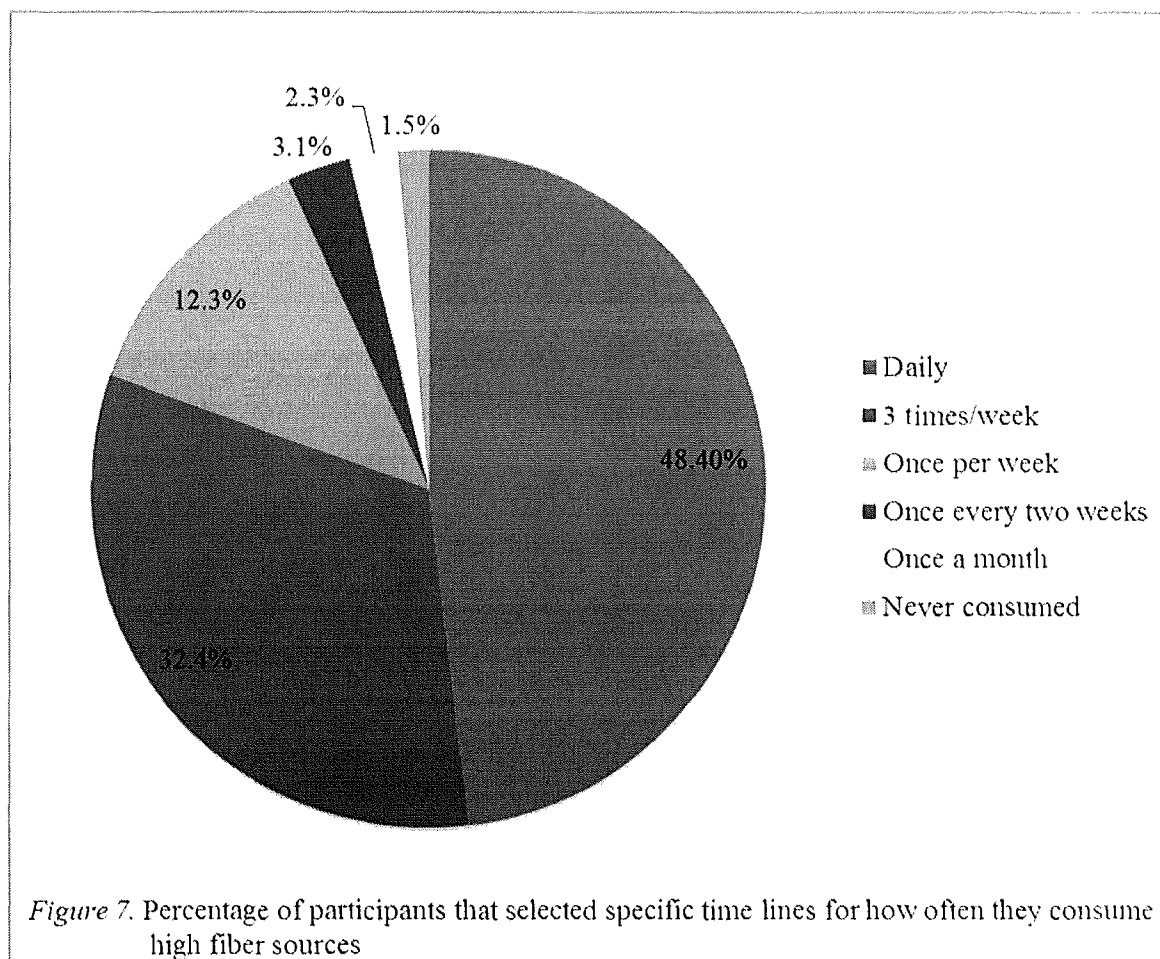
### **How Often Fiber Was Consumed**

How often the participants consumed foods, products or supplements that are high in dietary fiber was also reported. Sixty three participants or 48.4% indicated that they consume high fiber sources on a daily basis. Table 9 indicates how often the participants believed they consume fiber and Figure 7 shows the percentage of participants that selected each time line.

Table 9

*The Number of Participants That Consumed High Fiber Sources in a Given Time Line*

<b>How often consumed</b>	<b>Number of participants</b>
Daily	63 (48.40%)
3 times/week	42 (32.4%)
Once per week	16 (12.3%)
Once every two weeks	4 (3.1%)
Once a month	3 (2.3%)
Never consumed	2 (1.5%)



Research objective number two investigated age differences in terms of consumption of fiber if participants aged 25-30 consume high dietary fiber whole foods, products, and/or fiber supplements more frequently than participants aged 18-24. Ten of fifteen participants aged 25 to 30 selected they consume high fiber foods, products and/or supplements daily; which is 66.7% (10) of total participants in this age category, compared to the 45% (51) of participants aged 18-24 selected consuming high fiber items daily. Additionally, 26.7% (4) of participants aged 25-30 selected consuming high fiber items three times per week and 6.6% (1) selected once per week consuming these items. Participants aged 18-24, 34.8% (39) selected consuming high fiber items three times per week and 14.2% (16) selected once per week consuming these items. These results demonstrate that more than half of students from the older age group consume high fiber

items more frequently than the younger age group, where less than half of participants consume high fiber items daily.

Figure 8 demonstrates the percentage of participants from the 25-30 age category and how often they consume high fiber items. Further, Table 10 depicts the difference in percentage between the age categories.

