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Comparison Of Nutritive Value, Cost, Viscosity, And Acceptability Among Three Developed Oral Nutritional Supplements And A Standard Commercially-Prepared Supplement

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Comparison of Nutritive Value, Cost, Viscosity, and Acceptability Among Three Developed Oral Nutritional Supplements and a Standard Commercially-Prepared Supplement

BY

Christa R. Huxel

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Abstract

The consumption of oral nutritional supplements may help prevent, or delay, malnutrition in the older adult population. Developing acceptable supplements, and discovering alternative methods to providing nutrition to older adults, is vital. The purpose of this study was to develop and evaluate three oral nutritional supplements in chocolate, strawberry, and vanilla flavors that were similarly priced and contained similar nutritive value as compared to the standard commercially-prepared supplement Ensure®. The study also focused on the comparison of appearance, smell, flavor, aftertaste, viscosity, and overall acceptability and preference between the researcher-developed and standard supplements. The researcher-developed supplements were less expensive per serving than the standard supplement and significantly more viscous than the standard supplement; yet the researcher-developed supplements were nutritionally comparable. An expert panel of eight registered dietitians evaluated the researcher-developed and standard supplements during sensory evaluations. The expert panel rated the standard chocolate, standard strawberry, and researcher-developed vanilla supplements more acceptable than their corresponding flavor supplement. However, after considering each supplement's quality characteristics overall, panel members indicated they would prefer to consume the standard strawberry, researcher-developed chocolate, and researcher-developed vanilla supplements over their corresponding flavor supplement. All supplements were recommended for older adult patients/clients by panel members. As a result of this study, older adults have a palatable, economical, and expert-recommended oral nutritional supplement that can be made in the comfort of one's home as an acceptable alternative to the standard commercially-prepared supplement.

Dedication

This thesis is dedicated to my parents, Terry and Lisa, for their constant love and support. Thank you for letting me transform the kitchen into a food laboratory, and the dinner table into my "office." Thank you for everything you have done to help me throughout this journey. I love you both.

This thesis is also dedicated to my brothers, Dane and Ryan, my grandfather, Merrell, and my boyfriend, Dr. Seth Hudson. Thank you for your love.

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Chapter 1

Introduction

Malnutrition has become a frequent and serious complication in the older adult population and is known to significantly increase the rate of morbidity and mortality (Ahmed & Haboubi, 2010). Nutritional recommendations for older adults change from adulthood due to changes in body composition and a decrease in physical activity and energy expenditure. Older adults (≥ 60 years old) need 20% fewer calories than younger adults. However, older adults need to consume higher levels of protein to prevent muscle wasting, weakened immune status, and delayed wound healing (Morais, Chevalier, & Gougeon, 2006). On average, muscle mass decreases by 15% between the times that one is in their mid-twenties to their mid-seventies (Krinke, 2005).

With advancing age, older adults tend to experience a physiologic reduction in food intake. Sensory functions such as taste, smell, and vision begin to diminish among older adults, which may result in a decreased pleasure and comfort in eating. Other factors that may limit older adults' energy and dietary intake include decreased appetite-regulating mechanisms, limited finances to purchase foods, and/or missing teeth, ill-fitting dentures, pain and discomfort with chewing or swallowing, and dry mouth (Krinke, 2005). Oral nutritional supplements may benefit the older adult population by providing vital energy and nutrients in an easy-to-consume liquid form.

Oral nutritional supplements, specifically in liquid form, are energy-dense formulas with protein, vitamins, minerals, and other nutrients that assist in weight management (Lauque et al., 2004). These supplements are beneficial for older adults experiencing involuntary weight loss and poor nutritional status. In one study, 55% of

the participants (N=89) who consumed oral nutritional supplements achieved an average increase in total energy intake of ≥ 250 kcal/day, resulting in an average weight gain of 1.62 (3.54 lb) kg compared to the control group with 0.04 kg (0.09 lb) (Payette, Boutier, Coulombe & Gray-Donald, 2002).

Since oral nutritional supplement consumption may be beneficial in the older adult population, knowing the various factors affecting supplement acceptability is important. These factors may include, but are not limited to, taste, appearance, viscosity, nutritional value, and cost. Older adults may prefer to develop their own oral nutritional supplements over the standard commercially-prepared supplement if the researcher-developed supplements have high acceptability ratings and require few resources to make.

Purpose of the Study

The purpose of the present study was to develop and evaluate three oral nutritional supplements in varying flavors that were similarly priced and contained similar nutritive value as compared to the standard commercially-prepared supplement Ensure® (Abbott Laboratories). The study also focused on the comparison of appearance, smell, flavor, aftertaste, viscosity, and overall acceptability and preference between the researcher-developed supplements and the standard commercially-prepared supplement.

Research Objectives

Research objectives of the study included:

a. To determine the nutritive value of an eight-ounce serving of the three researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.

b. To determine the cost per serving of the researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.

c. To determine if there is a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

d. To determine if there is a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

e. To determine which sensory attribute(s) there is a significant difference if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

f. To determine in which flavor(s) there is a significant difference in sensory attribute(s) if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

g. To determine if there is a significant difference between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

h. To determine in which flavor(s) there is a significant difference in overall acceptability if there was a significant difference found between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

i. To determine panel members' preference between the researcher-developed oral nutritional supplements and the corresponding standard commercially-prepared supplement.

Significance of the Study

The results of this study benefit health professionals since there are alternative oral nutritional supplements their patients may consume to increase energy and nutrient intake. Healthcare facilities may save money by decreasing the amount of funds used to purchase commercially-prepared supplement products. Older adult consumers may also save money by developing their own palatable and economical oral nutritional supplements in the comfort of their home.

The researcher-developed supplements were intended to be easy for older adults to make by containing minimal ingredients, requiring little equipment for preparation, and using mostly nonperishable ingredients. In addition, the researcher-developed supplements are economical since there is little waste for producing them. Results of this study are beneficial for those persons who are in need of nutritional support and looking to save money, but are not willing to sacrifice taste.

Assumptions

It was assumed that the expert panel who conducted the sensory evaluation was knowledgeable in older adult nutrition and was familiar with the standard commercially-prepared oral nutritional supplement. It was also assumed that panel members were able to distinguish any differences in appearance, smell, flavor, aftertaste, and viscosity.

Definition of Terms

Acceptability. Acceptability is the degree that one regards as true, reasonable, or satisfactory (Webster's Concise English Dictionary, 2006).

Expert. An expert is described as having, involving, or displaying special skills or knowledge derived from training or experience (Webster's Concise English Dictionary, 2006).

Food insecurity. Food insecurity is "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Klesges, Pahor, Shorr, Wan, Williamson, & Guralnik, 2001, p. 69).

Malnutrition. Malnutrition is poor nutrition resulting from insufficient dietary intake to meet requirements for energy or nutrient needs (Brown, 2005). Malnutrition consists of both under- and overnutrition; however, the focus of this study was solely on undernutrition.

Older adult. Older adults are those aged 60 years and older (Krinke, 2005).

Oral nutritional supplement. Oral nutritional supplements are energy-dense food items fortified with proteins, vitamins, minerals, and other nutrients in a small

volume (Lauque et al., 2004). This study focused on liquid supplement forms when addressing oral nutritional supplements.

Satiation. Satiation is the "appetite-regulating process that occurs while eating that inhibits further food intake and terminates the meal" (Wilson, Purushothaman, & Morley, 2002, p. 944).

Satiety. Satiety is the "state following a meal during which hunger is dampened and the urge to consume food is inhibited" (Wilson et al., 2002, p. 944).

Viscosity. Viscosity refers to the thickness of a liquid, or its resistance to flow (Nelms, Sucher & Long, 2007).

Summary

Older adults have an increased risk of malnutrition due to changes in body composition, energy and nutrient needs, sensory function, and income. Oral nutritional supplements are marketed towards the older adult population to promote weight gain and prevent involuntary weight loss when needed. These supplements are energy-dense liquid formulas fortified with protein, vitamins, minerals, and other nutrients in a small volume.

This study is significant for older adult consumers and health professionals. There are palatable and economical supplements available as an alternative to the standard commercially-prepared supplement. Ultimately, understanding the various factors affecting supplement consumption may help prevent, or at least delay, malnutrition in the older adult population.

Chapter 2

Review of Literature

This review of literature examines older adults and their risk for malnutrition, and the effect of sensory functions and accessibility on food intake. The review also examines oral nutritional supplements, the comparison between liquid and solid supplements, the use of subjective and objective evaluations, and subjective evaluation protocol. While malnutrition consists of both under- and overnutrition, this review of literature focuses specifically on the effects of undernutrition when addressing malnutrition.

Older Adults and Malnutrition

Due to the advancement in medicine and healthcare, life expectancy continues to rise along with those in the older adult population. Projections estimate that by the year 2030, the number of those 65 years and older will double to 71.5 million as compared to 35 million in 2000. In 2030, individuals 65 years and older will make up 20% of the total population. Currently, those 85 years and older represent the fastest-growing population segment, and it is projected that the number of individuals 85 years and older will grow from 5.3 million in 2006 to nearly 21 million by the year 2050 ("Federal Interagency Forum on Aging-Related Statistics", 2008).

Nutritional recommendations for older adults dramatically change from young- and mid-adulthood. Increased age presents changes in body composition, nutritional needs, and overall nutritional status. Due to a decrease in energy expenditure, older adults need 20% fewer calories than the average adult. However, older adults need to

consume higher levels of protein to prevent sarcopenia (muscle wasting), weakened immune status, and delayed wound healing (Krinke, 2005).

The proportion of people with good to excellent health decreases with age. During the period 2004-2006, 78% of men aged 65–74 reported good or better health, while 63% of those aged 85 and over reported good or better ratings ("Federal Interagency Forum on Aging-Related Statistics", 2008). The changes in an older adult's nutritional needs may lead to concerns if individual nutritional needs are not met as one ages, and, eventually, malnutrition may become a serious complication.

Malnutrition, specifically undernutrition, is defined as faulty or inadequate nutritional status. Malnutrition is characterized by insufficient dietary intake, poor appetite, muscle wasting, and weight loss (Chen, Schilling, & Lyder, 2001). Having a Body Mass Index of ≤ 18.5 classifies an individual as underweight, or malnourished (Silver, 2009). Malnutrition significantly increases the rate of morbidity and mortality in the older adult population, and may lead to inadequate diet quality, nutrient deficiencies, increased susceptibility to infection, reduced rate of drug metabolism, impairment of physical and cognitive function, depression, and healthcare burden (Chen et al., 2001).

A review conducted by Lesourd and Maxari (1999) focused on the influence of nutritional factors on immune deficiency among malnourished older adults. The researchers believed that a decrease in immune function was highly correlated with nutritional deficiencies, which may lead to immunodeficiency in malnourished older adults. Results indicated that nutritional supplementation, at the recommended dietary intake level and higher, may enhance the immune response of older adults comparable

with healthy younger adults. The researchers concluded that immune changes found in malnourished older adults may be reversible by nutritional therapy.

Sensory Function & Food Intake Among Older Adults

Aging, disease, and medications are associated with a decline in sensory functions, including the ability to taste, smell, and see (Krinke, 2005). Thus, with advancing age, older adults tend to experience a physiologic reduction in food intake. A decrease in visual and hearing senses could make food preparation difficult, or even impossible, for some older adults (Chen et al., 2001). In 2006, close to one-half of older men aged 65 and older and more than one-third of older women reported trouble hearing; vision problems affected 17% of the older adult population ("Interagency Forum on Aging-Related Statistics", 2008). A decrease in senses may lead to decreased sense of enjoyment of eating and decreased ability to prepare foods (Krinke, 2005).

For older adults who experience cavities, missing teeth, ill-fitting dentures, pain and discomfort with chewing or swallowing, and/or dry mouth, the simple act of consuming food may be uncomfortable or even painful. Eating may be deferred, or even avoided, leading to decreased food intake; this may result in malnutrition and/or dehydration (Krinke, 2005). In 2006, 23% of individuals aged 65-74 years and 32% of those aged 85 years and older experienced edentulism, having no natural teeth ("Interagency Forum on Aging-Related Statistics", 2008).

In addition to a decrease in senses and physical changes, appetite-regulating mechanisms become weaker with increasing age and prevent elderly from realizing hunger and thirst. By and large, the cause of decline in older adults' sensory perception is exceptionally complex. Disease, mechanical complications, and psychosocial factors

are all elements that may play a role in older adults' sensory perception and overall food intake (Wilson et al., 2002).

Food Accessibility Among Older Adults

Financial dependency is common among older adults. It has been found that 9% of individuals aged 65-74 years live in poverty, and 10% of those aged 75 years and older live in poverty. In 2006, women 65 years and older (12%) were more likely to live in poverty as compared to men (7%) ("Federal Interagency Forum on Aging-Related Statistics", 2008). Increased financial dependency places the older adult population at significant risk for poor access to nutritionally adequate food. In the year 2000, 8-16% of the older adult population had experienced food insecurity within a 6-month timeframe (Klesges et al., 2001).

Klesges et al. (2001) conducted a study that examined the prevalence and characteristics of low income and food accessibility in disabled women 65 years and older. The researchers found that 23.9% of the women included in the study reported financial difficulty in acquiring food. These reports of food insecurity were related to poor energy and dietary intake. When older adults experience financial hardship, medications and home utilities may even take precedence over food (Chen et al., 2001).

Oral Nutritional Supplements

Oral nutritional supplements are energy-dense liquid formulas fortified with protein, vitamins, minerals, and other nutrients in a small volume (Lauque et al., 2004). Commercial supplement products have been readily available to consumers since the early 1990s (Tieken, Leidy, Stull, Mattes, Schuster & Campbell, 2007). These supplements are meant to promote weight gain and prevent involuntary weight loss for

those challenged in regulating energy balance, especially those in the older adult population.

Payette et al. (2002) studied the effects of oral nutritional supplementation on the nutritional status, muscle strength, perceived health, and functional status of free-living older adults. Eighty-nine males and females over the age of 65 years, receiving long-term home services and considered at high nutritional risk, were included in the study. Those in the experimental group were provided two cans per day of Ensure® or Ensure® Plus (Abbott Laboratories, Columbus, OH) liquid formula for 16 weeks. Those in the control group did not receive any treatment. Results found that, among the experimental (supplemented) group participants, 55% achieved an average increase in total energy intake of ≥ 250 kcal/day, resulting in an average weight gain of 1.62 kg compared to the control group with 0.04 kg. The number of days participants stayed in bed significantly increased in the control group; no change was found in the experimental group. Researchers concluded that providing nutritional supplementation results in significant improvement in nutritional status among undernourished older adults.

Lauque et al. (2004) examined the effects of oral nutritional supplements in older adults with Alzheimer's disease. Ninety-one older adults, previously diagnosed with Alzheimer's disease, were included in the study. The experimental group was assigned to receive supplementation for 3 months. The control group was not to receive supplementation and continue with usual care. Researchers found that, in the experimental group, total energy intake after 3 months was 291 kcal/day higher than energy intake at baseline. Protein intake also increased to 16 g/day. At 6 months, even 3 months after supplementation was stopped, significant increases were found in the

experimental group for weight (1.57 kg average), BMI (0.66 kg/m^2 average), and fat-free mass (0.63 kg average).

Studies have also shown the effect of oral nutritional supplements on the cognitive performance of older adults. Kaplan, Greenwood, Winocur, and Wolever (2001) conducted a study to examine this effect. Participants between the ages of 61-79 years old were to drink one of four test drinks (placebo, protein, carbohydrate, or fat) within 5 minutes, and complete a series of tests that measured cognitive function. These tests included three word recalls, a paragraph recall, a Trail Making (Trails) test, and an attention test. Results indicated that all three of the macronutrient drinks (protein, carbohydrate, and fat) improved delayed recall and improved immediate recall in the older adult participants. The researchers concluded that the ingestion of protein, carbohydrate, and fat improves memory performance in older adults.

Appetite-regulating mechanisms become weaker with increasing age and may prevent older adults from realizing hunger. Wilson et al. (2002) examined the effect of liquid supplements on satiation, satiety and energy intake in older adults. Thirty participants were included in the study; 15 were between 20-40 years old, and the other 15 were over 70 years old. For the first phase of the study, participants consumed 300 ml of a liquid supplement after a night of fasting. Liquid supplements included high-carbohydrate, high-protein, high-fat, and water/placebo. A test meal was given to participants within 5 minutes after consuming the supplement. Participants were to consume the test meal until satiation. For the second phase of the study, the test meal was offered to the participant on request, but not for at least 60 minutes after consuming the liquid supplement.

Results indicated that the request for the test meal in phase two was significantly longer among the older adults compared to the younger participants after consuming the high-fat and high-protein supplements. Overall energy intake was higher in both groups during phase two, when the test meal was not available until 60 minutes after the supplement. Researchers concluded that the consumption of liquid supplements with meals induces premature satiation in older adults. Therefore, supplements taken between meals and at least one hour before the next meal may counter the effect of premature satiation on food intake and my ultimately encourage increased caloric intake at the next meal (Wilson et al., 2002). Oral nutritional supplements in liquid form may increase these potential benefits as compared to solid supplements since liquid foods provide less satiation value than solid foods.

Liquid vs. Solid Nutritional Supplements

Liquid and solid supplement products are marketed to help with weight loss, weight gain, weight management, or overall general health (Stull, Apolzan, Thalacker-Mercer, Iglay & Campbell, 2008). However, liquid supplements do not provide the same satiation value as traditional solid foods or solid nutritional supplements. Thus, the addition of caloric-dense oral nutritional supplements in a liquid form may promote further food consumption and may lead to an increase in energy intake and weight gain in older adults (Mattes, 2006).

