

The Effects of Health Information on the Acceptability of a Functional Beverage Containing Fresh Turmeric

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ACADEMIC ABSTRACT

BACKGROUND: Turmeric is a root with curcumin and non-curcumin derivatives that serve as antioxidants, which reduce the risk of oxidative stress-induced chronic disease. The provision of health information has shown to increase the acceptability of functional foods that impart unfamiliar flavors. **PURPOSE:** The purpose of this study was to evaluate the acceptability and sensory qualities of a functional beverage with fresh turmeric, and the impact of information related to the beverage's health benefits on acceptability. This study also investigated personal and psychological factors associated with food acceptance. **METHODS:** Antioxidant capacity (ferrous equivalents) and polyphenolic content were evaluated in a fruit-based beverage containing 0g, 7g, 14g, and 22g of fresh turmeric. Sixty-one individuals were recruited to participate in a sensory evaluation of two fruit-based beverages with and without fresh turmeric. Thirty-one participants were given health information related to the beverage and 30 participants received no health information. The degree of liking was measured on a hedonic scale and sensory attributes were measured using a Just About Right (JAR) scale. Food choice motives and demographic characteristics were measured using a Food Choice Questionnaire and demographics questionnaire. **RESULTS:** The development of a functional beverage with 14 grams of turmeric was considered significantly more acceptable with the provision of health information and resulted in a significant increase in antioxidant capacity and polyphenolic content. There was a significant difference in acceptability scores of the functional beverage across antioxidant interest groups and health motivation groups.

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GENERAL AUDIENCE ABSTRACT

Turmeric is a root composed of antioxidants, which reduce the risk of certain diseases. The provision of health information has shown to positively impact the overall liking of functional foods containing unfamiliar flavors. The purpose of this study was to evaluate the overall liking and sensory qualities of a functional beverage with fresh turmeric, and the impact of information related to the beverage's health benefits on acceptability. This study also investigated personal and psychological factors associated with food acceptance. Antioxidant capacity and polyphenolic content were evaluated in a fruit-based beverage containing 0g, 7g, 14g, and 22g of fresh turmeric. Sixty-one individuals were recruited to participate in a sensory evaluation of two fruit-based beverages with and without fresh turmeric. Thirty-one participants were given health information related to the beverage and 30 participants received no health information. The degree of liking was measured on hedonic scale and sensory attributes were measured using a Just About Right (JAR) scale. Food choice motives and demographic characteristics were measured using a Food Choice Questionnaire and demographics questionnaire. The functional beverage with 14 grams of turmeric was considered significantly more acceptable with the provision of health information and resulted in a significant increase in antioxidant capacity and polyphenolic content. There was a significant difference in acceptability scores of the functional beverage across antioxidant interest groups and health motivation groups.

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ABBREVIATIONS

FRAP: Ferric Reduction Antioxidant Power

CDC: Centers for Disease Control

IFIC: International Food Information Council

ROS: Reactive oxygen species

CHAPTER 1: INTRODUCTION

Chronic disease results in 7 out of the top 10 leading causes of death in the United States.[1] The prevalence of chronic disease continues to rise primarily due to poor diet, sedentary lifestyle, or tobacco use. Less than 1 in 5 adults eat enough fruit, and less than 1 in 7 eat enough vegetables in the United States.[1] Fruits and vegetables are rich in antioxidants and polyphenolic compounds, which serve to protect the body from oxidative stress-related diseases. A diet low in antioxidants and polyphenolic compounds increase the risk of life-threatening diseases. As public awareness of health and nutrition arise, the food and beverage industry are taking action to meet consumer's demands for healthier products. According to the 2013 Functional Foods Consumer Survey conducted by the International Food Information Council (IFIC), almost nine in ten Americans (86%) are interested in learning more about foods that have health benefits beyond nutrition.[2] Functional foods or beverages provide more than basic nutritional needs and are consumed to either improve physiological functions or to reduce the risk of specific pathologies. Long-term consumption of functional foods or beverages is used as a strategy to control and maintain long-term health.[3]

Turmeric is a trending functional ingredient added to foods and beverages to provide added health benefits. Production of turmeric in the United States is increasing as the market potential grows. Dietary consumption of turmeric in the United States has grown and is now a standard spice used in the kitchen of many US households. Fresh turmeric can be purchased in almost every major city in the United States and is a frequent ingredient in smoothies and juices.[4]

Turmeric and its bioactive constituent, curcumin, have been shown to demonstrate therapeutic properties that impact inflammatory conditions including diabetes, irritable bowel syndrome and other gut conditions, and multiple cancers. Processing turmeric into a spice form decreases the non-curcuminoid content that is primarily located in fresh turmeric root. The rhizomes of fresh turmeric demonstrate greater bioavailability and antioxidant properties than rhizomes after it has been processed into dried turmeric. Studies investigated turmeric's antioxidant properties in its processed form, usually dried powder, in a pill, extract or gel.[5, 6] A whole food approach using turmeric to evaluate its impact on health is absent in the literature. Provision of the bioactive components of food in a pill or supplement form promotes a medicinal approach to health, whereas, communicating the health benefits of whole foods for disease prevention controls and supports a lifestyle approach to health.