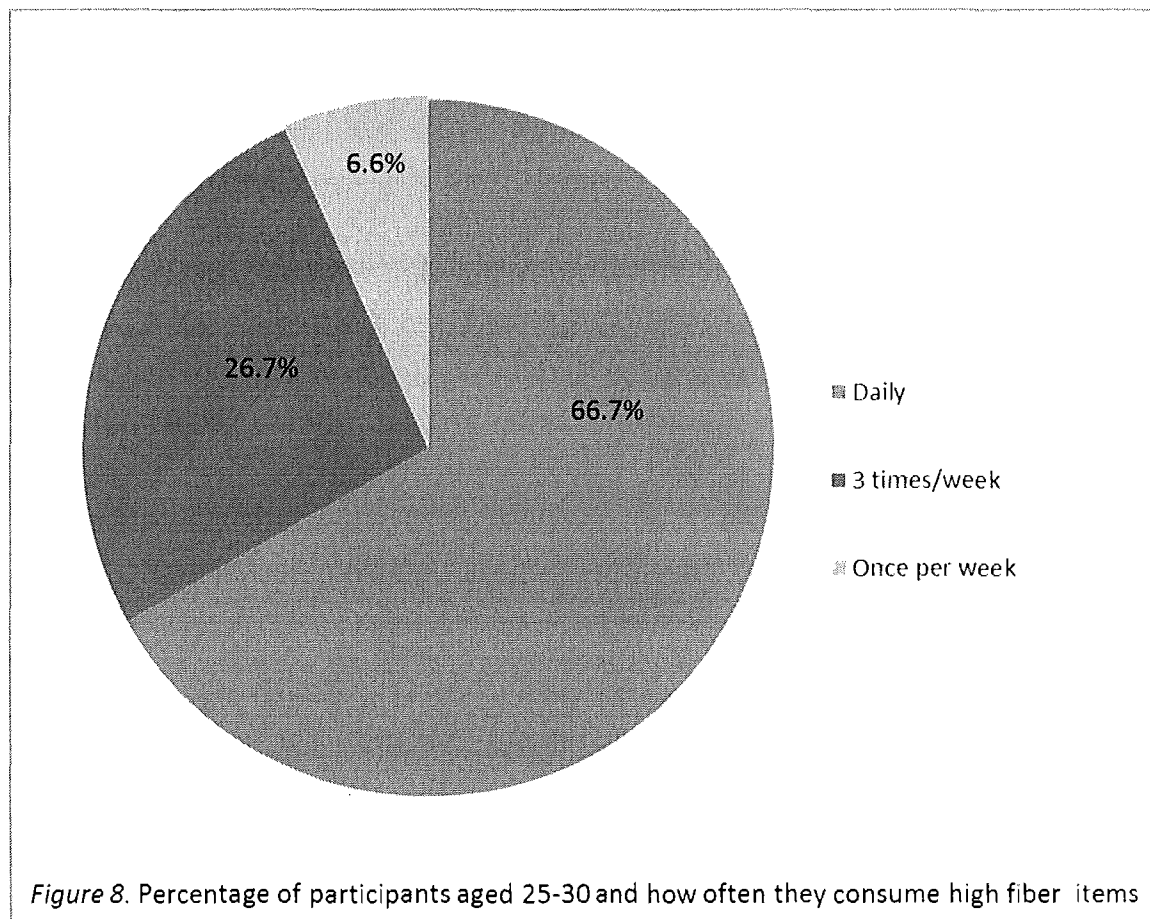


Table 10

*The Number of Participants That Consumed High Fiber Sources in a Given Time Line Between Two Age Range Categories*

<b>How often consumed</b>	<b>18 - 24 years old (N=112)</b>	<b>25 - 30 years old (N=15)</b>
Daily	45% (51)	66.7% (10)
3 times/week	34.8% (39)	26.7% (4)
Once per week	14.2% (16)	6.6% (1)
Once every two weeks	3% (4)	0% (0)
Once a month	2% (3)	0% (0)
Never consumed	1% (2)	0% (0)

### **Reasons for Consumption of High Fiber**

The last question asked on the survey pertained to the reasons why participants do or do not consume high fiber foods. Table 11 shows the multitude of answers that were given and the percentage of participants that made a similar statement. Note that some participants may have made multiple comments. As shown, health benefits were the number one reason that participants (34.6%) said they consumed dietary fiber as frequently as they do. Another 25.3% of participants indicated that they eat fiber because it helps their bowels stay regular. A lack of knowledge was once again demonstrated when 9.22% (3.07% of participants that don't like the taste of fiber + 6.15% of participants that do like the taste of fiber = 9.22%) of participants said they like or dislike the taste of fiber. Fiber is a nutrient that is found within whole foods, such as raspberries, apples, spinach and rice. Participants (9.22%) were unaware that many foods, as just mentioned, had dietary fiber in them.

Table 11

*Top Reasons Why Participants Consumed High Fiber Foods and the Percentage of Participants That Responded Similarly*

<b>Comments participants made</b>	<b>Number that made comment<sup>1</sup></b>	<b>Percentage of participants</b>
Health benefits	45	34.6
Helps bowels stay regular	33	25.3
Most of the food I eat already have fiber in it	24	18.4
Not applicable/non representative answer given	15	11.5
Don't know what foods have fiber	9	6.9
I have good knowledge of fiber	7	5.38
Don't like the taste of fiber	4	3.07
I do like the taste of fiber	8	6.15
I cannot afford fiber products	4	3.07
Fiber keeps my satiety up	8	6.15
Doctors orders to eat a high fiber diet	1	0.769
I was brought up eating a lot of fiber	1	0.769

<sup>1</sup>Participants may have typed multiple reasons for why they consume or no don't consume high fiber items; therefore the total number of comments is greater than 130

N=130 total participants

## **Chapter V: Discussion**

### **Introduction**

The purposes of this study were to 1) determine the perceptions of dietary fiber, 2) determine the knowledge level about dietary fiber, and 3) determine how often the participants consumed dietary fiber at the University of Wisconsin-Stout campus. Results were analyzed according to the responses given on a thirteen-question survey through Compusense<sup>®</sup> after participants had consumed a high (3.33 grams of fiber in provided sample) and a low fiber (.33 grams of fiber in provided sample) snack bar. This chapter will discuss major findings of statistical data of the study, conclusions, limitations and recommendations for further research that may help consumers increase their dietary fiber intake and better their overall health with increased knowledge about dietary fiber.

### **Major Findings**

Statistical analyses of data were calculated on all responses to questions from all study participants to determine differences and significance among perceptions of dietary fiber, knowledge level about dietary fiber and the frequency of consumption of dietary fiber. Aspects of the study were cross-tabulated (texture, appearance and flavor of the snack bars); when two or more variables display any distribution between each other. Standard deviations were determined by analyzing the amount of data that was collected around the means, the texture, appearance and flavor of the snack bars. Analysis of variance and ANOVA tests were run at a significance level of 0.05. Comments about why the participants consume foods with fiber, the frequency of eating those foods and the types of foods were categorized into like responses and averaged.

Demographical data that were collected included a total of 130 participants, however, three were excluded due to their age was older than the sample size being tested, making the total 127 participants, 86.2% of those participants aged 18-24 years old, 90 participants of the 127 (70%) females. Of the total participants, 58.4% of them studied within a food or nutrition related major (Food and Nutritional Sciences, Food Systems and Technology, and Dietetics).

The amount of participants that selected the top two responses of “moderately like” and “extremely like” were combined together for the questions about texture, appearance and flavor. Evaluation of texture is a very important aspect to companies when creating food products. According to Agricultural Research (2001), new technologies allow these companies to add more dietary fiber to foods without changing the texture of the product. Foods with high fiber content, such as the high fiber bar that was used in this study, tend to absorb water content thus making the food less moist in texture. According to Onwulata from Agricultural Research (2001), “reducing the water-holding capacity of the fiber improves food quality and allows more fiber to be added without changing its texture” (p. 14).

Approximately 83% (83.1%) of participants selected either “moderately like” or “extremely like” on the texture of the high fiber bar. The low fiber bar had 75.4% participants that selected either “moderately like” or “extremely like” responses; indicating that the texture was rated higher for high fiber bar over the low fiber bar by 7.7% of participants.

The purpose for analyzing overall appearance was a vital characteristic of food choices, most people want food to look appealing and be tasteful. Hutchings (2007) agrees that many individual factors contribute to the total perception of the appearance of a food product. Hutchings (2007) believes total perception is built up from all the visual sensations of a product when it is on the shelf, being prepared and on the plate ready for consumption. Although, the

snack bars in this study were not undesirable, they did have slightly different appearances noted. For example, the high fiber bar had more visible nuts than the low fiber bar and the low fiber bar had larger chunks of chocolate than the high fiber bar. A study conducted by Bower and Whitten (2007) found that consumers prefer chewy snack bars with chocolate more than the hard and crunchy snack bars. Bower and Whitten (2007) studied 56 consumer panelists on their degree of like and perception for textural aspects and flavor of two snack bars; one being chewy with chocolate and the other snack bar being hard and crunchy. In this study, participants preferred the high fiber snack bar more in both texture and overall appearance, which had more visual nuts and less chocolate than the low fiber snack bar. Results for the combined top two responses for high fiber bar appearance rating was 91.6%. The low fiber bar had 73.8% combined likability; which indicated 17.8% of participants selected the high fiber bar over the low fiber bar on the appearance characteristic.