Stull et al. (2008) conducted a study to assess the influences of liquid versus solid supplement products on postprandial appetite ratings and subsequent food intake. After an overnight fast, the older adult participants were to consume either a liquid (beverage) or solid (bar) supplement product. Participants rated their appetite level before and 15,

30, 45, 60, 90, 120, and 150 minutes post supplement consumption. At minute 120, participants were offered a bowl of oatmeal to consume until they reached a comfortable level of fullness. Participants consumed an average 13.4% more oatmeal after initially consuming the liquid supplement compared to the solid supplement. Therefore, results indicated that a larger quantity of food is consumed at the next eating occasion after one consumes liquid supplement products compared to solid supplement products. Results supported the researchers' hypothesis that postprandial hunger, desire to eat, and thoughts of food would be higher, and fullness lower, post-liquid supplement consumption.

Liquid oral nutritional supplements have lower expected satiety value, lower demand for oral processing, shorter gastrointestinal transit times, and the energy they contain has greater bioaccessibility and bioavailability than solid supplements (Mattes, 2008). Therefore, older adults in need of nutritional support would benefit more from consuming an oral nutritional supplement in liquid form as compared to solid form.

Oral nutritional supplements are beneficial in the older adult population. Understanding the various factors affecting supplement consumption and acceptability is important and may ultimately help prevent, or at least delay, malnutrition in older adults. To determine the acceptability of oral nutritional supplements, subjective evaluations are conducted to help improve existing supplement products on the market and to foresee consumer acceptability ratings for future supplement products.

Subjective Evaluation in Food Studies

Subjective evaluation, also known as sensory evaluation, is used in food studies to measure the responses of people to products as perceived by their senses; sensory evaluation involves physical, physiological, and psychological processes

(Duxbury, 2005). Flavor is the combination of physiological responses involving odor, taste, texture, and temperature (Patterson, Owen, Frank, Smith, & Cadusch, 2004). Therefore, using the human senses to evaluate food items is an essential component in the development of food products.

Foods require sensory evaluations conducted by sensory panels to understand the human perception of foods. Characteristics often evaluated by sensory panels include flavor, texture, appearance, and aroma (McWilliams, 2005). The evaluation relies solely on the opinions of the individuals testing the product. Thus, sensory evaluation is the only type of testing that is able to gauge consumer preference and acceptability (Vaclavik, 1998).

When conducting sensory evaluations, the evaluation panel may consist of either untrained or trained "expert" panel members. An untrained panel has no specific training regarding a product evaluation (McWilliams, 2005). Evaluations that use untrained panel members are conducted to determine potential consumer reactions of the particular product.

Trained "expert" panel members are educated and familiar with the product being tested. A sensory evaluation using experts is beneficial during the production of a new product in that it helps determine the product's acceptability prior to being available to consumers. Expert panels help ensure that products are palatable and upholds the highest possible quality for present and future consumers.

Subjective Evaluation Protocol

Sensory panels used for evaluation need to be healthy, nonsmokers, not color blind, and have no strong opinions regarding the food being tested. Typically the best

time for testing during the day is midmorning or midafternoon since individuals are not overly hungry or full before testing (Brown, 2007). Regarding the testing environment, all distractions and bias must be minimized so the evaluation is truly an evaluation of the product being tested (Vaclavik, 1998). Room temperature, humidity, smells, noise, and lighting must be monitored closely in order to keep the testing environment comfortable and quiet for the sensory panel.

All food samples must be the same size, temperature, and in the same containers. Sample sizes do not need to be large; in general, 15 ml of a liquid sample or 30 g of a solid sample is sufficient for evaluation purposes (McWilliams, 2005). Simple white or clear containers are usually preferred, and presentation order of the samples should be randomized. Panelists are asked to sip room temperature water and/or have a bite of a cracker before sampling and in between testing each sample; at least a 30 second rest period should be taken between samples (Vaclavik, 1998). For sensory evaluations being conducted over several different days, it is important for everything to remain consistent in order to produce accurate results. In addition, sample numbers should be rotated among the samples being tested at each session (McWilliams, 2005).

Objective Evaluation in Food Studies

Objective evaluation measures the physical properties a food through the use of mechanical devices; objective evaluation is valuable in developing new products and maintaining quality (McWilliams, 2005). Objective tests measure one particular characteristic at a time, such as color, viscosity, and moisture content; they are necessary for routine quality control (Vaclavik, 1998). Data obtained from objective tests are concrete information given as specific numbered results as compared to opinions and

words with subjective tests. Therefore, objective tests provide repeatable results, whereas sensory test results vary by human response and opinion (Vaclavik, 1998). Objective evaluation is important for monitoring any changes in food item characteristics during product development, for managing specific characteristics in existing products, and for comparing and contrasting a product's physical characteristics to competitor products.

Summary

Older adults are at an increased risk for malnutrition due to changes in body composition, sensory function, and functional disability as well as financial dependence. Oral nutritional supplements are energy-dense liquid formulas fortified with protein, vitamins, minerals, and other nutrients in a small volume. Consumption of oral nutritional supplements may benefit older adults by increasing total energy and nutrient intake in order to maintain weight and prevent involuntary weight loss.

In this study, the researcher developed and tested three oral nutritional supplements in varying flavors that contained similar nutritive value and were similarly priced to the standard commercially-prepared supplement. Both objective and subjective evaluation was conducted on the researcher-developed and standard supplements. The expected outcome was that older adults in need of nutritional support would have an acceptable alternative to commercially-prepared oral nutritional supplement products. Older adults may be able to prepare palatable, economical supplements in the comfort of their home, using mostly nonperishable ingredients, without sacrificing nutrition or additional funds.

Chapter 3

Methodology

The purpose of the present study was to develop and evaluate three oral nutritional supplements in varying flavors that were similarly priced and contained similar nutritive value as compared to the standard commercially-prepared supplement. The commercial supplement used in this study was Ensure® (Abbott Laboratories) in Creamy Milk Chocolate, Homemade Vanilla, and Strawberries and Cream flavors. Ensure® was used as the standard oral nutritional supplement in this study since it has the largest market share and is the most doctor-recommended brand among commercially-prepared nutritional shakes (Abbott Laboratories, 2010).

The researcher used readily available products including soymilk, soy powder, non-fat dry milk, and meal replacement shake mix to develop chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements. Once the final supplement formulas were developed, objective and subjective data were collected. Objective data collected included the determination of the nutritive value, cost, and viscosity of each supplement (researcher-developed and commercially-developed).

Subjective data regarding supplement acceptability was collected through sensory ballots given to eight expert panel members during sensory evaluations. A total of 10 evaluation sessions were scheduled. Each panel member attended three separate evaluation sessions to fully participate in the study. Having the panel members participate in the sensory evaluation three separate times strengthened intra-rater reliability since the same sensory evaluation was completed by the same rater on multiple occasions. In each of these sensory evaluations, the chocolate, strawberry, and vanilla

researcher-developed supplements and the standard commercially-prepared supplement in corresponding flavors were evaluated. Therefore, a total of six supplements (two chocolate, two strawberry, and two vanilla) were evaluated by each panel member during each of the three sensory evaluations he/she attended. If the researcher-developed supplements received high acceptability ratings and were recommended by the expert panel, it was assumed that older adults would view these supplements as an acceptable alternative to commercially-prepared supplement products. Older adults may be able to prepare palatable, economical, and expert-recommended oral nutritional supplements in the comfort of their home.

Design

The design of the study was quasi-experimental since there was no random assignment of participants (Trochim, 2006). The researcher used a selected sample that fit into the criteria of being a practicing registered dietitian. Quantitative data were collected through cost comparisons, nutritive analysis, and viscometer results. Ballot results provided both quantitative and qualitative data. The sensory evaluation sessions used descriptive tests to evaluate each supplement sample based on selected sensory attributes. The expert panel of nutrition professionals evaluated the researcher-developed chocolate, strawberry, and vanilla supplements and the standard commercially-prepared supplement in corresponding flavors during each evaluation session.

Sample

In this study, expert purposive sampling was used to assemble an expert panel of male and female nutrition professionals of any age or ethnicity. To be considered a nutrition professional, each panel member must have been a practicing registered dietitian

at the time of the study. The study sample size included eight panel members. A panel of at least three to five experts is considered a valid sample size in research (Leedy & Ormrod, 2004). Therefore, the sample size of eight expert panel members increased the content validity of the study.

Registered dietitians were recruited as evaluators since they are familiar with the nutritional needs of the older adult population and are aware of sensory factors that affect older adult food consumption. This study did not test on the older adult population since the researcher wanted to develop and ensure high quality supplements before further research was conducted on older adults.

Prior to testing, an email with a brief overview of the study was sent to eligible registered dietitians in the Charleston-Mattoon, Illinois area (see Appendix A). The email included the dates, times, and location of the 10 scheduled sensory evaluation sessions. To fully participate in the study, panel members attended three of the 10 scheduled sessions. Information regarding potential food allergens in the supplements was also included in the email.

Panel members were asked to refrain from eating for at least 1 hour prior to each evaluation session. On the test dates, before participating in the sensory evaluation, each panel member was required to complete a consent form (see Appendix B). This form educated the panel members about the study, their participant rights, and potential allergens found in the supplements.

Pilot Test

The researcher previously conducted a pilot study in order to test the methodology. A strawberry-flavored oral nutritional supplement was developed and

compared to two commercially-prepared strawberry supplements including Ensure® (Abbott Laboratories) and Boost® (Nestle Nutrition). Nutritional analysis was conducted using NutritionData software (Condé Nast Digital, 2009). Results indicated that the nutritive content of the researcher-developed supplement was comparable to the commercially-prepared supplements. Cost comparisons among the three supplements were analyzed manually in the same procedure that was anticipated for the present study. For an eight-ounce serving, Ensure® cost $1.16, Boost® cost $1.08, and the researcher-developed supplement cost $1.12.

A sensory evaluation was conducted with 22 independent-living older adult participants. Fourteen (64%) of the participants were female, and eight (36%) of the participants were male. The participants ranged in age from 67 to 87 years old; the mean age was 76. The researcher-developed oral nutritional supplement had consistently higher ratings than Ensure® and Boost® regarding participant acceptability of the supplements' appearance, flavor, and viscosity. The researcher-developed supplement received the highest rating of overall supplement preference. Fifty-seven percent (n=12) of participants preferred the researcher-developed supplement; 24% (n=5) preferred Boost®; and 19% (n=4) preferred Ensure®. Even though the researcher-developed supplement was not significantly less expensive than the commercial supplements, older adults may find that the flavor of the supplement or the ability to prepare it in their home outweighs the cost depending on individual preference.

In the present study, the researcher modified the developed supplement to closer match the nutritive content of the standard commercially-prepared supplement. The researcher also developed supplements in chocolate and vanilla flavors in addition to

strawberry. Only one commercially-prepared supplement (Ensure®) was used in the current study for feasibility purposes and to compare the newly developed supplements with the current standard supplement in the consumer market. Boost® was not evaluated and used for comparison in the current study.

The current study did not test on the older adult population. The researcher wanted to develop and ensure high quality supplements before further research was conducted on older adults. To ensure high quality supplements, an expert panel of nutrition professionals was chosen for the present study to evaluate the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement during sensory evaluation sessions.

In addition to appearance, flavor, viscosity, and preference, the researcher sought to determine the expert panel's acceptability and perception of other supplement attributes that may affect older adult acceptability and consumption. Additional attributes evaluated in the present study included the expert panel's acceptability of each supplement's smell, the expert panel's perception of each supplement's aftertaste, and the expert panel's overall acceptability of each supplement. The researcher also wanted to determine if the expert panel would recommend the researcher-developed and standard supplements to older adult (≥ 60 years old) patients/clients. If the researcher-developed supplements received high acceptability ratings in the present study, then future research within the older adult population would be recommended.

Instrument

Ballots consisting of seven to eight items for each supplement sample were used to collect panel members' acceptability and perception ratings for each researcher-

developed supplement and the standard commercially-prepared supplement in chocolate, strawberry, and vanilla flavors (see Appendix C). The ballots were examined for face validity by three graduate faculty members in the School of Family and Consumer Sciences of Eastern Illinois University.

On each ballot, items pertained to the panel members' acceptability of each supplement's appearance and smell, and the panel members' perception of each supplement's flavor, aftertaste, and viscosity. Each panel member circled his/her rate of acceptability or perception for each sensory attribute on the given Likert scale. In addition, the panel member described each sensory attribute using two to three words. At the bottom of the ballot, the panel member provided his/her overall acceptability rating of the supplement sample being tested and indicated whether or not he/she would recommend the supplement to older adult ($\geq$ 60 years old) patients/clients. Lastly, each panel member circled the number of the sample that he/she would prefer to consume between the two chocolate samples, the two strawberry samples, and the two vanilla samples.

Ballots were presented individually to each panel member with the supplement sample it pertained to. The panel member completed each ballot while evaluating the sample. Each ballot, along with the sensory evaluation of the given sample, took approximately 5 minutes to complete. The overall length of participation, including reading and signing the consent form, the sensory evaluations, and filling out the ballots took approximately 30 minutes for each evaluation session. Panel members attended three of the 10 scheduled sessions.

Data Collection & Analysis

Objective and subjective evaluations were conducted to collect both quantitative and qualitative data. This section presents details regarding objective and subjective data collection methodology.

Objective evaluation of supplements. Objective evaluation was used to determine the researcher-developed supplements' nutritive value and cost, and to determine the viscosity of the researcher-developed supplements and the standard commercially-prepared supplement. All objective evaluations were conducted to meet the following research objectives:

a. *To determine the nutritive value of an eight-ounce serving of the three researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.*

When the final formulas were developed, the researcher determined the nutritive value of the researcher-developed supplements using NutritionData software. The information in NutritionData's database "comes from the United States Department of Agriculture's National Nutrient Database for Standard Reference" (Condé Nast Digital, 2009, para. 2). Nutritional analyses conducted by the software are based on calculations using Daily Reference Values, Reference Daily Intakes, published research, and current Food and Drug Administration recommendations (Condé Nast Digital, 2009).

The researcher entered every ingredient's nutrition information into the NutritionData software using the ingredient's nutrition facts label. Once all ingredient nutrition information was in the software for one of the researcher-developed supplements, the researcher entered the quantity needed of each ingredient to produce the

supplement. The software multiplied the quantity needed for each ingredient with its pertaining nutrition information to determine the nutritive value of each ingredient in the recipe. The nutritive values for all ingredients were added together by the software to determine the overall nutritive value of the researcher-developed supplement. This process was used for the three flavored researcher-developed supplements, and findings were compared to the standard commercially-prepared supplement. NutritionData developed nutrition facts labels for the researcher-developed chocolate-, strawberry-, and vanilla-flavored supplements and the standard commercially-prepared supplement in corresponding flavors.

b. *To determine the cost per serving of the researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.*

To determine the cost to make each supplement, the researcher manually divided the original price of each food item used by the quantity provided in that particular item to find the unit price. The unit price was multiplied by the amount used in the final supplement recipe to determine each ingredient's cost. All ingredient costs were added together to find the researcher-developed supplements' per serving cost. Cost findings of the researcher-developed supplements were compared to the standard commercially-prepared supplement. The researcher determined if the cost to produce the developed supplements was less or more expensive than the standard supplement.

c. *To determine if there is a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

The researcher used a Thomas-Stormer viscometer (Arthur H. Thomas Co.) to test the viscosity of each supplement. The researcher-developed supplements were produced 2.5 hours prior to testing, the same amount of time they were produced before the sensory evaluations. Since viscosity is affected by fluid temperature (Mertz Garcia, Chambers, Matta, & Clark, 2008), all supplement samples being tested were refrigerated for at least 2 hours prior to testing, and were kept at or below 40° F. Therefore, viscosity was measured close to the same temperature panel members consumed the supplements.

For each test, the viscometer was placed on a sturdy flat table so that the driving weight could drop without obstruction. An ice water bath and thermometer were used to keep the supplement being tested at a constant temperature of 40° F. A test cup containing 100 ml of the supplement being tested was placed in the ice water bath, and the platform containing the water bath and test cup was raised until the contents of the test cup covered the viscometer rotor to a depth of 0.25 in (Arthur H. Thomas Co., 1969).

Prior to testing, the viscometer's revolution counter was set to zero. With stop watch in hand, the brake holding the driving weight was released and the time in seconds required for 100 revolutions of the rotor, as indicated by the revolution counter, was measured. After each test, the driving weight was rewound and the revolution counter was reset to zero. This process was conducted three times for each supplement (Arthur H. Thomas Co., 1969).

After testing each supplement, the test cup was rinsed out and thoroughly dried prior to pouring in the next supplement to be tested. The viscometer rotor was also wiped clean and thoroughly dried. The researcher-developed chocolate, strawberry, and vanilla supplements and the standard supplement in corresponding flavors were tested three times each on three separate occasions, resulting in a total of nine timed viscometer results for each supplement.

Viscometer results, including averages, were presented in table format using Microsoft® Office Excel 2007. Univariate Analysis of Variance (ANOVA) was conducted using SPSS® 17.0 (IBM®, Armonk, NY) to determine if there was a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement with a pre-determined significance level of $p \leq .05$. The researcher had assistance from a statistical consultant for all statistical tests conducted in SPSS® 17.0.