One of the main reasons consumers, not surprisingly, purchase food products are a result of flavor. According to Nestle, Wing, Birch, DiSogra, Drewnowski, Middleton, Sigman, Sobal, Winston and Economos (2009) discuss most consumers' state that their food choices are largely determined by taste, as opposed to any other factors. Results of the overall flavor category indicated a similar outcome in terms of percentage of participants as the results from the texture category. Participants selected (83.9%) either "moderately like" or "extremely like" responses for flavor of the high fiber bar. The low fiber bar had 76.9% combined rating from participants; indicating the overall rating was 7.0% of participants liked the high fiber bar over the low fiber bar. All three characteristics (texture, appearance and flavor) were considered statistically significant ( $p < 0.05$ ) for the high fiber bar.



Interestingly, all individual attributes were rated higher for the high fiber bar, the high fiber bar was preferred by 58.5% of participants (41.5% of participants preferred the low fiber bar for overall preference). Although there was a significant difference between the two snack bars in texture, appearance and flavor, interestingly there was not a significant difference between the high fiber bar (Fiber One<sup>®</sup>) and low fiber bar (Trail Mix<sup>®</sup>) in overall product preference at both a  $p < 0.05$  and  $p < 0.01$  values. This indicated that though the participants preferred the high fiber bar in terms of all the specific attributes of texture, appearance and flavor, the overall preference between the high and low fiber snack bars was not significant. Bower and Whitten (2007) state that the majority of consumers ranked taste as the most important characteristic influencing their purchase intent, followed by textural features, price and appearance.

When determining participant's perceptions about their dietary fiber knowledge, all participants equally, at 38.4%, perceived their knowledge to be "moderately knowledgeable" or "very much knowledgeable" regarding dietary fiber. The researcher indicated that "very much knowledge" meant that the participant knew a considerable (understanding the types of fiber and what foods contain fiber) amount of information regarding dietary fiber. Another possibility for these responses could have been that participants have not been exposed to educational material in detail regarding fiber and therefore may have lacked confidence about their actual knowledge. The relation between confidence and knowledge is significant; having more knowledge about dietary fiber would make you have more confidence when answering questions regarding fiber. As previously discussed in Chapter Two, Davy, Benes and Driskell (2006) stated that females reported obtaining most of their nutritional knowledge in the order that follows: family members, classes, magazines/newspapers, friends, instinct, television, physicians, books, health

professionals and Registered Dietitians. Males were slightly different in their order of where they obtain their nutritional knowledge from; classes, family members, friends, magazines/newspapers, television, instinct, physicians, books, other health professionals and lastly Registered Dietitians. Health professionals and Registered Dietitians are the experts on nutritional knowledge, yet the last resources for which both males and females obtained their knowledge.

A final possibility in this study could have been that the participants that stated they were “not knowledgeable” (3.8%) may have never been introduced to fiber and how it has the potential to have a positive impact on the health. Those that perceived their knowledge to be “extremely knowledgeable” (3.8% of participants) may have studied fiber more in depth within nutrition courses than other students and therefore have increased confidence about their knowledge and as a result improved scores of the portion of the study that measured knowledge about dietary fiber. Ridgeway, Shirk, Becher, Taylor, Clutter and Wolf (2010) report that general nutrition knowledge significantly increased from pre-test to post-test for 82 high school students in a knowledge and skill-building summer wellness course. The wellness course educated on topics such as nutrition guidelines, energy balance, and general nutrition knowledge and health outcomes. Additionally, Ridgeway, et al. (2010) state self-efficacy toward healthy lifestyle behaviors also increased significantly; and school-based nutrition education programs are an effective approach to increase knowledge and confidence and to install healthy lifestyle behaviors.

Marietta, Welshimer and Anderson (1999) examined the influence of 1990 Nutrition Labeling and Education Act food labels on college students. Marietta, Welshimer and Anderson (1999) wanted to determine whether educational experience with labels was associated with

label-reading knowledge, attitudes, and behaviors. Two hundred and eight students were surveyed, results of this study were that knowledge scores were positively correlated with attitudes toward labels and use of labels. Previous education from the students in reading labels was associated with higher knowledge scores. This further verifies that knowledge on label reading can have a positive correlation with dietary fiber consumption.

Determining participant's ability to select high fiber items from a list was an important aspect to evaluate. According to the Food and Drug Administration (FDA) (2005), a food, product or dietary fiber supplement is considered a high source of dietary fiber if it contains at least 5 grams of fiber or more per serving. Seven items from the list of fifteen were considered a high fiber source in the questionnaire portion of the study. After evaluating the percentages of participants that selected each item, it was determined that knowledge about certain breakfast foods are higher in dietary fiber was evident for all groups. For example, 68.5% of participants correctly selected Kellogg's® All Bran cereal as a high fiber source, 70.8% of participants correctly selected General Mills® Fiber One bars as a high fiber source and 63.1% incorrectly selected instant oatmeal as a high fiber source. Although most different brands of instant oatmeal contain 3 grams of fiber, it is not a high source but it is important to note that 3 grams of fiber is considered a good source, according to the Food and Drug Administration (FDA) (2005). Also, recently with the fiber trend in society; there are several brands that have high fiber instant oatmeal as an option to purchase for customers. Hiza, Fungwe, and Bente (2007) state there are evident trends in the availability of dietary fiber in the United States food supply. This fiber trend in society is related to the many products and companies that are developing items with added fiber to ensure that the product is high in dietary fiber. Dietary fiber has been added to

multiple foods recently including anything from yogurt to pancake mix to Splenda<sup>®</sup>. The USDA (2007) states,

Manufacturers have embarked on ventures to promote the use of grain-based foods and ingredients for their dietary fiber benefits, as well as for their other many health benefits. Several manufacturers have developed ingredients that offer all the nutrition of whole grain with a taste and texture similar to that of refined grains. At the same time, many manufacturers are reformulating existing products to incorporate more whole grains. Many manufacturers have, as well, used consumer education campaigns to increase consumers' awareness and consumption of these reformulated or new products. (p. 2)

This is giving consumers more opportunities to increase their dietary fiber intake.

Participants correctly selected various food sources such as kidney beans (53.8% of participants) and whole wheat pasta (62.3%) as high fiber food sources; these foods were high sources of fiber (6 g of fiber/1 cup for both kidney beans and whole wheat pasta). On the other hand there were a number of participants that selected Wheat Thin<sup>®</sup> crackers as a high fiber source incorrectly, nearly one quarter of the participants (22.3%); when in fact Wheat Thins<sup>®</sup> are not a significant source of fiber (1 g of fiber per 12 crackers) (Nabisco<sup>®</sup>, 2009). As discussed earlier, labeling and advertisements may be misleading on certain products and foods in supermarkets making it confusing for consumers to make the healthier choice. Kantor, Variyam, Allshouse, Putnam and Lin (2001) state that, increased intake of whole-grain foods may be limited by a lack of consumer awareness of health benefits, difficulty in identifying whole-grain foods in the marketplace, and they continue to discuss consumer perceptions of inferior taste and palatability to these types of products and foods. Additionally, only about one quarter of

participants (26.2%) correctly selected raspberries as a high fiber source; when in fact it is one of the highest fiber sources per serving (6 g of fiber per 1 cup) of all fruits (USDA, 2008).

When analyzing fiber supplements, the participants selected the items that had the word fiber in the name of the product as a high fiber item. For example, 77.7% of participants selected Fiber Choice<sup>®</sup> as a high fiber source and although it was a good source at 4 grams per serving, it was not considered a high fiber source. Additionally, 75.4% of participants selected Benefiber<sup>®</sup> as a high fiber source and that also contains 4 grams per serving. The item most frequently chosen on the list that was actually a high fiber source at 10 grams per serving was the Metamucil<sup>®</sup> and 49.2% of participants correctly selected this item. However, this may have been difficult for them because, fiber is on this label but only half of the participants selected it, so they may have not know how to gauge the “high” fiber definition on any of the products. Overall, students aged 18-30 years seemed to be unable to understand items that were high sources of dietary fiber, although they were able to select seven of the fifteen items.

It is important to have knowledge about supplements, according to the American Dietetic Association (2009), the use of dietary supplements is prevalent and growing in the United States, with approximately one-third of the adults using some sort of nutrient supplementation. The American Dietetic Association (2009) continues to state that, consumers may not be well informed about the safety and efficacy of supplements and some may have difficulty interpreting product labels. It is the expertise of dietetic practitioners that is needed to help educate consumers on fiber supplement selection. It would be helpful for consumers to understand fiber amount in supplements.

Frequency of consumption of dietary fiber as reported by study participants was determined to be 48.4%. This indicated that less than half of participants believed they were

consuming fiber daily; which means the other 51.6% of participants believed they were not consuming fiber daily. This could illustrate several ideas; participants were having fiber on a daily basis and were unaware the foods consumed contain fiber or college-aged students may be choosing less healthful options more often (fruits, vegetables and whole grains) which may mean less daily fiber intake. Consuming high fiber sources three times per week was selected by 32.4% of participants. Eating high fiber foods only once per week was selected by 12.3% of participants. Again, these perceptions could be a lack of knowledge regarding foods consisting of five or more grams of fiber; indicating that they may not have been aware of their amount of fiber consumption. Schnoll and Zimmerman (1997) believe that nutritional knowledge was very important but not sufficient enough for dietary change. This became evident when Schnoll and Zimmerman (1997) conducted a study with 113 randomly selected undergraduate nutrition students and assigned the groups to set goals and self-monitor their dietary fiber consumption. Subjects that set goals scored 15% higher on the dietary fiber self-efficacy scale and consumed 100% more dietary fiber than the students that did not set goals. Self-monitoring showed no significant change in their fiber consumption. This study demonstrated that not only knowledge about dietary fiber was needed but also individuals that set goals to increase their fiber consumption have positive dietary changes. As stated previously, increased knowledge regarding dietary fiber rewards consumers to have increased confidence to make positive dietary changes.

Finally, when participants were asked reasons why they consumed high fiber foods, 34.6% of participants stated health benefits. Approximately one quarter of the participants (25.3%) stated they consumed fiber because it helped them stay regular (passing bowel movements on a continued daily basis). Interestingly, 9.22% of participants stated they either

liked or dislike the taste of fiber. This research has demonstrated that participants prefer the high fiber snack bar in all characteristics tested, including flavor and overall acceptances. Piland and Hoss (2008) similarly demonstrated by adding higher fiber-containing to soup and fruit smoothies, subjects accepted the taste. The soups' fiber content increased from 4 grams to 7.3 grams with the addition of peas, and from 4 grams to 11.1 grams with the addition of lentils. Also, the fruit smoothie fiber increased from 1.7 grams to 2.2 grams with the addition of applesauce and from 1.7 grams to 7.4 grams with the addition of prune puree. Piland and Hoss (2008) concluded that 100% of consumer taste panelists stated that all of the tested products would be acceptable for consumers. In this study, there may be a lack of knowledge of which foods have fiber naturally in them, which caused some participants to state they do not like the taste of fiber. For example, as stated previously, 96 participants did not select raspberries as a high fiber food source; raspberries are naturally high in dietary fiber containing eight grams per cup.

Combining results of texture, appearance and flavor together may help better understand the studies' outcomes. For example, if participants preferred the high fiber bar in terms of texture, appearance and flavor over the low fiber bar and are able to select high fiber sources, then this may actually signify that the study participants were consuming high fiber foods with a consistent frequency. This was proven with results of 49.2% of participants consuming fiber on a daily basis. Clark and Johnson (2006) further demonstrated that fiber-enriched foods fulfilled pre-set acceptability criteria for white bread, muffins, pasta, and breakfast bars with forty-four consumer panelists. Clark and Johnson (2006) continued to state that in all fiber-enriched products, flavor was the attribute most highly correlated with overall acceptability; results were significant. Clark and Johnson's study was similar to this research by demonstrating a

correlation between fiber-enriched products; in this study the product was a snack bar and the ability to select high fiber sources, which offers consumers the knowledge to consume high fiber products with increased frequency in their consumption.

Combining results of respondents together, participant's perceptions about their knowledge on fiber, "moderately knowledgeable", "very much knowledgeable" and "extremely knowledgeable" resulted in 80.6% of total participants. This finding was significant and when it was combined with at least 50% of participants selecting high fiber sources, demonstrated that overall participants believed they may possess enough knowledge, based on significant findings, to make educated decisions regarding high fiber food selections.

### **Conclusions**

This study concluded that college-aged students do prefer the high fiber snack bar over the low fiber snack bar in all attributes examined; appearance, texture and flavor (test was significant). The students also preferred the high fiber snack bar more in overall acceptance (test was not significant). The older age group (25-30) of participants consumes high fiber items on a daily basis more frequently (66.7%) than the younger age group (18-24) consumes high fiber items (45%). It was also determined that the students have the ability to select that at least 50% or more high fiber items from a given list of foods, products and fiber supplements, 71.5% of all participants were able to do this. Males selected more of the high fiber items correctly, more often than females with a narrow margin of 6.3% difference. Most participants were from a food/nutrition related major, with these students selecting more high fiber items correctly more often (77.6%), indicating they have more knowledge on dietary fiber, compared to the 60.7% of non-nutritional related majors selecting at least 50% or more of the high fiber items correctly.



Most participants consume high fiber items on a daily basis for health benefits (45) and keeping them regular (33).

This study determined that most (76.8%) of the participants believe that they have moderate to very much knowledge regarding dietary fiber. Ninety-five (75%) total participant's selection of their own perception was accurate to what they actually achieved when selecting high fiber items. Future research can determine if students or populations in this age range (18-30 years old) choose or not choose to read food labels when selecting healthy foods, including high fiber items.

Findings of this study were participants significantly preferred the high fiber snack bar more over the low fiber snack bar in all three characters attributes; including, flavor, texture and appearance. Additionally, participants preferred the high fiber snack bar more over the low fiber snack bar in overall acceptance, although this finding was not significant. A recommendation is to further study other high fiber and low fiber-containing foods to determine if the same outcomes would occur, the high fiber food being the preferred consumer choice.

Not only can this age group start a new health trend but by consuming more dietary fiber they may be able to, as previously discussed in chapter 2, slow down a negative trend of increased health problems including digestive, intestinal problems and even weight management.

### **Limitations**

One limitation of this study was there was not an equal distribution of males (30%) versus females (70%). If there was an equal amount of each gender then the researcher can truly see if there is a difference in perceptions on the high fiber versus the low fiber snack bar in examined attributes, how often high fiber items are consumed and their ability to select high

fiber items from a list may have been a different margin than what was represented in this study (6.3% difference).