Subjective evaluation of supplements. Subjective evaluation was used to determine the panel members' acceptability of the supplements' appearance and smell, their perception of flavor, aftertaste, and viscosity, their overall acceptability, and preference between the researcher-developed supplements and the standard commercially-prepared supplement. Subjective evaluation was conducted to meet the following research objectives:

d. *To determine if there is a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

Sensory data were collected from sensory ballots given to each panel member during sensory evaluations. The first item on the sensory ballot asked, "To what extent is the sample visually appealing?" The panel member circled his/her rate that he/she found each supplement visually appealing on the given Likert scale (1=not appealing; 5=very appealing). The second item asked, "To what extent is the sample's smell appealing?" The panel member circled his/her rate that he/she found each supplement's smell appealing on the given Likert scale (1=not appealing; 5=very appealing). The third item asked, "To what extent would you rate the sample's strength of [chocolate, strawberry, or vanilla] flavor?" The panel member circled his/her rate of the supplement's strength of flavor on the given Likert scale (1=no [chocolate, strawberry, or vanilla]; 5=very [chocolate, strawberry, or vanilla]). The fourth item asked, "To what extent would you rate the sample's aftertaste?" The panel member circled his/her rate of the supplement's aftertaste on the given Likert scale (1=no aftertaste; 5=very strong aftertaste). The fifth item on the sensory ballot given to each panel member asked, "To what extent is the sample's viscosity (thickness)?" The panel member circled his/her rate of the supplement's viscosity on the given Likert scale (1=not viscous; 5=very viscous). In addition to rating his/her acceptability or perception of each sensory attribute, the panel member provided a description of each sensory attribute using two to three words.

Ballot results of sensory attributes were tabulated and illustrated in table format using Microsoft® Office Excel 2007. Comparison tables were developed to display

ballot results from each panel member for each supplement attribute being tested throughout the evaluation sessions. Each panel member's average rating for each attribute was also calculated and displayed in the comparison tables. Using collected sensory data, Multivariate Analysis of Variance (MANOVA) was conducted using SPSS® 17.0 to determine if there was a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement with a pre-determined significance level of $p \leq 0.05$. The MANOVA test was chosen since it is able to study multiple related dependent variables (sensory attributes) while controlling for the correlation between the dependent variables (R. Wilkinson, personal communication, March 24, 2011).

e. *To determine which sensory attribute(s) there is a significant difference if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

Multivariate Analysis of Variance (MANOVA) was conducted using SPSS® 17.0 to determine if there was a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement with a pre-determined significance level of $p \leq 0.05$. If a significant difference was found between the researcher-developed supplements and the standard supplement, the individual ANOVAs among the dependent variables (sensory attributes) were analyzed (R. Wilkinson, personal communication, March 24, 2011). Using a pre-determined significance level of $p \leq 0.05$, the researcher determined in which sensory attribute(s) a significant difference existed.

f. To determine in which flavor(s) there is a significant difference in sensory attribute(s) if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

Multivariate Analysis of Variance (MANOVA) was conducted using SPSS® 17.0 to determine if there was a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement with a pre-determined significance level of $p \leq 0.05$. If a significant difference was found between the researcher-developed supplements and the standard supplement, a post hoc Duncan's test was conducted to determine in which flavor(s) (chocolate, strawberry, and/or vanilla) there was a significant difference in sensory attribute(s) (R. Wilkinson, personal communication, March 24, 2011).

g. To determine if there is a significant difference between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

The sixth item on the sensory ballot given to each panel member asked, "To what extent would you rate your overall acceptability of the sample?" The panel member circled his/her rate for overall acceptability of each supplement on the given Likert scale (1=not acceptable; 5=very acceptable). Ballot results of each panel member's overall acceptability of each supplement were tabulated and illustrated in a comparison table using Microsoft® Office Excel 2007. Each panel member's average rating was also calculated and displayed in the comparison table.

The individual ANOVA regarding overall acceptability was analyzed after the initial MANOVA was conducted on all sensory data. A pre-determined significance level of $p \leq 0.05$ was used to determine if there was a significant difference between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

h. *To determine in which flavor(s) there is a significant difference in overall acceptability if there was a significant difference found between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

Multivariate Analysis of Variance (MANOVA) was conducted on all sensory data using SPSS® 17.0. The researcher determined if there was a significant difference in panel members' overall acceptability between the researcher-developed supplements and the standard supplement by analyzing the ANOVA for the dependent variable regarding overall acceptability. If a significant difference was found between panel members' overall acceptability of the researcher-developed supplements and the standard supplement, a post hoc Duncan's test was conducted to determine which flavor(s) (chocolate, strawberry, and/or vanilla) there was a significant difference in overall acceptability (R. Wilkinson, personal communication, March 24, 2011).

i. *To determine panel members' preference between the researcher-developed oral nutritional supplements and the corresponding standard commercially-prepared supplement.*

The eighth item on the sensory ballot given to each panel member after trying both the standard and develoepd chocolate, strawberry, or vanilla supplements asked,

"Between the two [chocolate, strawberry, or vanilla] samples, which one would you prefer to consume?" The panel member circled his/her preference between the two chocolate, two strawberry, or two vanilla supplements on the sensory ballot. Ballot results of each panel member's supplement preference for each flavor were tabulated and displayed in tables using Microsoft® Office Excel 2007. Pie charts were also developed using Microsoft® Office Excel 2007 to illustrate panel member preference between the two chocolate, two strawberry, and two vanilla supplements.

Sensory evaluation testing procedures. Panel members attended three of 10 scheduled sensory evaluations to evaluate the three researcher-developed supplements and the standard commercially-prepared supplement in chocolate, vanilla, and strawberry flavors. For each evaluation session, one-ounce servings of the researcher-developed and standard supplements were presented in sanitized, transparent, two-ounce plastic containers. All six supplement samples were labeled with different random three-digit sample numbers. The researcher-developed supplements were produced 2.5 hours prior to each evaluation session. The researcher-developed supplements, along with the standard supplement, were then portioned, poured into the sample cups, and placed in a refrigerator. All samples were chilled in a refrigerator for at least 2 hours prior to each sensory evaluation. To ensure proper food handling, all sample temperatures were kept at or below 40° F.

For each sensory evaluation, panel members entered the room where the study was being held and sat at an open location. Tri-fold display boards were set up at every panel member's location to prevent any talking or distractions among members. The

tri-fold board faced the panel member, and instructions for the sensory evaluation were presented on the board (see Appendix D).

At every panel member's location, the consent form, a pen, a cup of room temperature water, and three unsalted crackers on a white napkin were present. The water and unsalted crackers were for each panel member to cleanse his/her palate in between each sample. Each panel member was instructed to raise his/her hand after he/she read and signed the consent form. The researcher collected the consent form and provided the panel member with one supplement sample, either researcher-developed or commercially-prepared, and its pertaining ballot. The panel member began the sensory evaluation for that sample and filled out the ballot accordingly. Before tasting the sample, the panel member rated his/her acceptability and provided two to three descriptive words of the sample's appearance and smell. Once the panel member tasted the sample, he/she then rated the sample's flavor, aftertaste, and viscosity characteristics and provided two to three descriptive words for each. The panel member then rated his/her overall acceptability of the sample, and indicated whether or not he/she would recommend the sample to older adult patients/clients.

Once each panel member finished evaluating the first supplement sample, he/she was instructed to raise his/her hand. The researcher collected the ballot, but left the sample for him/her to later determine his/her preference between samples. The researcher then provided the panel member with the other sample of the same flavor. If the researcher-developed supplement was given to the panel member first, the standard commercially-prepared supplement was then given to him/her, or vice versa. The panel member conducted the sensory evaluation with the new sample in the same manner as

previously. However, at the bottom of the second ballot, the panel member circled the sample number he/she would prefer to consume between the two samples.

Once the panel member finished the evaluation, he/she was instructed to raise his/her hand. The researcher collected the ballot and both samples, and provided the panel member with the first sample of the next flavor to be tested and its pertaining ballot. The panel member conducted the sensory evaluation with the new-flavored samples in the same manner as previously. This process was repeated until all samples in the three different flavors were evaluated.

Once the sensory evaluation was complete, the panel member exited the testing area and the researcher immediately collected the final ballot. All consent forms and ballots were kept in a locked file container that only the researcher had access to. The sample containers, water, napkins, and crackers were disposed.

The researcher ensured consistency with all methodology for each of the 10 evaluation sessions. Brands and flavors of ingredients used for the researcher-developed supplements were consistent for each session, and the same equipment was used every time for producing the supplements. Supplements were made 2.5 hours prior to each evaluation session, refrigerated for at least 2 hours prior, and kept at or below 40° F throughout the evaluation. For each session the tables, chairs, tri-fold boards, and panel members' place settings were set up the exact same way. The same type of sample containers, cups, and crackers were also used for each sensory evaluation.

Summary

The commercial supplement used in this study was Ensure® in Creamy Milk Chocolate, Homemade Vanilla, and Strawberries and Cream flavors. The researcher used

readily available products to develop chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements. Once the final formulas were developed, objective and subjective evaluations were conducted to collect both quantitative and qualitative data.

Objective data collected included the nutritive value, cost, and viscosity of each supplement (researcher-developed and commercially-developed). NutritionData software was used to determine the nutritive value of the researcher-developed supplements and the standard commercially-prepared supplement and created nutrition facts labels for each. The cost of the standard commercially-prepared supplement and the cost to prepare the researcher-developed supplements were determined and analyzed manually. A Thomas-Stormer viscometer was used to determine each supplement's viscosity, and results were presented in table format using Microsoft® Office Excel 2007. One-way ANOVA was conducted using SPSS® 17.0 to determine if there was a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially prepared supplement with a pre-determined significance level of $p \leq 0.05$.

Subjective data regarding supplement acceptability were collected through sensory ballots given to eight expert panel members during sensory evaluations. Sensory ballots were used to determine the panel members' acceptability of the supplements' appearance and smell, their perception of flavor, aftertaste, and viscosity, their overall acceptability, and overall preference between the researcher-developed supplements and the standard commercially-prepared supplement. Ballot results from the sensory evaluations were tabulated and illustrated in table and chart format using Microsoft® Office Excel 2007.

Multivariate Analysis of Variance (MANOVA) was conducted using SPSS® 17.0 to determine if there was a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement. If a significant difference was found between the researcher-developed supplements and the standard supplement, a post hoc Duncan's test was conducted to determine in which flavor(s) (chocolate, strawberry, and/or vanilla) there was a significant difference in the expert panel's rating of sensory attribute(s) and/or overall acceptability.

Chapter 4

Results and Discussion

The purpose of the present study was to develop and evaluate three oral nutritional supplements in varying flavors that were similarly priced and contained similar nutritive value as compared to the standard commercially-prepared supplement Ensure® (Abbott Laboratories). The study also focused on the comparison of appearance, smell, flavor, aftertaste, viscosity, and overall acceptability and preference between the researcher-developed supplements and the standard commercially-prepared supplement.

Researcher-Developed Oral Nutritional Supplements

The researcher used readily available products to develop chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements. Ingredients included light vanilla soymilk (Great Value™), meal replacement shake mix in French Vanilla, Milk Chocolate, and Strawberry Supreme flavors (Slim-Fast®), nonfat instant dry milk (Great Value™), soymilk powder (Better Than Milk®), and water. The final formula for the researcher-developed supplements is shown in Table 1.

Table 1
Researcher-Developed Chocolate, Strawberry, and Vanilla Oral Nutritional Supplement Formula (8 oz serving)

Ingredient	Brand	Amount[a]
Light Vanilla Soymilk	Great Value™	130.35
Meal Replacement Shake Mix[b]	Slim-Fast®	18.46
Nonfat Instant Dry Milk	Great Value™	10.81
Soymilk Powder (Original Flavor)	Better Than Milk®	20.70
Water		74.40

[a]Recorded in grams (g).
[b]French Vanilla, Milk Chocolate, or Strawberry Supreme Flavor.

Objective Evaluation of Supplements Results

Objective evaluation was used to determine the researcher-developed supplements' nutritive value and cost, and to determine the viscosity of the three researcher-developed supplements and the standard commercially-prepared supplement. All objective evaluations were conducted to meet the following research objectives:

a. *To determine the nutritive value of an eight-ounce serving of the three researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.*

After the final formula was developed for the chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements, the researcher determined the nutritive value of the three supplements. Nutritional findings of the researcher-developed supplements were then compared to the standard commercially-prepared supplement Ensure® in Creamy Milk Chocolate, Homemade Vanilla, and Strawberries and Cream.

Nutritional analysis using the NutritionData software (Condé Nast Digital, 2009) determined the nutritive content of the three researcher-developed supplements and the standard commercially-prepared supplement and created nutrition facts labels for each. Figure 1 shows the nutritive content of an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Creamy Milk Chocolate and the researcher-developed chocolate-flavored oral nutritional supplement.

For an eight-ounce serving, the researcher-developed chocolate oral nutritional supplement provided 250 calories (kcal). The overall caloric content was equivalent to an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Creamy Milk Chocolate (250 kcal). The researcher-developed supplement's total fat

Figure 1
Nutritive Value of Standard and Researcher-Developed Chocolate-Flavored Supplements

Ensure® in Creamy Milk Chocolate

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 5mg	2%
Sodium 190mg	8%
Total Carbohydrate 41g	14%
Dietary Fiber 3g	12%
Sugars 22g	
Protein 9g	

Vitamin A	25%	• Vitamin C	50%
Calcium	30%	• Iron	25%

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

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Researcher-Developed Chocolate Supplement

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 44
	% Daily Value*
Total Fat 5g	8%
Saturated Fat 0g	2%
Trans Fat 0g	
Cholesterol 3mg	1%
Sodium 286mg	12%
Total Carbohydrate 38g	13%
Dietary Fiber 4g	16%
Sugars 18g	
Protein 10g	

Vitamin A	21%	• Vitamin C	33%
Calcium	52%	• Iron	25%

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

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content (5 g) and saturated fat content (0 g) was lower than the standard supplement's fat and saturated fat content (6 g, 1 g, respectively). Therefore, more of standard supplement's caloric content is derived from fat (50 kcal from fat) as compared to the researcher-developed supplement (44 kcal from fat).

The sodium content of the researcher-developed chocolate oral nutritional supplement (286 mg) was 96 mg higher than the chocolate standard commercially-prepared supplement (190 mg). Dietary fiber (4 g) and protein content (10 g) were also higher in the researcher-developed supplement as compared to the standard supplement (3 g, 9 g, respectively). However, in the researcher-developed supplement, cholesterol content (3 mg) was 2 mg lower than the standard supplement's cholesterol content (5 mg); total carbohydrate content (38 g) was 3 g lower than the standard supplement's total carbohydrate content (41 g); and sugar content (18 g) was 4 g lower than the standard supplement's sugar content (22 g). Regarding vitamin and mineral content, the researcher-developed chocolate oral nutritional supplement provided 21% vitamin A, 33% vitamin C, 52% calcium, and 25% iron; the chocolate standard commercially-prepared supplement provided 25%, 50%, 30%, and 25%, respectively.

Figure 2 shows the nutritive content of an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Strawberries and Cream and the researcher-developed strawberry-flavored oral nutritional supplement. For an eight-ounce serving, the researcher-developed strawberry oral nutritional supplement provided 250 kcal. The overall caloric content was equivalent to an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Strawberries and Cream (250 kcal). The researcher-developed supplement's total fat content (6 g) was also

Figure 2
Nutritive Value of Standard and Researcher-Developed Strawberry-Flavored Supplements

Ensure® in Strawberries and Cream

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 5mg	2%
Sodium 200mg	8%
Total Carbohydrate 41g	14%
Dietary Fiber 3g	12%
Sugars 23g	
Protein 9g	
Vitamin A 25% • Vitamin C	50%
Calcium 30% • Iron	25%

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

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Researcher-Developed Strawberry Supplement

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 48
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 0g	2%
Trans Fat 0g	
Cholesterol 3mg	1%
Sodium 301mg	13%
Total Carbohydrate 38g	13%
Dietary Fiber 3g	14%
Sugars 23g	
Protein 10g	
Vitamin A 21% • Vitamin C	33%
Calcium 52% • Iron	28%

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

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equivalent to the standard supplement's total fat content (6 g). However, the researcher-developed supplement's saturated fat content (0 g) was lower than the standard supplement's saturated fat content (1 g), resulting in less calories being derived from fat in the researcher-developed supplement (48 kcal from fat) as compared to the standard supplement (50 kcal from fat).

The sodium content of the researcher-developed strawberry oral nutritional supplement (301 mg) was 101 mg higher than the strawberry standard commercially-prepared supplement (200 mg). Protein content (10 g) was also higher in the researcher-developed supplement as compared to the standard supplement (9 g). However, in the researcher-developed strawberry supplement, cholesterol content (3 mg) was 2 mg lower than the standard supplement's cholesterol content (5 mg), and total carbohydrate content (38 g) was 3 g lower than the standard supplement's total carbohydrate content (41 g).

Dietary fiber (3 g) and sugar content (23 g) were equal between the researcher-developed strawberry supplement and the standard strawberry supplement. Regarding vitamin and mineral content, the researcher-developed oral nutritional supplement provided 21% vitamin A, 33% vitamin C, 52% calcium, and 28% iron; the standard commercially-prepared supplement provided 25%, 50%, 30%, and 25%, respectively.