Another limitation could be that several of the lower fiber items on the given list of foods, products and fiber supplements were incredibly close to the high fiber items, making it extremely difficult to determine if the item was in fact a high or low fiber item. For example, both Benefiber® and Fiber Choice® provide four grams of dietary fiber per serving (two tablets equals one serving). According to the FDA, a food, product or supplement is not considered a high fiber item unless it provides five grams of dietary fiber or more per serving size. This narrow margin of only one gram may have been misleading to participants, as these were the two most often selected items from all participants on the given list. It is important to note that the word 'fiber' is in both of the names of supplements.

### **Recommendations**

As a result of the findings of this study and limitations that occurred, the following research suggestions are recommended:

- 1) To conduct a study in which the pre-selected participants complete a food diary which would include, a food log and photography food record and turn in to the researcher prior to the taste-testing. Then compare estimated amounts consumed from the questionnaire with actual amounts consumed by the food diary record.
- 2) To conduct the same study with children and/or adolescents. Additionally, with seniors greater than 65 years of age, to determine different perceptions about fiber consumption in daily diet. Their perceptions then could be compared to what this study found with college-aged students, 18-30 years of age. Also, various age groups have different dietary fiber needs and consume a variety of foods and/or products

differently between these age groups. Obtaining the data from new studies of the various age groups may help health professionals inform the different populations (age groups) of the specific knowledge they need to know and understand the amount of fiber in the types of foods those age groups eat more frequently. Health issues related to dietary consumption is preventable and knowledge about dietary fiber can help reduce risk factors that are related to those health issues.

- 3) Another recommendation could be to take this study and conduct it at a national level to determine where there would be more of a diverse background of participants and different levels of knowledge regarding dietary fiber. This can help health professionals determine what education needs to be done to this age population on a national level.

## References

- Anderson, J., & Deskins, B. (1995). *The nutrition bible*. New York: William Morrow and Company.
- American Association of Cereal Chemists. (2008). *Definition of dietary fiber*. Retrieved June 29, 2008, from <http://www.aaccnet.org/definitions/default.asp>
- American Heart Association (2009). *Cardiovascular disease statistics*. Retrieved March 30, 2009 from <http://www.americanheart.org/presenter.jhtml?identifier=4478>
- Bazzano, L. A., He, J., Ogden, L. G., Loria, C. M., & Whelton, P. K. (2003). Dietary fiber intake and reduced risk of coronary heart disease in US men and women: The National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Arch Internal Medicine*, 163, 1897-1904.
- Berg, C. M., Jonsson, I., Conner, M. T., Lissner, L. (2002). Relation between breakfast food choices and knowledge of dietary fat and fiber among Swedish schoolchildren. *Journal of Adolescent Health*, 31(2), 199-207.
- Bingham, S. A., Day, N. E., Luben, R., Ferrari, P., Slimani, N., Norat, T., Clavel-Chapelon, F., Kesse, E., Nieters, A., Boeing, H., Tjonneland, A., Overvad, K., Martinez, C., Dorronsoro, M., Gonzalez, C. A., Key, T. J., Trichopoulou, A., Naska, A., Vineis, P., Tumino, R., Krogh, V., Bueno-de-Masquita, H., Peeters, P. H. M., Berglund, G., Hallmans, G., Lund, E., Skele, G., Kaaks, R., & Riboll, E. (2003). Dietary fibre in food and protection against colorectal cancer in the European prospective investigation into cancer and nutrition (EPIC): An observational study. *Lancet*, 361, 1496-1501.
- Bower, J. A., & Whitten, R. (2007). Sensory characteristics and consumer liking for cereal barsnack foods. *Journal of Sensory Studies*, 15(3), 327-345.

- Brandt, L. A. (2003). Fiber fascination. *Nutra Solutions: New Product Annual*, 19-22.
- Brown, L., Rosner, B, Willett, W. W., & Sacks, F. M. (1999). Cholesterol-lowering effects of dietary fiber: A meta-analysis. *American Journal of Clinical Nutrition*, 69, 30-42.
- Burgess-Champoux, T. L., Marquart, L., Vickers, Z., & Reicks, M. (2006, July/August). Perceptions of children, parents, and teachers regarding whole-grain foods, and implications for a school-based intervention. *Journal of Nutrition Education and Behavior*, 38(4), 230-237.
- Burgess-Champoux, T. L., Rosen, R., Marquart, L., & Reicks, M. (2008). The Development of psychosocial measures for whole-grain intake among children and their parents. *Journal of the American Dietetic Association*, 108(4), 714-717.
- Carbohydrates: Simple carbohydrates*. (2008). Centers for Disease Control and Prevention. Retrieved March 23, 2009, from <http://www.cdc.gov/nutrition/everyone/basics/carbs.html#Simple%20Carbohydrates>
- Cellulose. (2008). In Merriam-Webster Online Dictionary. Retrieved June 30, 2008, from <http://www.merriam-webster.com/dictionary/cellulose>
- Clark, R., & Johnson, S. (2006). Sensory acceptability of foods with added lupin (*Lupinus angustifolius*) kernel fiber using pre-set criteria. *Journal of Food Science*, 67(1), 356-362.
- Cummings, J. H., Bingham, S. A., Heaton, K. W., & Eastwood, M. A. (1992). Fecal weight, colon cancer risk, and dietary intake of nonstarch polysaccharides (dietary fiber). *Gastroenterology*, 103, 1783-1789.

- Davy, S. R., Benes, B. A., & Driskell, J. A. (2006). Sex differences in dieting trends, eating habits, and nutrition beliefs of a group of Midwestern college students. *Journal of the American Dietetic Association, 106*(10), 1673-1677.
- Deniz, E. M. (2004). Investigation of the relation between decision making, self-esteem, decision making style and problem solving skills of university students. *Eurasian Journal of Educational Research 15*, 23-35.
- Diamond, A. (2010). Family meals are good for hearts and waistlines. *Nursing Standards, 24*(24), 28.
- D'inca, R., Pomerri, F., Vettorato, M. G., Dal Pont, E., Di Leo, V., Ferronato, A., Medici, V., & Sturniolo, G. C. (2007). Interaction between rifaximin and dietary fibre in patients with diverticular disease. *Alimentary Pharmacology & Therapeutics, 25*, 771-779. Retrieved June 30, 2008, from <http://ezproxy.lib.uwstout.edu:2170/ehost/pdf?vid=11&hid=17&sid=497e64c3-6b83-4ec6-b41e-41b04d278d7a%40sessionmgr106>
- Dextrin. (2009). In *Merriam-Webster Online Dictionary*. Retrieved March 24, 2009, from <http://www.merriam-webster.com/dictionary/dextrin>
- Diverticulosis and diverticulitis*. (2006). National Digestive Diseases Information Clearinghouse (NDDIC). Retrieved June 30, 2008, from <http://digestive.niddk.nih.gov/ddiseases/pubs/diverticulosis/index.h%20top>
- Eglash, A., Lane, C. H., & Schneider, D. M. (2006). Clinical inquiries. What is the most beneficial diet for patients with diverticulosis? *Journal of Family Practice, 55*, 813-815.
- Flight, I., & Clifton, P. (2006). Cereal grains and legumes in the prevention of coronary heart disease and stroke: A review of the literature. *European Journal of Clinical Nutrition*,