Figure 3 shows the nutritive content of an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Homemade Vanilla and the researcher-developed vanilla-flavored oral nutritional supplement. For an eight-ounce serving, the researcher-developed vanilla oral nutritional supplement provided 250 kcal. The overall caloric content was equivalent to an eight-ounce serving of the standard commercially-prepared supplement Ensure® in Homemade Vanilla (250 kcal). The researcher-

Figure 3
Nutritive Value of Standard and Researcher-Developed Vanilla-Flavored Supplements

Ensure® in Homemade Vanilla

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 5mg	2%
Sodium 200mg	8%
Total Carbohydrate 41g	14%
Dietary Fiber 3g	12%
Sugars 23g	
Protein 9g	
Vitamin A 25% • Vitamin C	50%
Calcium 30% • Iron	25%

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

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Researcher-Developed Vanilla Supplement

Nutrition Facts
Serving Size Entire Recipe 253g (253 g)

Amount Per Serving	
Calories 250	Calories from Fat 48
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 0g	2%
Trans Fat 0g	
Cholesterol 3mg	1%
Sodium 301mg	13%
Total Carbohydrate 38g	13%
Dietary Fiber 3g	14%
Sugars 22g	
Protein 10g	
Vitamin A 21% • Vitamin C	33%
Calcium 52% • Iron	28%

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

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developed supplement's total fat content (6 g) was also equivalent to the standard supplement's total fat content (6 g). However, the researcher-developed supplement's saturated fat content (0 g) was lower than the standard supplement's saturated fat content (1 g), resulting in less calories being derived from fat in the researcher-developed supplement (48 kcal from fat) as compared to the standard supplement (50 kcal from fat).

The sodium content of the researcher-developed vanilla oral nutritional supplement (301 mg) was 101 mg higher than the vanilla standard commercially-prepared supplement (200 mg). Protein content (10 g) was also higher in the researcher-developed supplement as compared to the standard supplement (9 g). However, in the researcher-developed supplement, cholesterol content (3 mg) was 2 mg lower than the standard supplement's cholesterol content (5 mg); total carbohydrate content (38 g) was 3 g lower than the standard supplement's total carbohydrate content (41 g); and sugar content (22 g) was 1 g lower than the standard supplement's sugar content (23 g). Dietary fiber (3 g) was equal between the researcher-developed supplement and the standard supplement. Regarding vitamin and mineral content, the researcher-developed vanilla oral nutritional supplement provided 21% vitamin A, 33% vitamin C, 52% calcium, and 28% iron; the vanilla standard commercially-prepared supplement provided 25%, 50%, 30%, and 25%, respectively.

The nutritive value of the researcher-developed chocolate, strawberry, and vanilla oral nutritional supplements was comparable to the standard commercially-prepared supplement Ensure® in corresponding flavors. The researcher-developed supplements' total caloric content was equivalent to the standard supplement. Being as energy-dense as the standard supplement, the researcher-developed supplements provide

equal benefits to older adults in promoting weight gain and preventing involuntary weight loss.

Total fat and saturated fat content in the researcher-developed supplements was ≤ 1 g less than the standard supplement; and cholesterol content was 2mg less than the standard supplement. A lower total fat, saturated fat, and cholesterol content may appeal to those older adults with cardiovascular concerns. Total carbohydrate content in the researcher-developed supplements was 3 g less than the standard supplement; and sugar content of the researcher-developed supplements was ≤ 4 g less than the standard supplement. Dietary fiber in the researcher-developed supplements was ≤ 1 g higher than the dietary fiber in the standard supplement. The protein content of the researcher-developed supplements was 1 g higher than the standard supplement; an increased amount of protein is desirable since older adults need to consume higher levels of protein to prevent sarcopenia, weakened immune status, and delayed wound healing (Krinke, 2005).

There was a considerable difference among the researcher-developed and standard supplements' sodium content; the researcher-developed supplements' sodium content was 96-101 mg higher than the standard supplement's sodium content. Those older adults following a low-sodium diet for health concerns may favor the standard supplement due to the lower sodium content; however, it would still be possible to incorporate the researcher-developed supplement into one's allotted daily sodium intake.

Regarding vitamin and mineral content, the researcher-developed supplements provided 4% less vitamin A and 17% less vitamin C than the standard supplement. However, the researcher-developed oral nutritional supplements provided 22% more

calcium, which is desirable for preventing osteopenia and osteoporosis among older adults. The researcher-developed supplements also provided ≤ 3% more iron than the standard supplement.

Similar to the standard commercially-prepared supplement, the researcher-developed supplements provided over 20% vitamin A, vitamin C, calcium, and iron, meaning that the researcher-developed supplements are considered an excellent source of those nutrients according to the United States Food and Drug Administration (Unites States Department of Health and Human Services, 2011). Vitamin A and vitamin C support immune function among older adults. Vitamin A also aids in maintaining older adults' vision which is known to decline with age; and vitamin C prevents skin breakdown, a complication found in the older adult population, and promotes wound healing (Ledikwe, Hay, Smiciklas-Wright, & Treu, 2001).

b. *To determine the cost per serving of the researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.*

Cost comparisons between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement were analyzed. To determine the cost to make the developed supplements, the researcher divided the original price of each food item used by the quantity provided in that particular item to find the unit price. The unit price was multiplied by the amount used in the final supplement recipe to determine each ingredient's cost. All ingredient costs were added together to find the researcher-developed supplements' per serving cost. As shown in Table 2, for an eight-ounce

serving, the researcher-developed chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements cost $1.11 each.

Once the researcher-developed oral nutritional supplements' costs were determined, the researcher compared the results with the cost of an eight-ounce serving of the standard commercially-prepared supplement Ensure®. Ensure® in Creamy Milk Chocolate, Homemade Vanilla, and Strawberries and Cream flavors cost $1.16 each while the researcher-developed supplements cost $1.11 each. Per eight-ounce serving, the researcher-developed chocolate, strawberry, and vanilla oral nutritional supplements cost five cents less than the standard commercially-prepared supplement.

Literature indicates that financial dependency is common among older adults; and when funds are limited, people choose less expensive food items (Klesges et al., 2001). Therefore, the researcher-developed supplements may be beneficial for those persons who are in need of nutritional support, but are not willing to sacrifice additional funds. The researcher-developed supplements were found to cost less than the standard supplement; however, nutritional content of the researcher-developed supplements was not affected. Results indicate that a supplement developed in one's home with mostly nonperishable food items would provide adequate nutrition without causing additional financial strain among older adults.

Table 2

Researcher-Developed Oral Nutritional Supplement Ingredients and Cost (8 oz serving)

Ingredient	Brand	Amount[a]	Cost[b]
Light Vanilla Soymilk	Great Value™	130.35	0.18
Meal Replacement Shake Mix[c]	Slim-Fast®	18.46	0.43
Nonfat Instant Dry Milk	Great Value™	10.81	0.11
Soy Beverage Mix (Original)	Better Than Milk®	20.70	0.39
Water		74.40	--
			1.11 Total

[a]Recorded in grams (g).

[b]Recorded in dollars ($).

[c]French Vanilla, Milk Chocolate, or Strawberry Supreme flavor.

c. *To determine if there is a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

The researcher used a Thomas-Stormer viscometer (Arthur H. Thomas Co.) to test the viscosity of the standard and researcher-developed oral nutritional supplements. The time in seconds required for 100 revolutions of the viscometer rotor immersed in each supplement was measured. The researcher-developed chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements and the standard commercially-prepared supplement Ensure® in the corresponding flavors were tested three times each on three separate occasions, resulting in a total of nine timed viscometer results for each supplement. Viscometer results for the standard and researcher-developed supplements, including averages, are displayed in Table 3.

Viscosity is defined as a liquid's thickness, or resistance to flow (Nelms et al., 2007). The more viscous a supplement was the more resistance was exerted on the viscometer rotor. Therefore, as supplement viscosity increased, the time needed for the rotor to make 100 revolutions in the supplements increased, and vice versa.

All three researcher-developed supplements required more time as compared to the standard supplement for the viscometer rotor to make 100 revolutions. The average time required for the rotor to make 100 revolutions while being immersed in the standard and researcher-developed supplements was 3.30 s ($SD = .61$) and 4.42 s ($SD = .61$), respectively. The researcher-developed oral nutritional supplements were found to be significantly more viscous than the standard commercially-prepared supplement ($p = < .001$). However, older adults with impaired swallowing may find the researcher-

Table 3

Viscometer Results for Standard and Researcher-Developed Supplements

	Standard			Researcher-Developed		
	Chocolate	Strawberry	Vanilla	Chocolate	Strawberry	Vanilla
Trial 1	4.28	3.79	3.94	5.31	5.38	5.22
	4.00	4.41	4.00	5.00	5.28	5.50
	4.41	3.75	4.43	5.00	5.08	5.13
Trial 2	2.85	3.06	2.91	3.69	4.23	4.06
	2.97	2.81	2.75	3.78	4.30	4.16
	2.78	2.84	3.04	3.78	3.88	4.30
Trial 3	3.06	2.65	3.09	3.75	4.25	4.19
	2.83	2.84	2.78	3.62	4.30	4.14
	2.93	3.09	2.85	3.62	4.30	4.10
Mean	3.35	3.25	3.31	4.17	4.56	4.53
	$M = 3.30$* ($SD = .61$)			$M = 4.42$* ($SD = .61$)		

Note. The viscometer measured the time in seconds required for 100 revolutions of viscometer rotor using a 100 ml sample size for each supplement. Supplements were tested three times each during three separate trials. Researcher-developed supplements were significantly more viscous than the standard supplement ($p = < .001$).

*Significantly different, $p \leq .05$.

developed supplements easier to consume. Evidence has shown that increased viscosity of a liquid promotes safe swallowing and minimizes the risk of fluid aspiration (Garcia, Chambers IV, & Molander, 2005).

Subjective Evaluation of Supplements Results

Subjective data regarding supplement acceptability and preference were collected through sensory ballots given to eight expert panel members during sensory evaluations. Panel members attended three of 10 scheduled sensory evaluations to evaluate the three researcher-developed oral nutritional supplements and the standard commercially-prepared supplement in chocolate, strawberry, and vanilla flavors. Subjective evaluations were conducted to meet the following research objectives:

d. To determine if there is a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

Sensory data collected from the sensory evaluations were entered into SPSS® 17.0. Multivariate Analysis of Variance (MANOVA) was conducted to determine if there was a significant difference in sensory data between the researcher-developed supplements and the standard supplement with a pre-determined significance level of $p \leq .05$. Results indicated that there was an overall significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement ($p = < .001$).

e. *To determine which sensory attribute(s) there is a significant difference if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

Since there was a significant difference in sensory data between the researcher-developed supplements and the standard supplement, the researcher analyzed the individual ANOVAs among the dependent variables (sensory attributes) to determine if there was a significant difference in sensory attribute(s) using a pre-determined significance level of $p \leq .05$. The sensory attributes evaluated by panel members and tested for any significant differences included the following:

Supplement appearance. The first item on the sensory ballot given to each panel member asked, "To what extent is the sample visually appealing?" The panel member circled his/her rate that he/she found each supplement visually appealing on the given Likert scale (1=not appealing; 5=very appealing). Table 4 displays each panel member's rate of the standard and researcher-developed supplements' visual appeal for each evaluation session. Each panel member's average rating was also calculated and is displayed in Table 4. Panel member numbers appearing in the table coincide with the panel member numbers used for comments and descriptions.

The expert panel's average rating for the standard supplement being visually appealing was 3.8 (SD = .99). The expert panel's average rating for the researcher-developed supplements being visually appealing was 4.0 (SD = .79). There was no significant difference between the expert panel's acceptability of the standard

Table 4

Panel Member Ratings for Standard and Researcher-Developed Supplements Being Visually Appealing

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	5	5	5	5.0	5	4	5	4.7
2	3	2	4	3.0	2	4	2	2.7
3	4	5	--[a]	4.5	3	3	--[a]	3.0
4	4	4	3	3.7	3	3	4	3.3
5	5	5	5	5.0	5	4	4	4.3
6	4	5	5	4.7	5	5	5	5.0
7	2	3	3	2.7	5	4	4	4.3
8	5	5	5	5.0	4	4	4	4.0
	Standard Strawberry				Researcher-Developed Strawberry			
1	4	4	5	4.3	3	5	5	4.3
2	--[a]	4	3	3.5	4	2	4	3.3
3	--[a]	3	--[a]	3.0	4	3	3	3.3
4	4	3	3	3.3	4	4	4	4.0
5	5	5	5	5.0	4	5	4	4.3
6	2	4	4	3.3	5	5	5	5.0
7	4	4	4	4.0	3	4	5	4.0
8	4	--[a]	5	4.5	5	4	3	4.0
	Standard Vanilla				Researcher-Developed Vanilla			
1	4	5	4	4.3	4	4	4	4.0
2	2	2	3	2.3	2	2	4	2.7
3	3	3	3	3.0	3	4	--[a]	3.5
4	4	3	3	3.3	3	4	4	3.7
5	5	2	5	4.0	4	4	4	4.0
6	4	4	4	4.0	5	4	5	4.7
7	2	3	3	2.7	4	4	5	4.3
8	4	5	5	4.7	4	4	--[a]	4.0
			Standard *M* =	3.8			Developed *M* =	4.0
			SD =	.99			*SD* =	.79

Note. Panel member ratings using a five-point Likert scale (1=not appealing; 5=very appealing). Panel members (N = 8) rated each supplement during three separate evaluation sessions. There was no significant difference between panel member ratings of the standard supplement's appearance and the researcher-developed supplements' appearance ($p = .33$).

[a]Rating absent on panel member's ballot.

supplement's appearance and the researcher-developed supplements' appearance ($p = .33$).

The expert panel's average rating for the standard chocolate supplement being visually appealing was 4.2; the researcher-developed chocolate supplement's average rating was 4.0. Panel member 2 found the standard chocolate supplement's appearance to be "somewhat watery" with "weak color," while others identified the supplement's appearance similar to "chocolate milk or yoo-hoo®" (Panel Member 3) and "dark [and] muddy" (Panel Member 6). Panel Member 7 described the appearance of the standard chocolate supplement as "grayish" two out of three sessions he/she attended.

Common descriptions used among panel members for the researcher-developed chocolate supplement's appearance included "light brown," "milk chocolate," "cloudy," and "frothy." Panel Member 8 found the researcher-developed chocolate supplement's appearance "acceptable" with "good color."

The average rating for both the standard and the researcher-developed strawberry supplements was 4.0. Multiple panel members described the standard strawberry supplement's color as "dark pink." However, Panel Member 4 described the standard supplement's color as "dirty pink," while Panel Member 5 described the color as "rosy." Of the eight panel members, four found the standard strawberry supplement's appearance comparable with Pepto-Bismol®.

For the researcher-developed strawberry supplement, Panel Member 1 found it to have a "pleasing, nice pink color," and Panel Member 8 identified the supplement having a "strawberries and cream appearance." Other common descriptions of the researcher-developed strawberry supplement's appearance included "light pink," "strawberry milk,"

"cloudy," and "frothy/foamy." Panel Member 7 found the "[researcher-developed supplement's] foam not appealing."

The expert panel rated the researcher-developed vanilla supplement more visually appealing than the standard vanilla supplement with an average rating of 3.9 for the researcher-developed supplement and 3.5 for the standard supplement. Panel members commonly described the standard vanilla supplement's appearance as "creamy" and "dark," or "grayish" according to Panel Member 7. The standard vanilla supplement's color was also described as "dark almond, not appealing as white" (Panel Member 1), "tan, almost like pudding" (Panel Member 6), and "a little off-putting" (Panel Member 3). Panel Member 2 commented that the supplement had a "weak appearance [and] artificial color."

The researcher-developed vanilla supplement was described as "yellowish, watery" (Panel Member 2), "pale" (Panel Member 8), and "gray/off white" (Panel Member 7) by panel members. More common descriptions for the researcher-developed vanilla supplement's appearance among panel members included "creamy," "milky," "light," and "frothy/foamy."

The expert panel, on average, rated the appearance of the researcher-developed and standard oral nutritional supplements closely, with the researcher-developed supplements' froth/foam being the most notable difference among panel members. The researcher blended the developed supplements prior to each sensory evaluation session, incorporating air into the supplements during preparation. Blending resulted in a notable frothy/foamy appearance among the researcher-developed supplements. However, older adults may find the researcher-developed supplements' frothy appearance to look light

and homemade-like; thus, depending on personal acceptability, older adults may find the researcher-developed supplement's appearance appealing.

Supplement smell. The second item on the sensory ballot given to each panel member asked, "To what extent is the sample's smell appealing?" The panel member circled his/her rate that he/she found each supplement's smell appealing on the given Likert scale (1=not appealing; 5=very appealing). Table 5 displays each panel member's rate of the standard and researcher-developed supplements' smell for each evaluation session. Each panel member's average rating was also calculated and is displayed in Table 5. Panel member numbers appearing in the table coincide with the panel member numbers used for comments and descriptions.

The expert panel's average rating of the standard supplement's smell being appealing was 3.0 (SD = .94); the expert panel's average rating of the researcher-developed supplements' smell being appealing was 3.6 (SD = 1.03). Between the standard and researcher-developed oral nutritional supplements, there was a significant difference in the expert panel's acceptability of the supplements' smell (p = .001). The researcher-developed oral nutritional supplements' smell was significantly more appealing to the expert panel as compared to the standard commercially-prepared supplement.

The standard chocolate supplement's smell received an average rating of 2.8; the researcher-developed chocolate supplement's smell received an average rating of 3.1. Some panel members found that the standard chocolate supplement's smell was "non-apparent" or "faint" while others found that the supplement had a "vitamin" or medicine" smell, or an "artificial chocolate" smell according to Panel Member 5.