- 60, 1145-1159. Retrieved June 30, 2008, from <http://ezproxy.lib.uwstout.edu:2170/ehost/pdf?vid=7&hid=102&sid=b4e1cfce-65f3-488f-85b3-d3e46e187534%40sessionmgr109>
- Georgiou, C. C., Betts, N. M., Hoerr, S. L., Keim, K., Peters, P. K., Stewart, B., & Voichick, J. (1997). Among young adults, college students and graduates practiced more healthful habits and made more healthful food choices than did nonstudents. *Journal of the American Dietetic Association, 97*(7), 754-759.
- Giacco, R., Parillo, M., Rivellese, A.A., Lasorella, G., Giacco, A., D'Episcopo, L., & Riccardi, G. (2000). Long-term dietary treatment with increased amounts of fiber-rich low-glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients. *Diabetes Care, 23*, 1461-1466.
- Glandelman, G. (2007). Coronary heart disease. Retrieved November 7, 2008 from <http://www.nlm.nih.gov/medlineplus/ency/article/007115.htm>
- Grodner, M., Long, S., & DeYoung, S. (2004). Foundations and clinical applications of nutrition: A nursing approach (3<sup>rd</sup> edition). St. Louis, MO: Mosby.
- Gropper, S. S., Simmons, K. P., Gaines, A., Drawdy, K., Saunders, D., Ulrich, P., & Connell, L. J. (2009). The freshman 15- A closer look. *Journal of the American College Health 58*(3), 223-231.
- Haber, G. B., Heaton, K. W., Murphy, D., & Burroughs, L. F. (1977). Depletion and disruption of dietary fibre: Effects on satiety, plasma-glucose, and serum-insulin. *Lancet, 2*, 679-682.
- Hiza, H., Fungwe, T., & Bente, L. (2007). Trends in dietary fiber in the U.S. food supply: Sales of grain products. United States Department of Agriculture, CNPP fact sheet No. 2.

- Howe, C. R., Benito, E., Castelleto, R., Cornee, J., Esteve, J., Gallagher, R. P., Isovich, J. M., Deng-ao, J., Kaaks, R., & Kune, G. A. (1992). Dietary intake of fiber and decreased risk of cancers of the colon and rectum: Evidence from the combined analysis of 13 case-control studies. *Journal of National Cancer Institute*, *84*, 1887-1896.
- Howe, G. R., Hirohata, T., Hislop, T. G., Isovich, J. M., Katsouyanni, K., Lubin, F., Marubini, E., Modan, B., & Rohan, T. (1990). Dietary factors and risk of breast cancer: Combined analysis of 12 case-control studies. *Journal of National Cancer Institute*, *82*, 561-569.
- Hutchings, J. B. (2007). The importance of visual appearance of foods to the food processor and the consumer. *Journal of Food Quality*, *1*(3), 267-278.
- Inflammatory bowel disease*. (2008). Mayo Clinic. Retrieved July 1, 2008, from <http://www.mayoclinic.org/ibd/>
- Kantor, L. S., Variyam, J. N., Allshouse, J. E., Putnam, J. J., & Lin, B. (2001). Choose a variety of grains daily, especially whole grains: A challenge for consumers. *Journal of Nutrition*, *131*(2), 473-486.
- Karakaya, S., & Kavas, A. (1999). Absorption of direct-acting and indirect-acting mutagens by various dietary fibers. *International Journal of Food Sciences and Nutrition*, *50*, 319-323. Retrieved July 1, 2008, from <http://ezproxy.lib.uwstout.edu:2170/ehost/pdf?vid=5&hid=3&sid=d56154d8-62fc-4347-a57c-c16f5b9ea19c%40sessionmgr8>
- Kaufman, F. R. (2002). Type 2 Diabetes in Children and Young Adults: A "New Epidemic". *American Diabetes Association: Clinical Diabetes*, *20*(4), 217-218.



- Kolodinsky, J., Harvey-Berino, J. R., Berlin, L., Johnson, R. K., & Reynolds, T. W. (2007). Knowledge of current dietary guidelines and food choice by college students: Better eaters have higher knowledge of dietary guidance. *Journal of the American Dietetic Association, 107*(8), 1409-1413.
- Kovacs, B. (2000). *Fiber*. MedicineNet.com. Retrieved June 28, 2008, from [www.medicinenet.com/fiber/page2.htm](http://www.medicinenet.com/fiber/page2.htm)
- Kristal, A. R., Abrams, B. F., Thornquist, M. D., Disogra, L., Croyle, R. T., Shattuck, A. L., & Henry, H. J. (1990). Development and validation of a food use checklist for evaluation of community nutrition interventions. *American Journal of Public Health, 80*(11), 1318-1322.
- Kromhout, D., Bloemberg, B., Seidell, J.C., Nissinen, A., & Menotti, A. (2001). Physical activity and dietary fiber determine population body fat level: the seven countries study. *International Journal of Obesity, 25*, 301-306.
- LeBlanc, N., Osteen, T., & Gerald, B. L. (2005). Knowledge of health benefits of fiber and risk factors for cardiovascular disease and type 2 diabetes on acceptability and willingness to purchase whole grain pasta. *Abstracts of the American Dietetic Association, 105*(8), A-14.
- Leefeldt, A., & Fang, C. (2007). *Improving dietary fiber intake among college students a web-based, combined assessment and personalized educational module*. Poster session presented at the annual meeting of the American Dietetic Association, Philadelphia, PA.
- Lagua, R. T., & Claudio, V. S. (2004). *Nutrition and diet therapy reference dictionary*. (5<sup>th</sup> edition). Ames, IA: Blackwell Publishing Professional.

- Mahanna, K., Moskowitz, H. R., & Lee, S. Y. (2009). Assessing consumer expectations for food bars by conjoint analysis. *Journal of Sensory Studies, 24*, 851-870.
- Marietta, A. B., Welshimer, K. J., & Anderson, S. L. (1999). Knowledge, attitudes, and behaviors of college students regarding the 1990 nutrition labeling education act food labels. *Journal of the American Dietetic Association, 99*(4), 445-449.
- Marlett, J. A., McBurney, M. I., & Slavin, J. L. (2002). Position of the American Dietetic Association: Health implications of dietary fiber. *Journal of the American Dietetic Association, 102*(7), 993-1000.
- Marquart, L., Pham, A. T., Lautenschlager, L., Croy, M., & Sobal, J. (2006). Beliefs about whole-grain foods by food and nutrition professionals, health club members, and special supplemental nutrition program from women, infants, and children participates/state fair attendees. *Journal of the American Dietetic Association, 106*(11), 1856-1860.
- Mateljan, G. (2008). *World's healthiest foods: Dietary fiber*. Retrieved October 20, 2008 from <http://whfoods.org/>
- Mattes, R. D. (2007). Effects of a combination fiber system on appetite and energy intake in overweight humans. *Physiol Behavior, 90*, 705-711.
- Mayo Clinic Staff. (2007). *Dietary fiber: An essential part of a healthy diet*. Retrieved October 23, 2008 from <http://www.mayoclinic.com/health/fiber/NU00033>
- McCrary, E. (2004). The nature of lignin. *Alkaline Paper Advocate, 4*(4). Retrieved June 29, 2008, from <http://palimpsest.stanford.edu/byorg/abbey/ap/ap04/ap04-4/ap04-402.html>