Table 5

Panel Member Ratings on Finding Standard and Researcher-Developed Supplements' Smell Appealing

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	3	4	3	3.3	3	3	3	3.0
2	3	2	3	2.7	1	1	2	1.3
3	3	2	2	2.3	3	4	4	3.7
4	3	2	2	2.3	3	3	2	2.7
5	4	3	2	3.0	5	4	3	4.0
6	2	3	4	3.0	3	3	2	2.7
7	2	2	2	2.0	3	4	4	3.7
8	4	3	4	3.7	4	5	3	4.0
	Standard Strawberry[a]				Researcher-Developed Strawberry[a]			
1	5	2	4	3.7	3	5	3	4.3
2	2	2	3	2.3	4	3	3	3.3
3	4	4	2	3.3	5	4	4	4.3
4	3	3	4	3.3	3	4	3	3.3
5	5	4	3	4.0	4	2	5	3.7
6	5	4	2	3.7	3	1	5	3.0
7	4	3	3	3.3	3	5	4	4.0
8	4	2.5	4	3.5	4	5	4	4.3
	Standard Vanilla[a]				Researcher-Developed Vanilla[a]			
1	4	2	3	3.0	3	3	4	3.3
2	3	4	3	3.3	4	4	3	3.7
3	1	3	1	1.7	5	4	4	4.3
4	4	2	3	3.0	3	3	3	3.0
5	4	3	2	3.0	5	5	4	4.7
6	3	4	2	3.0	5	5	5	5.0
7	2	2	2	2.0	4	4	4	4.0
8	4	4	3	3.7	4	4	4	4.0
			Standard M =	3.0*			Developed M =	3.6*
			SD =	.94			SD =	1.03

Note. Panel member ratings using a five-point Likert scale (1=not appealing; 5=very appealing). Panel members (N = 8) rated each supplement during three separate evaluation sessions. There was a significant difference between the panel members' acceptability of the standard and researcher-developed supplements' smell ($p = .001$).

[a]Panel members rated the strawberry and vanilla supplements' smell significantly more appealing than the chocolate supplements' smell.

*Significantly different, $p \leq .05$.

Panel Member 3 commented that the standard chocolate supplement smelled "like chocolate at first, then chalky;" Panel Member 4 described the supplement's smell as "bitter." However, the supplement's smell was also found to be "acceptable" (Panel Member 1) and "appetizing" (Panel Member 5) among other panel members.

The researcher-developed chocolate supplement's smell received mixed comments and descriptions like the standard. While some panel members found the supplement's smell "undistinguishable," "subtle," or "mild," others described the supplement's smell as "chalky, mineral-like" (Panel Member 2), "strong chocolate" (Panel Member 4), or like a "chocolate vitamin" (Panel Member 6). Panel Member 3 identified the researcher-developed chocolate supplement's smell as "kind of earthy...a little off-putting" while Panel Member 5 identified the smell as "artificial chocolate...but still appetizing."

The standard strawberry supplement's smell received an average rating of 3.4; the researcher-developed strawberry supplement's smell received an average rating of 3.7. Descriptions of the standard supplement's smell included "fresh" (Panel Member 5), "fruity strawberry" (Panel Member 4), "medicinal" (Panel Member 3), and "vitamin smell" (Panel Member 2). Panel Member 1 indicated that the standard supplement had a "vanilla smell" to it; and Panel Member 6 found that the supplement's smell was "strong strawberry, almost imitation."

Many panel members described the researcher-developed strawberry supplement's smell as "faint" or "mild" strawberry. The supplement's smell was identified as "artificial" by Panel Member 2 and "sweet" by Panel Member 4. "Pleasant"

was the term used to describe the researcher-developed supplement's smell by Panel Member 2 and Panel Member 3.

The standard vanilla supplement's smell received an average rating of 2.8. Both Panel Member 3 and Panel Member 7 referred to the standard vanilla supplement's smell as "infant formula;" Panel Member 7 also identified the supplement's smell as a "can smell." The standard vanilla supplement's smell was described as "like a vitamin" (Panel Member 6) or "medicinal" by Panel Member 4 and Panel Member 8 (two out of three evaluation sessions). Panel Member 4 also described the smell as "nutty;" and Panel Member 5 found the standard vanilla supplement's smell "subtle, faint" and "artificial."

With an average rating of 4.0, the expert panel rated the researcher-developed vanilla supplement's smell more appealing than the other standard and researcher-developed supplements' smell. Three out of the eight panel members described the researcher-developed vanilla supplement's smell as "sweet" (Panel Member 3, 4, and 6). Sweet dessert-like descriptions of the researcher-developed supplement's smell among panel members included "like candy" (Panel Member 1), "cookie smell" (Panel Member 2), "like cupcakes" (Panel Member 3), "vanilla milkshake" (Panel Member 5), and "like Cold Stone [Creamery]® sweet cream" (Panel Member 6). However, Panel Member 7 identified the researcher-developed vanilla supplement's smell as "powdered milk."

The researcher-developed oral nutritional supplements' smell was found to be more appealing among panel members as compared to the standard commercially-prepared supplements' smell for all three flavors. Panel members indicated that the standard supplement had a "vitamin" or "medicine" aroma which may have lead the panel members to rate the standard supplement's smell less appealing. Depending on

personal acceptability and preference, older adults may favor the researcher-developed oral nutritional supplements over the standard commercially-prepared supplement since the researcher-developed supplements' smell had a higher average rating of acceptability among expert panel members.

Supplement strength of flavor. The third item on the sensory ballot given to each panel member asked, "To what extent would you rate the sample's strength of [chocolate, strawberry, or vanilla] flavor?" The panel member circled his/her perception of the supplement's strength of flavor on the given Likert scale (1=no [chocolate, strawberry, or vanilla]; 5=very [chocolate, strawberry, or vanilla]). Table 6 displays each panel member's perception of the standard and researcher-developed supplements' strength of flavor for each evaluation session. Each panel member's average rating was also calculated and is displayed in Table 6. Panel member numbers appearing in the table coincide with the panel member numbers used for comments and descriptions.

The expert panel's average rating of the standard supplement's strength of flavor was 4.0 (SD = 1.03); the expert panel's average rating of the researcher-developed supplements' strength of flavor was 3.6 (SD = 1.14). Between the standard and researcher-developed oral nutritional supplements, there was a significant difference in the expert panel's perception of the supplements' strength of flavor (p = .026). According to panel member perception, the standard commercially-prepared supplement's flavor was significantly stronger as compared to the researcher-developed oral nutritional supplements' flavor.

Panel members' average rating for the standard chocolate supplement's strength of chocolate flavor was 3.9; the average rating for the researcher-developed chocolate

Table 6

Panel Member Perception of the Standard and Researcher-Developed Supplements' Strength of Flavor

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	3	5	4	4.0	2	2	3	2.3
2	3	2	4	3.0	1	1	2	1.3
3	5	5	5	5.0	4	4	4	4.0
4	5	5	5	5.0	3	3	4	3.3
5	5	5	5	5.0	4	4	4	4.0
6	4	2	2	2.7	4	5	4	4.3
7	2	4	3	3.0	4	5	5	4.7
8	3	3	4	3.3	3.5	4	4	3.8
	Standard Strawberry				Researcher-Developed Strawberry			
1	5	4	3	4.0	2	2	3	2.3
2	2	2	4	2.7	3	2	3	2.7
3	5	5	5	5.0	5	5	5	5.0
4	5	5	4	4.7	4	4	3	3.7
5	4	5	4	4.3	3	2	2	2.3
6	5	5	3	4.3	1	1	5	2.3
7	4	5	4	4.3	3	4	4	3.7
8	5	4	4	4.3	3	2	4	3.0
	Standard Vanilla[a]				Researcher-Developed Vanilla[a]			
1	5	4	5	4.7	3	5	5	4.3
2	4	4	2	3.3	4	4	4	4.0
3	4	5	5	4.7	5	5	5	5.0
4	3	2	4	3.0	4	4	3	3.7
5	5	5	5	5.0	4	4	4	4.0
6	5	4	5	4.7	5	4	4	4.3
7	3	3	2	2.7	5	4	5	4.7
8	5	5	5	5.0	4	4	5	4.3
			Standard *M* =	4.0*			Developed *M* =	3.6*
			SD =	1.03			*SD* =	1.14

Note. Panel member ratings using a five-point Likert scale (1=no [chocolate, strawberry, or vanilla]; 5=very [chocolate, strawberry, or vanilla]). Panel members rated each supplement's strength of flavor during three separate evaluation sessions. There was a significant difference between the expert panel's perception of the standard and researcher-developed supplements' strength of flavor ($p = .026$).

[a]Panel members rated the vanilla supplements' flavor significantly stronger as compared to the chocolate and strawberry supplements' flavor.

*Significantly different, $p \leq .05$.

supplement's strength of chocolate flavor was 3.5. Common descriptions of the standard chocolate supplement's flavor included "sweet," "mild," and "not very chocolate." Panel Member 2 identified the standard supplement's flavor as "vitamin tasting." Panel Member 4 described the flavor as "strong and chalky" and "bitter;" and Panel Member 6 commented that "the [supplement's] other ingredients overpower." However, Panel Member 3 found the standard chocolate supplement's flavor "pleasant" with "nice chocolate overtones."

Three panel members identified the researcher-developed chocolate supplement's flavor as "chalky" (Panel Member 1, 2 and 4). Panel Member 3 described the researcher-developed supplement's flavor "like a Fudgsicle®" for all three evaluation sessions he/she attended, while Panel Member 5 referred to the supplement as having "somewhat of a mocha taste" and "artificial" flavor. Panel Member 6 expressed that the supplement's chocolate flavor reminded him/her of "powdered chocolate drinks- like Nesquik®;" and Panel Member 7 described the supplement's flavor as a "powder milk taste."

With an average of 4.2, the expert panel found that the standard strawberry supplement's flavor was stronger as compared to the researcher-developed strawberry supplement (3.1). Three of the panel members identified the standard strawberry supplement's flavor as "artificial/imitation strawberry" (Panel Member 2, 3, and 6). The supplement's strawberry flavor was found to be "sweet" for Panel Member 4 and "very sweet" for Panel Member 1 and Panel Member 8; Panel Member 1 commented that the supplement was "too sweet" two out of three evaluation sessions he/she attended. Other descriptions of the standard strawberry supplement's flavor included "fruity"

(Panel Member 4), like "bubble gum" (Panel Member 5), and "like a strawberry yogurt smoothie" (Panel Member 6). However, Panel Member 2 found that the standard strawberry supplement tasted like "vitamins," and Panel Member 7 found the supplement "somewhat chalky."

Three of the panel members described the researcher-developed strawberry supplement's flavor as "artificial/imitation strawberry" (Panel Member 2, 3, and 6). Panel Member 1 commented that the supplement tasted "like candy" two out of three evaluation sessions he/she attended, and Panel Member 2 also described the supplement as "more candy-like." Panel Member 5 expressed that the researcher-developed supplement's strawberry flavor was "not as strong as [he/she] would like" while Panel Member 8 also expressed that the supplement had "very little strawberry taste" and that the flavor was "hard to detect." According to Panel Member 7, there was "a little grit in the sample."

The average rating for the standard vanilla supplement's strength of vanilla flavor was 4.1; the average rating for the researcher-developed supplement's strength of vanilla flavor was 4.3. Three of the eight panel members identified the standard vanilla supplement's flavor as "sweet" (Panel Member 2, 3, and 4). Panel Member 2 and Panel Member 4 also identified the supplement as having a "vitamin" flavor. The standard supplement's vanilla flavor was "mild" or "not overwhelming" to a few panel members; however, Panel Member 5 found the supplement's vanilla flavor too strong for all three evaluation sessions he/she attended, commenting that the flavor was a "little too strong for my preference." Panel Member 3 expressed that the standard vanilla supplement was

"more pleasant than [he/she] expected based on smell, but the taste turned bad later." Panel Member 6 found that the supplement had a "strong" and "good vanilla flavor.

The researcher-developed vanilla supplement's flavor was "sweet" according to Panel Member 4 and Panel Member 8. The researcher-developed supplement was described as "buttery" by Panel Member 6 two out of three evaluation sessions he/she attended; and Panel Member 1 found that the supplement tasted "like candy." Panel Member 5 commented that the researcher-developed supplement's flavor was "not too strong vanilla, but still enough flavor" with a "good balance of vanilla." However, other panel members found the researcher-developed vanilla supplement "a bit chalky" (Panel Member 6) and that it tasted like "milk powder" (Panel Member 7).

As perceived by panel members, the standard supplement's flavor was significantly stronger than the researcher-developed supplements' flavor. Some individuals may find strong flavors desirable while others may have sensitive taste perception. In the older adult population, aging, disease, and medications are associated with a decline in sensory functions, including the ability to taste (Krinke, 2005). Thus, older adults with impaired taste may favor a strong-flavored supplement such as the standard supplement as compared to subtle-flavored supplements such as the researcher-developed supplements.

Supplement aftertaste. The fourth item on the sensory ballot given to each panel member asked, "To what extent would you rate the sample's aftertaste?" The panel member circled his/her perception of the supplement's aftertaste on the given Likert scale (1=no aftertaste; 5=very strong aftertaste). Table 7 displays each panel member's perception of the standard and researcher-developed supplements' aftertaste for each

evaluation session. Each panel member's average rating was also calculated and is displayed in Table 7. Panel member numbers appearing in the table coincide with the panel member numbers used for comments and descriptions.

The expert panel's average rating of the standard supplement's aftertaste was 3.0 (SD = 1.20). The expert panel's average rating of the researcher-developed supplements' aftertaste was 3.0 (SD = 1.24). There was no significant difference in the expert panel's rating between the standard commercially-prepared supplement's aftertaste and researcher-developed oral nutritional supplements' aftertaste (p = .944).

Panel member's average rating of the standard chocolate supplement's aftertaste was 3.0; the average rating of the researcher-developed chocolate supplement's aftertaste was 3.3. Some panel members found the standard chocolate supplement to have little or no aftertaste (Panel Member 1, 2, and 8); however, other panel members described the standard supplement's aftertaste as "strong, bitter" (Panel Member 4) and "unpleasant" (Panel Member 7). Panel Member 5 found the supplement to have an "artificial flavor aftertaste" while Panel Member 6 found the supplement to have a "vitamin" aftertaste that was "slightly metallic."

Some panel members identified the researcher-developed chocolate supplement's aftertaste as "little/light," "faint," "subtle," or nonexistent (Panel Member 1, 4, 7, and 8). However, other panel members described the standard supplement's aftertaste as "unpleasant" (Panel Member 2), and "bitter" (Panel Member 4). Two panel members commented that the supplement's aftertaste "lingered" (Panel Member 3 and 4). The researcher-developed supplement's aftertaste was described as a "vitamin aftertaste" and

Table 7

Panel Member Perception of the Standard and Researcher-Developed Supplements' Aftertaste

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	1	1	1	1.0	2	1	2	1.7
2	3	4	4	3.7	5	5	5	5.0
3	4	4	4	4.0	4	4	4	4.0
4	3	4	2	3.0	4	2	3	3.0
5	4	3	3	3.3	4	2	2	2.7
6	4	2	3	3.0	4	4	4	4.0
7	4	4	4	4.0	4	4	5	4.3
8	3	2	1	2.0	1	2	2	1.7
	Standard Strawberry				Researcher-Developed Strawberry			
1	1	1	1	1.0	1	1	1	1.0
2	5	4	4	4.3	4	4	3	3.7
3	4	2	4	3.3	3	4	4	3.7
4	4	4	4	4.0	3	3	2	2.7
5	3	4	3	3.3	4	3	4	3.7
6	1	1	3	1.7	3	3	5	3.7
7	3	4	4	3.7	3	5	4	4.0
8	3	1	1	1.7	1	2	2	1.7
	Standard Vanilla				Researcher-Developed Vanilla			
1	1	1	1	1.0	1	1	1	1.0
2	5	5	3	4.3	2	2	2	2.0
3	3	4	4	3.7	4	4	4	4.0
4	3	3	3	3.0	4	2	2	2.7
5	4	4	4	4.0	3	3	3	3.0
6	4	3	2	3.0	3	1	1	1.7
7	4	4	5	4.3	4	4	4	4.0
8	2	2	2	2.0	3	2	2	2.3
			Standard *M* =	3.0			Developed *M* =	3.0
			SD =	1.20			*SD* =	1.24

Note. Panel member ratings using a five-point Likert scale (1=no aftertaste; 5=very strong aftertaste). Panel members (N = 8) rated each supplement's aftertaste during three separate evaluation sessions. There was no significant difference in the panel members' rating between the standard and researcher-developed supplements' aftertaste ($p = .944$).

"chocolaty with something else" by Panel Member 6; he/she also identified the aftertaste as "metallic" two out of three evaluation sessions he/she attended.

The standard and researcher-developed strawberry supplements' aftertastes were rated closely with an average of 2.9 and 3.0, respectively. Two panel members described the standard strawberry supplement's aftertaste as "sweet" (Panel Member 4 and 6); Panel Member 4 also described the aftertaste as "fruity." Panel Member 2 found that the standard supplement's aftertaste was "unpleasant- not strawberry" and like a "vitamin," and Panel Member 5 identified the aftertaste as an "artificial strawberry taste."

The researcher-developed strawberry supplement's aftertaste was described as "artificial strawberry" by Panel Member 2; he/she also identified the aftertaste as "fruity" for one evaluation session he/she attended. Panel Member 3 commented that the supplement's aftertaste "lingered, but [was] pleasant." However, Panel Member 5 commented that the researcher-developed supplement's aftertaste was "not pleasant" and tasted "more powdery." The researcher-developed strawberry supplement had little to no aftertaste according to Panel Member 1, Panel Member 7, and Panel Member 8.