- Miller, C. K., Gabbay, R. A., Dillion, J., Apgar, J., & Miller, D. (2006). The effect of three snack bars on glycemic response in healthy adults. *Journal of the American Dietetic Association, 106*(5), 745-748.
- National Digestive Diseases Information Clearinghouse (NDDIC) staff. (2008). *Diverticulosis and diverticulitis*. Retrieved July 29, 2009, from <http://digestive.niddk.nih.gov/ddiseases/pubs/diverticulosis/>
- Nestle, M., Wing, R., Birch, L., DiSogra, L., Drewnowski, A., Middleton, S., Sigman Grant, M., Sobal, J., Winston, M., & Economos, C. (2009). Behavioral and social influences on food choice. *Nutrition Review, 56*(5), 50-64.
- Nicklas, T. A., Farris, R. P., Myers, L., & Berenson, G. S. (1995). Dietary fiber intake of children and young adults: The Bogalusa heart study. *Journal of the American Dietetic Association, 95*(2), 209-214.
- Nishiyama, C., Nagai, T., & Yano, T. (1991). Absorption of mutagens in distilled water by dietary fibers. *Agriculture Biochemistry 55*(3), 797-802.
- Nuttall, F. Q. (1993). Perspectives in diabetes: Dietary fiber in management of diabetes. *Diabetes, 42*. Retrieved March 30, 2009, from [http://web.diabetes.org/perspectives/V42searchable/ADAJournal\\_42\\_4\\_Searchable.pdf](http://web.diabetes.org/perspectives/V42searchable/ADAJournal_42_4_Searchable.pdf)
- Onwalata, C. I. (2001). New technology boosts fiber in foods. *Agriculture Research, 49*(3), 12-14.
- Patterson, R. E., Kristal, A. R., & White, E. (1996). Do beliefs, knowledge, and perceived norms about diet and cancer predict dietary change? *American Journal of Public Health, 86*(10), 1394-1400. Retrieved March 11, 2009, from <http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1380649&blobtype=pdf>

- Pereira, M. A., O'Reilly, E., Augustsson, K., Fraser, G. E., Goldbourt, U., Heitmann, B. I., Hallmans, G., Knekt, P., Liu, S., Pietinen, P., Spiegelman, D., Stevens, J., Virtamo, J., Willett, W. C., & Ascherio, A. (2004). Dietary fiber and risk of coronary heart disease: A pooled analysis of cohort studies. *Arch Internal Medicine*, *164*, 370-376.
- Peterson, S., Duncan, D. P., Null, D. B., Roth, S. L., & Gill, L. (2010). Positive changes in perceptions and selections of healthful foods by college students after a short-term point-of-selection intervention at a dining hall. *Journal of American College Health* *58*(5), 425-431.
- Piernas, C., & Popkin, B. M. (2010). Snacking increased among U.S. adults between 1977 and 2006. *The Journal of Nutrition*, *140*, 325-332.
- Piland, D. K., & Hoss, K. M. (2008). Improving palatability and fiber content in pureed diets using Spanish pureed soups and fruit smoothie. *Journal of the American Dietetic Association*, *103*(9), 49.
- Plant this idea: Fill up on fiber.* (2009). American Dietetic Association. Retrieved March 11, 2009, from [http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/nutrition\\_16953\\_ENU](http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/nutrition_16953_ENU)
- Position of the American Dietetic Association: Nutrient supplementation (2009). *Journal of the American Dietetic Association*, *109*, 2073-2085.
- Ridgway, N. D., Shirk, B. N., Becher, S. T., Taylor, C. A., Clutter, J. E., & Wolf, K. N. (2010). A school-based intervention increased nutrition knowledge and self-efficacy in high school students. *Journal of the American Dietetic Association*, *110*(9), A105.
- Rose, D. J., DeMeo, M. T., Keshavarzian, A., & Hamaker, B. R. (2007). Influence of dietary fiber on inflammatory bowel disease and colon cancer: Importance of fermentation pattern. *Nutrition Reviews*, *65*(2), 51-62. Retrieved July 1, 2008, from

<http://web.ebscohost.com/ehost/pdf?vid=7&hid=16&sid=e53e83e7-f53a-4e99-b220-a36c0c07fb65%40SRCSM1>

- Ruottinen, S., Lagström, H. K., Niinikoski, H., Rönnemaa, T., Saarinen, M., Pahkala, K. A., Hakanen, M., Viikari, J. S. A., & Simell, O. (2010). Dietary fiber does not displace energy but is associated with decreased serum cholesterol concentrations in healthy children. *American Journal of Clinical Nutrition*, *91*(3), 651-661.
- Schnoll, R., & Zimmerman, B. J. (1997). The effects of self-regulatory training on dietary behavior in an undergraduate nutrition class. *Journal of the American Dietetic Association*, *97*(9), A13.
- Schnoll, R., & Zimmerman, B. J. (2001). Self-regulation training enhances dietary self-efficacy and dietary fiber consumption. *Journal of the American Dietetic Association*, *101*(9), 1006-1011.
- Simpson, H. C. R., Simpson, R. W., Lously, S., Carter, R. D., Geekie, M., & Hockaday, T. D. R. (1981). A high-carbohydrate leguminous fiber diet improves all aspects of diabetic control. *Lancet*, *i*, 1-5.
- Sjódin, P. B., Nyman, M. E., Nilsson, I., & Lagerstad, M. I. (1985). Binding of C-label food mutagens by dietary fiber. *Journal of Food Science* *50*(6), 1680-1684.
- Spiller, G. A. (2001). Suggestions for a basis on which to determine a desirable intake of dietary fibre. *CRC Handbook of dietary fiber in Human Nutrition*. (2<sup>nd</sup> edition). Boca Raton, FL: CRC Press, 351-354.
- Sturtzel, B., & Elmadfa, I. (2008). Intervention with dietary fiber to treat constipation and reduce laxative use in residents of nursing homes. *Annals of Nutrition & Metabolism*, *52*(1), 54-56.

The American Heritage Medical Dictionary: Hemicellulose. (2007). Published by Houghton Mifflin Company. Retrieved March 24, 2009, from <http://medical-dictionary.thefreedictionary.com/hemicellulose>

Whelton, S. P., Hyre, A. D., Pedersen, B., Yi, Y., Whelton, P. K., & He., J. (2005). Effect of dietary fiber on blood pressure: A meta-analysis of randomized, controlled clinical trials. *Journal of Hypertension, 23*,475-481.

Whole Grain Council. (2004). *Whole grains 101*. Retrieved April 8, 2009, from <http://www.wholegrainscouncil.org/whole-grains-101/definition-of-whole-grains>

Appendix A: UW-Stout IRB Approval form



Research Services  
152 Voc Rehab Building

University of Wisconsin-Stout  
P.O. Box 790  
Menomonie, WI 54751-0790

715/232-1126  
715/232-1749 (fax)  
<http://www.uwstout.edu/rs/>

**Date:** May 18, 2011  
**To:** Tami Stibb  
**CC:** Dr. Charlene Schmidt

*Susan Foxwell*

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

**Subject: Protection of Human Subjects**

Your project, "*Perceptions of Taste and Knowledge of Sources of Fiber and How That Relates to Their Consumption of Dietary Fiber of Snack Bars*," has been approved by the IRB through the expedited review process. The measures you have taken to protect human subjects are adequate to protect everyone involved, including subjects and researchers.

**Please copy and paste the following message to the top of your survey/interview form before dissemination:**

**This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.**

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 approved by the UW-Stout IRB as required by the Code of Federal regulations Title 45 Part 46."**

This project is approved through **April 20, 2010**. Modifications to this approved protocol need to be approved by the IRB. Research not completed by this date must be submitted again outlining changes, expansions, etc. Federal guidelines require annual review and approval by the IRB.

Thank you for your cooperation with the IRB and best wishes with your project.

**\*NOTE: This is the only notice you will receive – no paper copy will be sent.**



Appendix B: Paper Copy of Survey Used in Compusense®

## Perceptions of Snack Bars

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Please taste the product and indicate how much you **LIKE, NEITHER LIKE OR DISLIKE** or **DISLIKE** the following. Click the box that represents your response. Please drink water in between tasting products.

1 Overall appearance of snack bar **845**

Dislike Extremely             Neither Like or Dislike             Like Extremely

2 Overall flavor of snack bar **845**

Dislike Extremely             Neither Like or Dislike             Like Extremely

3 Overall texture of snack bar **845**

Dislike Extremely             Neither Like or Dislike             Like Extremely

4 Overall appearance of snack bar **932**

Dislike Extremely             Neither Like or Dislike             Like Extremely

5 Overall flavor of snack bar **932**

Dislike Extremely             Neither Like or Dislike             Like Extremely

6 Overall texture of snack bar **932**

Dislike Extremely             Neither Like or Dislike             Like Extremely

7 Now that you have tasted both snack bars (845 and 932), which one do you prefer?

Please choose one:

**845**

**932**

8 Please indicate whether you are:

Male

Female

9 Please indicate what age range you are in currently:

18-24

25-30

30 +

10 Please type your major here: \_\_\_\_\_

11 Please select your perception of knowledge about dietary fiber.

Not Knowledgeable	Somewhat Knowledgeable	Moderately knowledgeable	Very Much Knowledgeable	Extremely knowledgeable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12 According to the Food and Drug Administration (FDA), a food, product or supplement is considered a high source of dietary fiber if it contains at least 5 grams of fiber per serving.

Please select any of the items below you believe to be high fiber sources:

	Yes	No
<b>Foods</b>		
Kidney beans, 1 cup	<input type="checkbox"/>	<input type="checkbox"/>
Whole wheat pasta, 1 cup	<input type="checkbox"/>	<input type="checkbox"/>
White bread, 2 slices	<input type="checkbox"/>	<input type="checkbox"/>
Nabisco®, Wheat Thin Crackers, 12 crackers	<input type="checkbox"/>	<input type="checkbox"/>
Raspberries, 1 cup	<input type="checkbox"/>	<input type="checkbox"/>
<b>Products</b>		
Kellogg's®, All Bran Cereal, ½ cup	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>

General Mills®, Fiber One Granola bars, 1 bar		
Oatmeal, instant, 1 cup	<input type="checkbox"/>	<input type="checkbox"/>
Low fat plain yogurt, 6 oz. cup	<input type="checkbox"/>	<input type="checkbox"/>
General Mills®, Cheerios, ¾ cup	<input type="checkbox"/>	<input type="checkbox"/>

**Supplements**

Activia®, 4 oz	<input type="checkbox"/>	<input type="checkbox"/>
Citrucel®, 2 teaspoons	<input type="checkbox"/>	<input type="checkbox"/>
Metamucil®, 2 teaspoons	<input type="checkbox"/>	<input type="checkbox"/>
Benefiber®, 2 tablets	<input type="checkbox"/>	<input type="checkbox"/>
Fiber Choice®, 2 tablets	<input type="checkbox"/>	<input type="checkbox"/>

12 How often do you consume foods, products or supplements high in Dietary Fiber?

Daily	3 Times/Week	Once a Week	Once every 2 weeks	Once a Month	Never Consume
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13 List as many reasons as you can that relate to the frequency about your consumption of these high fiber foods.

---



---



---



---



---



---



---

Note: This is a paper copy and many be slightly different than the version shown to participants on Compusense® computer program during actual study.

Appendix C: Consent to Participant in UW-Stout Approved Research Project

## CONSENT TO PARTICIPATE IN UW-STOUT APPROVED RESEARCH PROJECT

**This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.**

**Title:** Perceptions of Snack Bars

**Investigator:** Tami Stibb  
Dietetic Graduate Student  
[stibbt@uwstout.edu](mailto:stibbt@uwstout.edu)  
414-380-5248

**Research Sponsor:** Dr. Charlene Schmidt, PhD, RD, CD  
Associate Professor  
[schmidtc@uwstout.edu](mailto:schmidtc@uwstout.edu)  
715-232-1994

### Risks and Benefits:

Risks that could be presented to participants is cross contamination or food contamination from snack bar to cutting board, knife or myself. I will be taking all necessary precautions to minimize these risks; such as, wearing a clean lab coat and clean gloves, using a clean cutting board and clean knife to cut product in half. Product will go directly from package to cutting board to clean cup to participate. Investigator will be purchasing clean spring water that will be directly poured into a new clean cup and handed to participate instead of using tap water to prevent water contamination.

The benefits definitely outweigh the risks in this study. The campus will benefit because my final research will be posted in the thesis collection of literature at the UW-Stout library. I will also be presenting the information at the poster fair on campus to expand the knowledge of dietary fiber. Subjects will receive the joy of helping a fellow student with their research project, getting a little snack and enjoying a treat at the end.

### Description:

Subjects will come to the sensory evaluation laboratory in the Home Economic Building room 252 on the day of the data collection. They will sign in only if their instructor has indicated that they will receive extra credit in the course for participation. Their names will be directly given to the instructor and not have any part of the actual study. Participants will receive a snack bar in a clean cup for taste testing. The snack bar will be taken directly from the manufactures' packaging, cut on a clean surface with a clean knife by myself where I will have washed my hands properly and put on a lab coat and gloves. The product will be placed in the clean cup and directly handed to the subjects. After the first taste test they will receive another clean cup with spring water in it that was purchased for their use. They will then receive a second snack bar that was prepared under the same conditions as the first. On their way out of the lab they have the option of taking a treat as payment for participation.

### Time Commitment and Payment:

Total time for participation is 5-10 minutes and subjects will receive payment with a treat when completed with taste testing.

### Confidentiality:

Your name will not be included on any documents as a part of this research. We do not believe that you can be identified from any of the information that you have provided us.

### Right to Withdraw:

Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. However, should you choose to participate and later wish to withdraw from the study, there is no way to identify your anonymous document after it has been turned into the investigator.

### 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.

**Please turn over, Sign and Date.**

**Investigator:** Tami Stibb  
414-380-5248  
[stibbt@uwstout.edu](mailto:stibbt@uwstout.edu)

**Advisor:** Dr. Charlene Schmidt, PhD, RD, CD  
715-232-1994  
[Schmidt@uwstout.edu](mailto:Schmidt@uwstout.edu)

**IRB Administrator**  
Sue Foxwell, Director, Research Services  
152 Vocational Rehabilitation Bldg.  
UW-Stout  
Menomonie, WI 54751  
715-232-2477  
[foxwells@uwstout.edu](mailto:foxwells@uwstout.edu)

Signature of participant: \_\_\_\_\_ Date: \_\_\_\_\_