The expert panel found that the standard vanilla supplement had a stronger aftertaste than the researcher-developed vanilla supplement with an average rating of 3.2 and 2.6, respectively. The standard vanilla supplement's aftertaste was not apparent according to Panel Member 1 and Panel Member 8. Panel Member 5 described the supplement's aftertaste as "fairly strong since vanilla flavor so strong." Panel Member 5 also commented that the supplement had an "artificial flavor aftertaste;" however, Panel Member 6 commented that the supplement had a "real vanilla" aftertaste. The standard vanilla supplement's aftertaste was also described as "like vitamins" (Panel Member 2)

and "lingering" (Panel Member 3 and 4); and Panel Member 7 found the supplement's aftertaste unpleasant for all three evaluation sessions he/she attended.

The researcher-developed vanilla supplement's aftertaste was "minimal" (Panel Member 1 and 2) or "little/light" (Panel Member 4 and 5) for some panel members. Others found the supplement's aftertaste "strong, but pleasant" (Panel Member 3 and 7). Panel Member 6 described the supplement's aftertaste as having a "touch of vitamin," and Panel Member 8 commented that the researcher-developed vanilla supplement had an "after-texture more than a taste."

It is interesting to note that the supplements rated, on average, with high strength of flavor (standard chocolate, standard strawberry, and researcher-developed vanilla) were the supplements rated, on average, with low aftertaste. Depending on perception of taste and personal acceptability, older adults may favor the strong-flavored supplements over the subtle-flavored supplements due to their lower-rated aftertaste. However, some older adults with impaired sense of taste may find those supplements with high aftertaste desirable due to the supplements' increased duration of flavor in one's mouth.

Supplement viscosity. The fifth item on the sensory ballot given to each panel member asked, "To what extent is the sample's viscosity (thickness)?" The panel member circled his/her perception of the supplement's viscosity on the given Likert scale (1=not viscous; 5=very viscous). Table 8 displays each panel member's perception of the standard and researcher-developed supplements' viscosity for each evaluation session. Each panel member's average rating was also calculated and is displayed in Table 8. Panel member numbers appearing in the table coincide with the panel member numbers used for comments and descriptions.

Table 8

Panel Member Perception of the Standard and Researcher-Developed Supplements' Viscosity

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	2	3	3	2.7	4	3	4	3.7
2	4	3	4	3.7	3	5	3	3.7
3	4	4	3	3.7	3	3	4	3.3
4	5	4	4	4.3	3	3	3	3.0
5	--[a]	3	5	4.0	4	3	4	3.7
6	2	3	2	2.3	2	3	3	2.7
7	3	4	4	3.7	4	4	4	4.0
8	3	3	--[a]	3.0	4	3	2	3.0
	Standard Strawberry				Researcher-Developed Strawberry			
1	2	3	2	2.3	2	3	3	2.7
2	3	4	3	3.3	4	4	4	4.0
3	4	4	3	3.7	2	4	4	3.3
4	3	4	4	3.7	3	3	3	3.0
5	4	4	4	4.0	2	3	3	2.7
6	3	1	3	2.3	4	4	3	3.7
7	4	4	4	4.0	3	4	4	3.7
8	3	3	2	2.7	--[a]	4.5	3	3.8
	Standard Vanilla				Researcher-Developed Vanilla			
1	3	4	2	3.0	3	4	4	3.7
2	3	3	3	3.0	--[a]	5	4	4.5
3	4	4	3	3.7	4	4	2	3.3
4	3	3	4	3.3	3	3	4	3.3
5	4	5	4	4.3	3	4	3	3.3
6	1	1	2	1.3	3	3	2	2.7
7	3	4	4	3.7	3	4	4	3.7
8	4	4	2	3.3	3	4	3	3.3
		Standard M =		3.3		Standard M =		3.4
		SD =		.92		SD =		.70

Note. Panel member ratings using a five-point Likert scale (1=not viscous; 5=very viscous). Panel members rated each supplement's viscosity during three separate evaluation sessions. There was no significant difference between the panel members' rating of the standard and researcher-developed supplements' viscosity (p = .451).

[a]Rating absent on panel member's ballot.

The expert panel's average rating of the standard supplement's viscosity was 3.3 (SD = .92). The expert panel's average rating of the researcher-developed supplements' viscosity was 3.4 (SD = .70). There was no significant difference between the expert panel's rating of the standard commercially-prepared supplement's viscosity and the researcher-developed oral nutritional supplements' viscosity (p = .451).

The expert panel's average rating for both the standard and researcher-developed chocolate supplements' viscosities was 3.4. Panel Member 1 described the standard supplement's viscosity as "more liquid" while Panel Member 5 described the viscosity as "thick." Panel Member 6 provided mixed descriptions with identifying the supplement as "thin" for one evaluation session and "thick" for another. Panel Member 3 commented that the standard chocolate supplement was "not as thick as the appearance would lead you to believe," yet he/she also commented that the supplement was "a little thick...coats the tongue and seems to remain."

The researcher-developed chocolate supplement's viscosity received mixed descriptions. The supplement was described as "grainy" (Panel Member 4), "powdery" (Panel Member 5), "gritty" (Panel Member 6), and "chalky" (Panel Member 8) by some panel members. Panel Member 4 found the researcher-developed supplement to be "thin," and Panel Member 3 commented that the supplement was "pretty thin, but still coated the tongue." Panel Member 2 commented that the supplement's "appearance [was] watery; mouth feel [was] somewhat viscous." According to Panel Member 7, the researcher-developed chocolate supplement's viscosity was "about right."

The average rating for both the standard and researcher-developed strawberry supplements' viscosities was 3.3. The standard strawberry supplement was described as

"watery" (Panel Member 2), and Panel Member 1 described it as "a bit runny" for two out of three evaluation sessions he/she attended. Both Panel Member 3 and Panel Member 6 provided mixed descriptions. Panel Member 3 commented that the supplement "looked like it would be thicker," but then commented that the supplement was "pretty thick, like 2% milk" on a different evaluation session. Panel Member 6 expressed that the supplement had "some thickness that makes it more smoothie-like" for one evaluation session, but then commented "not thick at all" on a different evaluation session. For Panel Member 7, the standard strawberry supplement's viscosity was "as expected."

Descriptions for the researcher-developed strawberry supplement's viscosity included "runny" (Panel Member 1), "creamy" (Panel Member 2), "milky consistency" (Panel Member 5), and "thin" (Panel Member 7). Some panel members found the supplement to be "a little gritty" (Panel Member 3), "powdery" (Panel Member 5), and "chalky" (Panel Member 6 and 8). Panel Member 3 commented that the researcher-developed strawberry supplement was "pretty thin- I don't feel like it coats my tongue" while Panel Member 6 found the researcher-developed supplement to be "thicker, but smooth."

Panel members found the researcher-developed vanilla supplement slightly more viscous than the standard vanilla supplement, with average viscosity ratings of 3.4 and 3.2, respectively. The standard vanilla supplement's viscosity was described as "runny" (Panel Member 1), "not creamy/thick" (Panel Member 2 and 6), and as a "thin liquid" (Panel Member 6) by some panel members. However, both Panel Member 4 and Panel Member 5 found the supplement's viscosity "thick." Panel Member 3 commented that

the standard supplement "coated the tongue, but not very thick;" however, according to Panel Member 8, the standard vanilla supplement's viscosity was "just right."

The researcher-developed vanilla supplement's viscosity received mixed descriptions. Some panel members found the supplement's viscosity to be "more fluid" (Panel Member 1), "not very thick" (Panel Member 3), and "thin, creamy" (Panel Member 4), while others described the supplement's viscosity as "creamy- nice" (Panel Member 2), "thicker than milk consistency" (Panel Member 5), and "about right" (Panel Member 7). Panel Member 6 and Panel Member 8 both identified the researcher-developed supplement as "chalky;" Panel Member 6 also commented that the supplement had "a definite texture, almost gritty." Panel Member 3 expressed that the researcher-developed vanilla supplement's viscosity was "like a melted milkshake."

Objectively, the researcher-developed oral nutritional supplements were found to be significantly more viscous than the standard commercially-prepared supplement ($p = < .001$). However, subjectively, there was no significant difference between the expert panel's perception of the standard commercially-prepared supplement's viscosity and the researcher-developed oral nutritional supplements' viscosity ($p = .451$). Ballot results indicated that the expert panel rated, on average, the standard and researcher-developed chocolate and strawberry supplements' viscosity equal. Some panel members even described the standard supplements as more viscous as compared to the researcher-developed supplements. The researcher used a blender to prepare the developed supplements prior to each sensory evaluation session. It may be possible that the blended, frothy/foamy consistency of the researcher-developed supplements provided a light, less viscous mouth feel to some panel members. However, panel members rated,

on average, the researcher-developed vanilla supplement somewhat more viscous than the standard vanilla supplement.

f. To determine in which flavor(s) there is a significant difference in sensory attribute(s) if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

There was a significant difference in sensory data between the researcher-developed supplements and the standard supplement. There was also a significant difference between the standard and researcher-developed supplements' smell ($p = .001$) and strength of flavor ($p = .026$). A post hoc Duncan's test was conducted to determine in which supplement flavor(s) (chocolate, strawberry, and/or vanilla) there was a significant difference in smell and/or strength of flavor.

The expert panel's average rating on finding the standard and researcher-developed chocolate supplements' smell appealing was 3.0 ($SD = .143$). The expert panel's average rating on finding the standard and researcher-developed strawberry supplements' smell appealing was 3.6 ($SD = .143$); and the expert panel's average rating on finding the standard and researcher-developed vanilla supplements' smell appealing was 3.4 ($SD = .143$). Results indicated that the expert panel rated the strawberry and vanilla supplements' smell significantly more appealing than the chocolate supplements' smell. Depending on personal acceptability, older adults may favor to consume strawberry- and/or vanilla-flavored supplements over chocolate-flavored supplements since an expert panel of registered dietitians found the smell of strawberry- and vanilla-flavored supplements more appealing than chocolate-flavored supplements.

The expert panel's average rating for the standard and researcher-developed chocolate supplements' strength of flavor was 3.6 (*SD* = .155). The expert panel's average rating for the standard and researcher-developed strawberry supplements' strength of flavor was 3.7 (*SD* = .155); and the expert panel's average rating for the standard and researcher-developed vanilla supplements' strength of flavor was 4.2 (*SD* = .155). Results indicated that the expert panel perceived the standard and researcher-developed vanilla supplements' flavor significantly stronger as compared to the chocolate and strawberry supplements' flavor.

Results may be beneficial for older adults looking for stronger or more subtle-flavored oral nutritional supplements. An expert panel of registered dietitians found that the standard and researcher-developed vanilla supplements had a stronger flavor than the standard and researcher-developed chocolate and strawberry supplements. Depending on taste perception and personal preference of flavor, older adults with impaired taste may favor to consume vanilla-flavored supplements over chocolate- and strawberry-flavored supplements due to vanilla-flavored supplements' high strength of flavor.

g. *To determine if there is a significant difference between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

The sixth item on the sensory ballot given to each panel member asked, "To what extent would you rate your overall acceptability of the sample?" The panel member circled his/her rate regarding overall acceptability of the supplements on the given Likert scale (1=not acceptable; 5=very acceptable). Table 9 displays each panel member's rate of overall acceptability for the standard and researcher-developed supplements for each

Table 9

Panel Member Ratings of Overall Acceptability for the Standard and Researcher-Developed Supplements

Member	Session: 1	2	3	Mean	Session: 1	2	3	Mean
	Standard Chocolate				Researcher-Developed Chocolate			
1	3	5	4	4.0	3	4	4	3.7
2	4	3	4	3.7	1	1	1	1.0
3	5	4	4	4.3	4	4	4	4.0
4	3	3	3	3.0	3	3	3	3.0
5	5	3	4	4.0	4	5	4	4.3
6	3	3	3	3.0	4	3	3	3.3
7	2	3	3	2.7	4	5	4	4.3
8	3	3	4	3.3	3	4	4	3.7
	Standard Strawberry				Researcher-Developed Strawberry			
1	3	4	4	3.7	3	4	3	3.3
2	2	3	3	2.7	4	3	3	3.3
3	4	4	3	3.7	4	4	4	4.0
4	3	2	4	3.0	4	4	4	4.0
5	5	4	3	4.0	3	3	2	2.7
6	5	5	5	5.0	2	1	4	2.3
7	4	4	3	3.7	3	5	4	4.0
8	4	4	4	4.0	3	3	4	3.3
	Standard Vanilla				Researcher-Developed Vanilla			
1	4	4	4	4.0	3	5	4	4.0
2	2	4	3	3.0	4	4	4	4.0
3	3	4	2	3.0	5	5	4	4.7
4	4	2	3	3.0	4	4	4	4.0
5	4	3	4	3.7	5	5	5	5.0
6	5	5	5	5.0	3	3	5	3.7
7	3	3	2	2.7	5	5	4	4.7
8	5	4	4	4.3	2	3	4	3.0
			Standard M =	3.6			Developed M =	3.6
			SD =	.86			SD =	1.03

Note. Panel member ratings using a five-point Likert scale (1=not acceptable; 5=very acceptable). Panel members rated each supplement's overall acceptability during three separate evaluation sessions. There was no significant difference in the panel members' overall acceptability between the standard and the researcher-developed supplements (p = .756).

evaluation session. Each panel member's average rating was also calculated and is displayed in Table 9.

The expert panel's average rating of the standard supplement's overall acceptability was 3.6 (SD = .86). The expert panel's average rating of the researcher-developed supplements' overall acceptability was 3.6 (SD = 1.03). There was no significant difference in the panel members' overall acceptability between the standard commercially-prepared supplement and the researcher-developed supplements (p = .756).

The expert panel's average rating for overall acceptability was close between the standard and researcher-developed chocolate supplements with average acceptability ratings of 3.5 and 3.4, respectively. The average acceptability ratings for the standard and researcher-developed strawberry supplements were 3.7 and 3.4, respectively. Panel members rated the researcher-developed vanilla supplement more acceptable than the other standard and researcher-developed supplements with an average acceptability rating of 4.1; the standard vanilla supplement's average acceptability rating was 3.6.

The researcher-developed vanilla supplement was the only researcher-developed supplement rated, on average, more acceptable than the standard commercially-prepared supplement. Panel members rated, on average, the standard chocolate and strawberry supplements more acceptable than the researcher-developed chocolate and strawberry supplements. Given these results, it is interesting to find that the standard chocolate, standard strawberry, and researcher-developed vanilla supplements rated with higher acceptability (as compared to their corresponding flavored supplements) were also the three supplements rated with the highest strength of flavor and lowest aftertaste. The standard chocolate and researcher-developed vanilla supplements were also rated higher,

on average, than their corresponding flavored supplements for visual appeal. The researcher-developed vanilla supplement's smell was rated, on average, more appealing than the standard vanilla supplement.

h. *To determine in which flavor(s) there is a significant difference in overall acceptability if there was a significant difference found between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.*

There was no significant difference in the panel members' overall acceptability between the standard and researcher-developed oral nutritional supplements ($p = .756$). Therefore, further statistical testing among flavors was not conducted.

i. *To determine panel members' preference between the researcher-developed oral nutritional supplements and the corresponding standard commercially-prepared supplement.*

The eighth item on the sensory ballot given to each panel member after trying both chocolate, strawberry, or vanilla supplements asked, "Between the two [chocolate, strawberry, or vanilla] samples, which one would you prefer to consume?" The panel member circled his/her preference between the two chocolate, two strawberry, or two vanilla supplements on the sensory ballot.

Expert panel preference between chocolate supplements. Each panel member's preference between the standard commercially-prepared supplement Ensure® in Creamy Milk Chocolate and the researcher-developed chocolate supplement for the three sessions he/she attended is displayed in Table 10; Figure 4 illustrates the expert panel's overall preference between the standard and researcher-developed chocolate supplements.

Table 10

Panel Member Preference Between the Standard and Researcher-Developed Chocolate Supplements

Panel Member	Session 1	Session 2	Session 3
1	Standard	Standard	Standard
2	Standard	Standard	Standard
3	Developed	Developed	Standard
4	Developed	Developed	Developed
5	Standard	Developed	Standard
6	Developed	Developed	Standard
7	Developed	Developed	Developed
8	Developed	Developed	Developed

Note. Panel members (N = 8) attended three separate sensory evaluation sessions and indicated their preference between the standard chocolate supplement and the researcher-developed chocolate supplement after evaluating both.

Figure 4
Expert Panel Preference Between the Standard and Researcher-Developed Chocolate Supplements

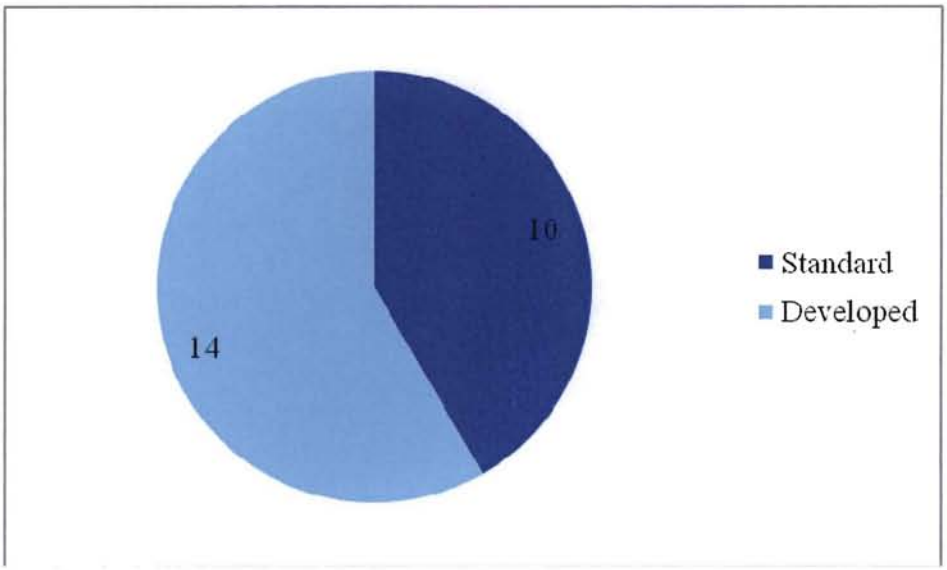

Figure 4. Note. This figure illustrates the expert panel's overall preference between the standard chocolate and researcher-developed chocolate supplement. Eight panel members attended three separate sensory evaluations and indicated their preference during each evaluation, resulting in 24 indicated preferences between the standard chocolate supplement and the researcher-developed chocolate supplement.

Expert panel members preferred the standard commercially-prepared supplement Ensure® in Creamy Milk Chocolate over the researcher-developed chocolate supplement 10 out of 24 times (41.7%). Two of the eight (25%) panel members preferred the standard supplement over the researcher-developed supplement for all three sensory evaluation sessions they attended. One panel member (12.5%) preferred the standard supplement over the researcher-developed supplement two out of three evaluation sessions he/she attended, and two panel members (25%) preferred the standard supplement over the researcher-developed supplement one out of three evaluation sessions they attended. Of the eight panel members, three (37.5%) preferred the standard commercially-prepared chocolate supplement over the researcher-developed chocolate supplement at least two out of three sensory evaluation sessions attended.

The researcher-developed chocolate supplement was preferred over the standard commercially-prepared chocolate supplement by expert panel members 14 out of 24 times (58.3%). Three of the eight panel members (37.5%) preferred the researcher-developed supplement over the standard supplement for all three sensory evaluation sessions they attended. Two panel members (25%) preferred the researcher-developed supplement over the standard supplement two out of three evaluation sessions they attended, and one panel member (12.5%) preferred the researcher-developed supplement over the standard supplement one out of three sessions he/she attended. Of the eight panel members, five (62.5%) preferred the researcher-developed chocolate supplement over the standard chocolate supplement at least two out of three sensory evaluation sessions attended.

Expert panel preference between strawberry supplements. Each panel member's preference between the standard commercially-prepared supplement Ensure® in Strawberries and Cream and the researcher-developed strawberry supplement for the three sessions he/she attended is displayed in Table 11. Figure 5 illustrates the expert panel's overall preference between the standard and researcher-developed strawberry supplements.

Expert panel members preferred the standard commercially-prepared supplement Ensure® in Strawberries and Cream over the researcher-developed strawberry supplement 13 out of 24 times (54.2%). Three of the eight (37.5%) panel members preferred the standard supplement over the researcher-developed supplement for all three sensory evaluation sessions they attended. One panel member (12.5%) preferred the standard supplement over the researcher-developed supplement two out of three evaluation sessions he/she attended, and two panel members (25%) preferred the standard supplement over the researcher-developed supplement one out of three evaluation sessions they attended. Of the eight panel members, four (50%) preferred the standard commercially-prepared strawberry supplement over the researcher-developed strawberry supplement at least two out of three sensory evaluation sessions attended.

The researcher-developed strawberry supplement was preferred over the standard commercially-prepared strawberry supplement by expert panel members 11 out of 24 times (45.8%). Two of the eight panel members (25%) preferred the researcher-developed supplement over the standard supplement for all three sensory evaluation sessions they attended. Two panel members (25%) preferred the researcher-developed supplement over the standard supplement two out of three evaluation sessions they

Table 11

Panel Member Preference Between the Standard and Researcher-Developed Strawberry Supplements

Panel Member	Session 1	Session 2	Session 3
1	Developed	Developed	Developed
2	Developed	Developed	Standard
3	Standard	Developed	Standard
4	Developed	Developed	Developed
5	Standard	Standard	Standard
6	Standard	Standard	Standard
7	Standard	Developed	Developed
8	Standard	Standard	Standard

Note. Panel members (N = 8) attended three separate sensory evaluation sessions and indicated their preference between the standard strawberry supplement and the researcher-developed strawberry supplement after evaluating both.

Figure 5
Expert Panel Preference Between the Standard and Researcher-Developed Strawberry Supplements

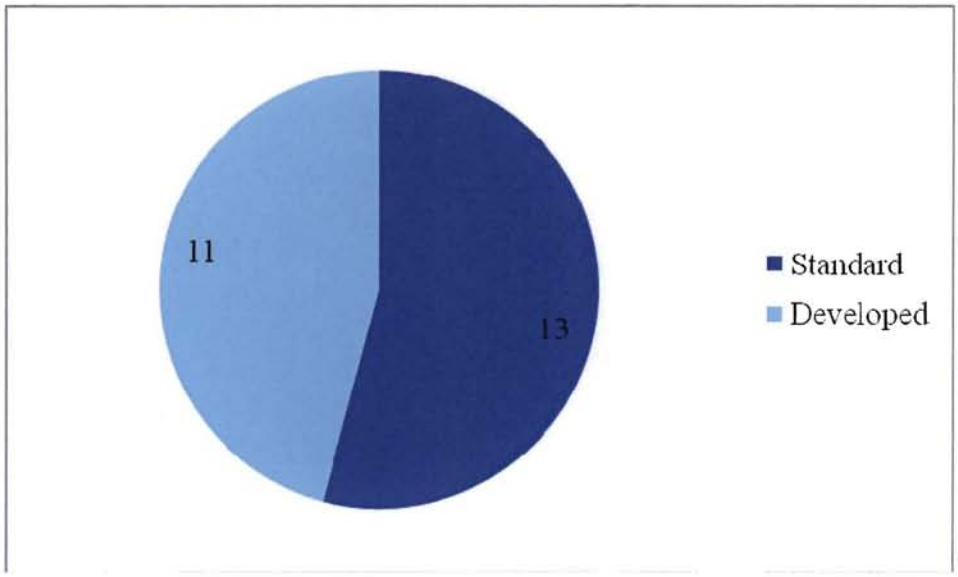

Figure 5. Note. This figure illustrates the expert panel's overall preference between the standard strawberry and researcher-developed strawberry supplement. Eight panel members attended three separate sensory evaluations and indicated their preference during each evaluation, resulting in 24 indicated preferences between the standard strawberry supplement and the researcher-developed strawberry supplement.

attended, and one panel member (12.5%) preferred the researcher-developed supplement over the standard supplement one out of three sessions he/she attended. Of the eight panel members, four (50%) preferred the researcher-developed strawberry supplement over the standard strawberry supplement at least two out of three sensory evaluation sessions attended.

Expert panel preference between vanilla supplements. Each panel member's preference between the standard commercially-prepared supplement Ensure® in Homemade Vanilla and the researcher-developed vanilla supplement for the three sessions he/she attended is displayed in Table 12. Figure 6 illustrates the expert panel's overall preference between the standard and researcher-developed vanilla supplements.

Expert panel members preferred the standard commercially-prepared supplement Ensure® in Homemade Vanilla over the researcher-developed vanilla supplement eight out of 24 times (33.3%). One of the eight panel members (12.5%) preferred the standard supplement over the researcher-developed supplement for all three sensory evaluation sessions he/she attended. Two panel members (25%) preferred the standard supplement over the researcher-developed supplement two out of three evaluation sessions they attended, and one panel member (12.5%) preferred the standard supplement over the researcher-developed supplement one out of three evaluation sessions he/she attended. Of the eight panel members, three (37.5%) preferred the standard commercially-prepared vanilla supplement over the researcher-developed vanilla supplement at least two out of three sensory evaluation sessions attended.

Table 12

Panel Member Preference Between the Standard and Researcher-Developed Vanilla Supplements

Panel Member	Session 1	Session 2	Session 3
1	Standard	Standard	Standard
2	Developed	Developed	Developed
3	Developed	Developed	Developed
4	Standard	Developed	Developed
5	Developed	Developed	Developed
6	Standard	Standard	Developed
7	Developed	Developed	Developed
8	Standard	Standard	Developed

Note. Panel members (N = 8) attended three separate sensory evaluation sessions and indicated their preference between the standard vanilla supplement and the researcher-developed vanilla supplement after evaluating both.

Figure 6
Expert Panel Preference Between the Standard and Researcher-Developed Vanilla Supplements

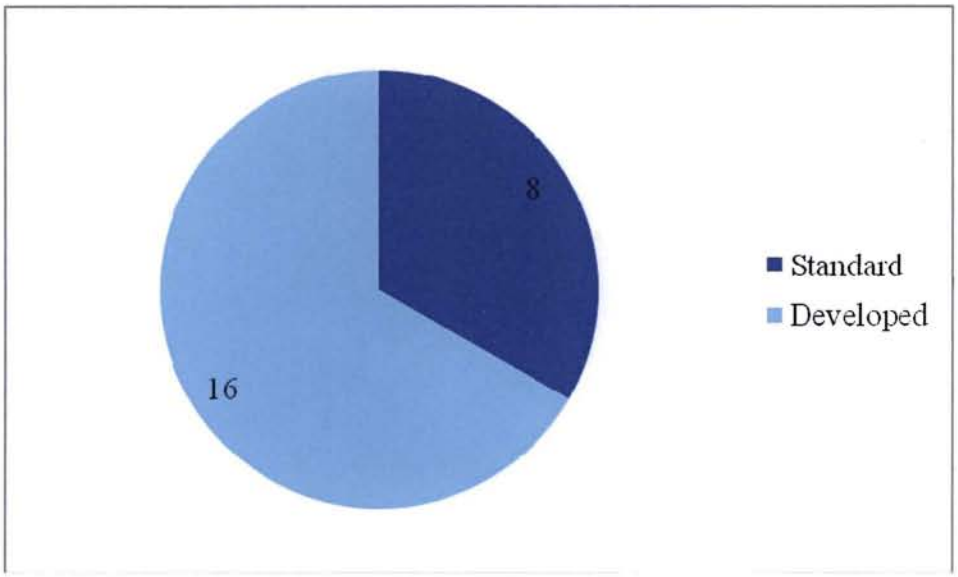

Figure 6. Note. This figure illustrates the expert panel's overall preference between the standard vanilla and researcher-developed vanilla supplement. Eight panel members attended three separate sensory evaluations and indicated their preference during each evaluation, resulting in 24 indicated preferences between the standard vanilla supplement and the researcher-developed vanilla supplement.

The researcher-developed vanilla supplement was preferred over the standard commercially-prepared vanilla supplement by expert panel members 16 out of 24 times (66.7%). Four of the eight panel members (50%) preferred the researcher-developed supplement over the standard supplement for all three sensory evaluation sessions they attended. One panel member (12.5%) preferred the researcher-developed supplement over the standard supplement two out of three evaluation sessions he/she attended, and two panel members (25%) preferred the researcher-developed supplement over the standard supplement one out of three sessions they attended. Of the eight panel members, five (62.5%) preferred the researcher-developed vanilla supplement over the standard vanilla supplement at least two out of three sensory evaluation sessions attended.

Panel members found the standard chocolate, standard strawberry, and researcher-developed vanilla supplements more acceptable than their corresponding flavored supplements. However, overall flavor preference is the combination of physiological responses involving odor, taste, and texture (Patterson, Owen, Frank, Smith, & Cadusch, 2004). Panel members overall indicated that they would prefer to consume the researcher-developed chocolate supplement over the standard chocolate supplement, the standard strawberry supplement over the researcher-developed strawberry supplement, and the researcher-developed vanilla supplement over the standard vanilla supplement after taking all supplement characteristics and physiological responses into consideration.

Expert panel supplement recommendations. The seventh item on the sensory ballot given to panel members asked, "Would you recommend this sample to older adult (≥ 60 years) patients/clients?" Panel members checked "Yes" or "No" to indicate if they

would, or would not, recommend the supplement being tested to older adult patients/clients. The standard chocolate supplement was recommended by expert panel members 21 out of 24 times (87.5%), and not recommended 3 out of 24 times (12.5%). Six of the eight panel members (75%) recommended the supplement for all three evaluation sessions attended. Panel Member 4 did not recommend the standard chocolate supplement one out of three sessions he/she attended, and Panel Member 6 did not recommend the standard supplement two out of three evaluation sessions he/she attended.

The researcher-developed chocolate supplement was recommended by expert panel members 18 out of 24 times (75%) and not recommended 6 out of 24 times (25%). Four of the eight panel members (50%) recommended the supplement for all three evaluation sessions attended. Panel Member 1, 4, and 6 did not recommend the researcher-developed chocolate supplement one out of three evaluation sessions attended. The researcher-developed supplement was not recommended by Panel Member 2 for all three evaluation sessions he/she attended.

Expert panel members recommended the standard strawberry supplement 22 out of 24 times (91.6%), and did not recommend the supplement two out of 24 times (8.3%). Six of the eight panel members (75%) recommended the supplement for all three evaluation sessions attended. Panel Member 2 and Panel Member 4 did not recommend the standard strawberry supplement one out of three evaluation sessions they attended.

The researcher-developed strawberry supplement was recommended by the expert panel 19 out of 24 times (79.2%), and not recommended five out of 24 times (20.8%). Five of the eight panel members (62.5%) recommended the researcher-developed supplement for all three evaluation sessions attended. Panel Member 8 did not

recommend the researcher-developed supplement one out of three evaluation sessions he/she attended. Panel Member 5 and Panel Member 6 did not recommend the researcher-developed strawberry supplement two out of three evaluation sessions they attended.

The standard vanilla supplement was recommended by the expert panel 19 out of 24 times (79.2%), and not recommended five out of 24 times (20.8%). Four of the eight panel members (50%) recommended the standard supplement for all three evaluation sessions attended. Panel Member 2, 4, and 5 did not recommend the standard supplement one out of three evaluation sessions they attended. Panel Member 3 did not recommend the standard vanilla supplement two out of three evaluation sessions he/she attended.

The highest recommended supplement among the expert panel was the researcher-developed vanilla supplement. The researcher-developed supplement was recommended 23 out of 24 times (95.8%), and not recommended one out of 24 times (4.2%). Seven of the eight panel members (87.5%) recommended the researcher-developed supplement for all three evaluation sessions attended. Panel Member 8 did not recommend the researcher-developed vanilla supplement one out of three evaluation sessions he/she attended.

Excluding the researcher-developed chocolate supplement, the chocolate, strawberry, and vanilla standard commercially-prepared supplements and the researcher-developed strawberry and vanilla supplements were recommended by all eight expert panel members at least once throughout the study. The researcher-developed chocolate supplement was recommended by seven out of eight panel members at least once throughout the study. Older adults may take comfort in knowing that the standard

commercially-prepared supplement Ensure® is recommended by registered dietitians. In addition, the researcher-developed oral nutritional supplements are an expert-approved alternative to the standard commercially-prepared supplement. Older adults who choose to make their own supplements at home will have confidence knowing that the researcher-developed supplements have been evaluated, recommended by an expert panel of registered dietitians, and is similarly priced and contains comparable nutritive value as the standard commercially-prepared supplement.

Chapter 5

Summary, Conclusions, and Recommendations

Malnutrition has become a frequent and serious complication in the older adult population and is known to significantly increase the rate of morbidity and mortality (Ahmed & Haboubi, 2010). Oral nutritional supplements, energy-dense liquid formulas with protein, vitamins, minerals, and other nutrients, are beneficial for older adults experiencing involuntary weight loss and poor nutritional status (Lauque et al., 2004). Understanding the various factors affecting supplement acceptability and consumption among older adults, such as nutritional value, cost, appearance, taste, and viscosity, is important and may help prevent, or delay, malnutrition in the older adult population. Depending on personal preferences, older adults may favor to develop their own oral nutritional supplements in the comfort of their home as an alternative to the standard commercially-prepared supplement.

Summary

The purpose of the present study was to develop and evaluate three oral nutritional supplements in varying flavors that were similarly priced and contained similar nutritive value as compared to the standard commercially-prepared supplement Ensure® (Abbott Laboratories). The study also focused on the comparison of appearance, smell, flavor, aftertaste, viscosity, and overall acceptability and preference between the researcher-developed supplements and the standard commercially-prepared supplement. Research objectives of the study included:

a. To determine the nutritive value of an eight-ounce serving of the three researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.
b. To determine the cost per serving of the researcher-developed oral nutritional supplements and compare with the corresponding standard commercially-prepared supplement.
c. To determine if there is a significant difference in viscosity between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.
d. To determine if there is a significant difference in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.
e. To determine which sensory attribute(s) there is a significant difference if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.
f. To determine in which flavor(s) there is a significant difference in sensory attribute(s) if there was a significant difference found in sensory data between the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.
g. To determine if there is a significant difference between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

h. To determine in which flavor(s) there is a significant difference in overall acceptability if there was a significant difference found between panel members' overall acceptability of the researcher-developed oral nutritional supplements and the standard commercially-prepared supplement.

i. To determine panel members' preference between the researcher-developed oral nutritional supplements and the corresponding standard commercially-prepared supplement.

The researcher used readily available products including soymilk, soy powder, non-fat dry milk, and meal replacement shake mix to develop chocolate-, strawberry-, and vanilla-flavored oral nutritional supplements. Once the final formula was developed, objective and subjective data were collected. Objective data collected included the determination of the nutritive value, cost, and viscosity of the researcher-developed supplements and the standard commercially-prepared supplement. Nutritive value was determined using NutritionData software (Condé Nast Digital, 2009), and the researcher-developed supplements were found to be nutritionally comparable to the standard supplement. Developed supplement cost was determined and analyzed manually by the researcher. The researcher-developed supplements cost $1.11 to produce; and the standard supplement cost $1.16. Supplement viscosity was determined using a Thomas-Stormer viscometer (Arthur H. Thomas Co.), and results indicate that the researcher-developed oral nutritional supplements were significantly more viscous as compared to the standard commercially-prepared supplement ($p = < .001$).

Subjective data were collected through sensory ballots given to an expert panel of eight nutrition professionals during sensory evaluations. Panel members evaluated the

chocolate, strawberry, and vanilla researcher-developed supplements and the standard commercially-prepared supplement in corresponding flavors during each evaluation session. Panel members rated their acceptability of each sample's appearance and smell, and rated their perception of each sample's flavor, aftertaste, and viscosity. In addition, panel members rated their overall acceptability of each sample.

Sensory data were entered into SPSS® 17.0 and evaluated for any significant differences. There was an overall significant difference between the standard commercially-prepared supplement and the researcher-developed oral nutritional supplements ($p = < .001$). The researcher-developed oral nutritional supplements' smell was significantly more appealing to the expert panel as compared to the standard commercially-prepared supplement ($p = .001$); and the expert panel rated the strawberry and vanilla supplements' smell significantly more appealing than the chocolate supplements' smell. According to panel member perception, the standard commercially-prepared supplement's flavor was significantly stronger as compared to the researcher-developed oral nutritional supplements ($p = .026$); and the expert panel perceived the standard and researcher-developed vanilla supplements' flavor significantly stronger as compared to the chocolate and strawberry supplements' flavor. There was not a significant difference found among the other sensory attributes evaluated.

There was no significant difference in the expert panel's overall acceptability between the standard commercially-prepared supplement and the researcher-developed supplements ($p = .756$). However, panel members, on average, preferred to consume the researcher-developed chocolate, standard strawberry, and researcher-developed vanilla supplements over their corresponding flavor supplement. All oral nutritional

supplements, excluding the researcher-developed chocolate supplement, were recommended by all eight expert panel members at least once throughout the study. The researcher-developed chocolate supplement was recommended by seven out of eight panel members at least once throughout the study.

Limitations

Limitations of the study included the sample size, location, and sensory evaluation session dates and times. The expert panel's size was dependent on the number of nutrition professionals willing to volunteer. The sample was drawn from the Charleston-Mattoon, IL area; and panel members had to fit the criteria of being a practicing registered dietitian at the time of the study.

The expert panel was also limited by the scheduled dates and times for the sensory evaluation sessions. Evaluation sessions were held two times daily- one morning session and one evening session- for five consecutive days. The expert panel's size may have been affected by potential members' availability during the five days scheduled for evaluations.

Recommendations for Practice

The findings of the present study can be applied to the future practice of health professionals, specifically registered dietitians. Registered dietitians may use the results of the expert panel's acceptability ratings and recommendations of the chocolate-, strawberry-, and vanilla-flavored Ensure® when recommending the supplement to older adult patients/clients.

As a result of this study, there are alternative oral nutritional supplements that older adult patient/clients may consume to increase energy and nutrient intake. The

researcher-developed chocolate, strawberry, and vanilla supplements were comparable to the standard commercially-prepared supplement in regards to nutritional value and cost. Registered dietitians may also use the results of the expert panel's acceptability ratings and recommendations of the researcher-developed supplements when recommending the supplements to older adult patients/clients.

Since the researcher-developed supplements were more viscous than the standard commercially-prepared supplement, those patients/clients with impaired swallowing may find the researcher-developed supplements easier to consume; evidence has shown that increased viscosity of a liquid promotes safe swallowing and minimizes the risk of fluid aspiration (Garcia, Chambers IV, & Molander, 2005). Patients/clients may also adjust the amount of liquid used in the researcher-developed supplements depending on the viscosity desired.

Depending on personal preferences, older adult patients/clients may find developing their own oral nutritional supplements in the comfort of their home an acceptable alternative to the standard commercially-prepared supplement. In addition, registered dietitians may recommend various measurements of the researcher-developed supplements' ingredients depending on their patients'/clients' individual nutritional status and needs. It is imperative for registered dietitians to find appropriate dietary strategies to aid in their older adult patients'/clients' nutritional status and overall health.

Recommendations for Future Research

This study did not test on the older adult population since the researcher wanted to develop and ensure high quality supplements before further research was conducted on older adults. The researcher-developed oral nutritional supplements in the present study

were found to be comparable to the standard commercially-prepared supplement, indicating that future research and testing among older adult consumers is needed. As one ages, sensory functions such as taste, smell, and vision begin to diminish. Therefore, older adults' acceptability of the researcher-developed and standard supplements and their characteristics may differ from this study's expert panel. Future research is also needed to determine older adults' willingness to prepare their own oral nutritional supplement at home rather than purchasing commercially-prepared supplements.

Research within the field of food science is also recommended for further supplement recipe modification. Panel members found the researcher-developed oral nutritional supplements chalky, powdery, frothy, and their flavors too "artificial/imitation." Other forms or brands of the supplements' powder ingredients should be researched and experimented with in order to determine the most dissolvable products. Supplement preparation methods should also be examined to reduce supplement foam/froth as a result of blending.

Recipe modification to eliminate lactose-containing ingredients is recommended so the researcher-developed supplements may be available to those older adults who are lactose-intolerant. Nutrient sources in addition to soy products should be researched. In regards to supplement flavor, the Slim-Fast® meal replacement mix- which provided the researcher-developed supplements' flavor in this study- could be modified or replaced. In addition, supplemental flavorings could be used to increase supplement palatability and overall acceptability.

The current study analyzed an expert panel's perception of each supplement's strength of flavor. This sensory attribute is highly dependent on individual acceptability

and sensitivity to taste. While the current study's focus was on panel members' perception of flavor, panel members may have rated their acceptability of each supplement's flavor. Further research is needed for a more complete examination of each supplement's strength of flavor along with panel members' acceptability of each supplement's flavor.

The use of additives and preservatives in food products is an increasing concern among consumers. Examining the types and amounts of additives and preservatives between the standard commercially-prepared supplement and the researcher-developed supplements may be an interesting area of further research. Older adult consumers may favor an oral nutritional supplement that is considered more "natural" with minimal additives and preservatives.

Conclusion

Malnutrition, specifically undernutrition, is a serious complication among older adults and is known to significantly increase the rate of morbidity and mortality (Ahmed & Haboubi, 2010). Older adults have an increased risk of malnutrition due to changes in body composition, energy and nutrient needs, sensory function, and income. Oral nutritional supplements, energy-dense liquid formulas fortified with protein, vitamins, minerals, and other nutrients, are beneficial in promoting weight gain and preventing involuntary weight loss when needed, especially in the older adult population.

The present study concludes that researcher-developed oral nutritional supplements, which may be prepared in one's home with mostly nonperishable ingredients, are similarly priced and provides similar nutritive content as compared to the standard commercially-prepared supplement. An expert panel consisting of eight

nutrition professionals preferred to consume the researcher-developed supplement formula in two out of the three flavors evaluated (chocolate and vanilla) after taking into consideration all supplement sensory attributes (appearance, smell, strength of flavor, aftertaste, and viscosity). Therefore, according to nutrition professionals, the researcher-developed supplements, overall, are more preferred over the standard supplement for older adult consumers. Study results indicate that the researcher-developed oral nutritional supplements are an acceptable alternative to the standard commercially-prepared supplement. Older adults may be able to prepare palatable, economical, and registered dietitian-approved supplements, even on a fixed income.

Future research, including sensory evaluations among the older adult population and determining older adults' willingness to prepare their own supplement at home is needed. Understanding the various factors affecting supplement acceptability and consumption among older adults is vital. Developing alternative and acceptable oral nutritional supplements such as those in this study, and discovering further methods of providing nutrition to older adults, may ultimately help prevent, or at least delay, malnutrition in the older adult population.

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Appendix A: Recruitment Email

Dear _____,

As a practicing registered dietitian, you are invited to participate in my graduate thesis research. The purpose of the study is to compare the acceptability of three developed oral nutritional supplements in varying flavors (vanilla, strawberry, and chocolate) with a standard commercially-prepared supplement through sensory evaluation. As a volunteer, you will serve as an expert on the sensory panel. (If you are lactose-intolerant or allergic to soy, it is asked that you do not participate to prevent any illness or complications)

If you volunteer to participate, you will be asked to evaluate a total of six oral nutritional supplement samples and complete a seven- to eight-item ballot for each sample on three different test times. While there are 10 sensory evaluation sessions scheduled, you will need to attend THREE to fully participate in the study. The overall length of participation will be about 30 minutes for each evaluation session. All evaluation sessions will be held in Klehm Hall room 2341 at Eastern Illinois University. Dates and times of the evaluation sessions are as follows; you may arrive anytime within the designated time (remember that you will need to attend THREE):

Monday, February 28th 10:00am-12:00pm; 4:30pm-7:00pm
Tuesday, March 1st 10:00am-12:00pm; 4:30pm-6:30pm
Wednesday, March 2nd 10:00am-12:00pm; 4:30pm-7:00pm
Thursday, March 3rd 10:00am-12:00pm; 4:30pm-6:30pm
Friday, March 4th 10:00am-12:00pm; 4:30pm-6:30pm

If you have any questions about the study or if you are interested in reserving your spot as an evaluator, please contact Christa Huxel below. Please respond by February 26th your desire to assist. Indicate the three evaluation sessions you will attend and the time you plan on arriving for each.

Thank you for your consideration.

Christa Huxel
Principle Investigator
Graduate Dietetic Student
Eastern Illinois University
Email: crhuxel@eiu.edu

Melanie Tracy Burns, PhD, RD
Faculty Mentor
Eastern Illinois University
Email: mdburns@eiu.edu
Phone: 217-581-6680

Appendix B: Informed Consent

CONSENT TO PARTICIPATE IN RESEARCH

Evaluation of Three Developed Oral Nutritional Supplements and A Standard Commercially-Prepared Supplement

You are invited to participate in a research study conducted by Christa Huxel (faculty sponsor: Melanie Burns, Ph.D, R.D.), from the School of Family and Consumer Sciences at Eastern Illinois University.
Your participation in this study is entirely voluntary. Please ask questions about anything you do not understand before deciding whether or not to participate.

Those who are lactose-intolerant (allergic to milk) or allergic to soy are excluded from the study to prevent any illness or complications.

- **PURPOSE OF THE STUDY**

The purpose of this study is to compare an expert panel's acceptability of three developed oral nutritional supplements in varying flavors with a standard commercially-prepared supplement through sensory evaluation. The evaluation will focus on the acceptability rating of each supplement's appearance, smell, flavor, and viscosity.

- **PROCEDURES**

If you volunteer to participate in this study, you will be asked to:

Evaluate a total of six oral nutritional supplements and complete a seven to eight-item ballot for each sample simultaneously. After tasting each supplement sample, you will rate your acceptability of the sample's appearance and smell, and rate the flavor, aftertaste, and viscosity of the sample on the ballot using the given Likert scale. In addition, you will need to provide two to three words that describe each of the supplement's characteristics. You will also need to indicate your overall acceptability of each sample, indicate if you would recommend the sample to patients/clients, and indicate what sample you would prefer to consume.

Once you have completed the sensory evaluation and the ballots, you will be able to exit the testing area. .

Each sample evaluation, including filling out the ballot will take approximately 5 minutes to complete. The overall length of participation will be about 30 minutes for each sensory evaluation session. There will be 10 separate sensory evaluation sessions scheduled; you must attend three sessions to fully participate.

- **POTENTIAL RISKS AND DISCOMFORTS**

The only risk to you is a possible allergic reaction to the supplements' ingredients.

Potential risks are minimized by previously informing you of the ingredients found in the supplements known to cause allergic reactions. Any risks to confidentiality will be minimized by immediately collecting all forms when you have completed the evaluation. All forms will be kept in a locked file container that only the researcher will have access to. After all data have been recorded, forms must be retained for three years after completion of the research and will then be properly shredded and disposed.

If any illness or complications occur, a referral will be given to the participant for the closest medical center.

- **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

Subjects will not benefit directly from participation.

This study will benefit health professionals since there will be alternative oral nutritional supplements their patients may consume to increase energy and nutrient intake. Older adult consumers will be able to develop their own palatable and economical oral nutritional supplements in various flavors in the comfort of their home. The supplements will be easy for older adults to make since they will contain minimal ingredients, require little equipment for preparation, and use mostly nonperishable ingredients. In addition, the developed supplements will be economical since there will be little waste for producing them. Results of this study will be beneficial for those persons who are in need of easy and convenient nutritional support.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by immediately collecting the data you have completed after the evaluation. All forms will be kept in a locked file container that only the researcher will have access to. All records relating to the research project must be retained for three years after completion of the research and will then be properly shredded and disposed. If you choose to formally withdraw from the study, all of your collected data will be disposed in the same manor.

- **PARTICIPATION AND WITHDRAWAL**

Participation in this research study is voluntary and not a requirement or a condition for being the recipient of benefits or services from Eastern Illinois University or any other organization sponsoring the research project. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits or services to which you are otherwise entitled. There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about this research, please contact:

Christa Huxel (principal investigator)
Email: crhuxel@eiu.edu

Melanie Burns, Ph.D, R.D (faculty sponsor)
Phone: 217-581-6680
Email: mdburns@eiu.edu

- **RIGHTS OF RESEARCH SUBJECTS**

If you have any questions or concerns about the treatment of human participants in this study, you may call or write:

Institutional Review Board
Eastern Illinois University
600 Lincoln Ave.
Charleston, IL 61920
Telephone: (217) 581-8576
E-mail: eiuirb@www.eiu.edu

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with EIU. The IRB has reviewed and approved this study.

I voluntarily agree to participate in this study. I understand that I am free to withdraw my consent and discontinue my participation at any time. I have been given a copy of this form.

_____
Printed Name of Participant

_____ _____
Signature of Participant Date

I, the undersigned, have defined and fully explained the investigation to the above subject.

_____ _____
Signature of Investigator Date

Appendix C: Ballot

Oral Nutritional Supplement Sensory Evaluation

Chocolate Sample #_____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *chocolate flavor*? No chocolate **1 2 3 4 5** Very chocolate	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	

Oral Nutritional Supplement Sensory Evaluation

Chocolate Sample #_____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *chocolate flavor*? No chocolate **1 2 3 4 5** Very chocolate	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	
8. **Between the two chocolate samples, which one would you *prefer* to consume?** ### ###	

Oral Nutritional Supplement Sensory Evaluation

Strawberry Sample #_____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *strawberry flavor*? No strawberry **1 2 3 4 5** Very strawberry	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	

Oral Nutritional Supplement Sensory Evaluation

Strawberry Sample #_____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *strawberry flavor*? No strawberry **1 2 3 4 5** Very strawberry	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	
8. **Between the two strawberry samples, which one would you *prefer* to consume?** ### ###	

Oral Nutritional Supplement Sensory Evaluation

Vanilla Sample # _____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *vanilla flavor*? No vanilla **1 2 3 4 5** Very vanilla	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	

Oral Nutritional Supplement Sensory Evaluation

Vanilla Sample #_____

Please circle the number according to your rating of each characteristic	**Using two to three words, describe the following characteristics of the sample**
1. To what extent is the sample *visually appealing*? Not appealing **1 2 3 4 5** Very appealing	**Appearance:**
2. To what extent is the sample's *smell* appealing? Not appealing **1 2 3 4 5** Very appealing	**Smell:**
3. To what extent is the sample's strength of *vanilla flavor*? No vanilla **1 2 3 4 5** Very vanilla	**Flavor:**
4. To what extent would you rate the sample's *aftertaste*? No aftertaste **1 2 3 4 5** Very strong aftertaste	**Aftertaste:**
5. To what extent is the sample's *viscosity* (thickness)? Not viscous **1 2 3 4 5** Very viscous	**Viscosity:**
6. To what extent would you rate your *overall acceptability* of the sample? Not acceptable **1 2 3 4 5** Very acceptable	
7. Would you recommend this sample to older adult (≥ 60 years) patients/clients? Yes_____ No_____	
8. **Between the two vanilla samples, which one would you *prefer* to consume?** ### ###	

Appendix D: Sensory Evaluation Instructions

If you are lactose-intolerant or allergic to soy, it is asked that you do not participate in the study to prevent any illness or complications.

It is asked that you remain quiet throughout the duration of the evaluation, and do not discuss your answers with other panel members.

Once you have read through the informed consent and sign, please raise your hand so the researcher knows you are ready to begin the sensory evaluation.

Sensory Evaluation Instructions:

1. Note the appearance and smell of the sample and record your acceptability ratings on the ballot.

2. Consume a small sip of the sample and record your ratings for the sample's *flavor, aftertaste, and viscosity* on the ballot.

3. Rate your *overall acceptability* of the sample and indicate if you would recommend the numbered sample to patients/clients.

4. When you have completed the evaluation for the sample, take a sip of water and/or take a bite of an unsalted cracker to cleanse your palate.

5. Please raise your hand so the researcher knows you are ready to begin the next sample evaluation.

Once you have completed all six sample evaluations, the researcher will inform you that you are free to leave.

Thank you for your participation in this study!