The sensory characteristics of fresh turmeric are considered pungent and bitter when presented in large quantities due to its composition of polyphenolic compounds, ketones, and sesquiterpene alcohols[7]. A preliminary study conducted at Virginia Tech evaluated the sensory qualities of a fruit-based beverage containing fresh turmeric and indicated a decrease in acceptability as the turmeric dosage increased [unpublished data].

Studies indicated that increased knowledge of the health benefits of functional foods/beverages could affect consumers perception and significantly increase the frequency of consumption. Less than half of U.S consumers believe they have enough information to understand which foods provide an added benefit.[2] Consumers who obtain knowledge, perceived benefits, and outcome expectations of the functional food/beverage are more likely to consume it. Nutrition and health information related to a food product has shown to have a positive impact on the acceptability of

a functional food if health intrinsically motivates the consumer. Bridging this knowledge and the behavioral gap can increase the consumption of functional foods/beverage and overall health in the U.S.

The purpose of this study is to validate the antioxidant capacity of a functional beverage containing fresh turmeric, as well as, to evaluate the acceptability of a functional beverage when given information related to its health benefits. Precisely, this study will (1) Determine the minimum dose of turmeric (7g, 14g, and 22g) that significantly increases the antioxidant capacity and phytochemical content of a fruit-based functional beverage, (2) Evaluate the acceptability and sensory qualities of a fruit-based beverage with (functional beverage) and without (control beverage) turmeric, (3) Evaluate the impact of the provision of health information on acceptability and sensory score of the functional beverage between the conditions, and (4) Investigate personal (age, gender, turmeric familiarity and interest level of antioxidants) and psychological (health motivation) factors associated with food acceptance.

CHAPTER 2: LITERATURE REVIEW

2.1 Diet and Health

According to the CDC, 7 of the top 10 causes of death are chronic diseases.[1] Heart disease is reported to be the top cause of death in the United States. Cancer and heart disease make up nearly 46% annual deaths in America when combined.[1] In 2016, the National Health Council reported a yearly cost of \$1.3 trillion on chronic disease-related health care.[8] Risk factors for chronic disease include, but are not limited to, tobacco use, alcohol abuse, physical inactivity, high blood pressure, elevated fasting blood glucose, obesity, high cholesterol and dietary

factors.[9] Modifications of diet can prevent or reduce the risk of chronic diseases such as increased consumption of fruits, vegetables, and whole grains and limited intake of added sugar, sodium, saturated fat and excessive calorie intake.[10] A diet rich in fruits and vegetables is highly composed of polyphenols and antioxidants, which is beneficial to human health.[11]

2.2 Polyphenols and Antioxidants

A diet high in fruits and vegetables may inhibit or delay the development of disease states due to the abundance of antioxidants and polyphenolic compounds. Polyphenols are secondary metabolites found in plants that serve to protect the body from chronic diseases caused by oxidative stress.[11] Polyphenols are recognized for scavenging free radicals and their role in preventing oxidative stress-related chronic diseases.[11]

Antioxidants protect cells and tissue against the continuous production of reactive oxygen species (ROS) during normal metabolism. Examples of ROS include superoxide radical anion, H_2O_2 , hydroxyl radical and singlet oxygen.[12] Excess ROS can impair bodily functions by altering or damaging biological molecules (DNA, proteins, carbohydrates) through oxidative damage.[12] Scavenging for ROS decreases when there is an imbalance between ROS and the antioxidant defense system. This imbalance can contribute to the development of diseases including cardiovascular disease, forms of cancer, rheumatoid arthritis and neurodegenerative disease. The body's defensive system mediated by ROS is characterized by inflammation and results in redness, swelling, pain, and heat, and can result in loss of function of the tissue. Chronic inflammation left untreated can increase the risk of rheumatoid arthritis, osteoarthritis, inflammatory bowel disease, type 2 diabetes, psoriasis, and atherosclerosis.[13]

2.3 Functional Foods and Beverages

Functional foods or beverages are manufactured products that provide more than basic nutrition needs.[14] Functional foods target consumers who want to either improve specific physiological functions or reduce the risk of certain diseases.[15] There is no universal definition of functional foods because the scope and regulatory framework differ amongst nations.[16] In the 1980s, the Japanese Ministry of Health and Welfare created the concept of functional foods to improve the country's overall health while decreasing healthcare costs.[16]

According to the Functional Foods Consumer Survey conducted by the IFIC, consumers have been significantly more aware of food products containing health-promoting nutrients.[2] By 2020, it has been estimated that the potential global market for functional foods and beverages will be worth \$192 billion. [16] Functional beverages are expected to receive attention from entrepreneurs in the beverage industry in 2018. [17] The experimentation of functional beverages led to the growth of developing classifications of beverages such as fermented drinks, vegetable dairy alternatives, plant waters, cold brew coffee, and new fruit and herbal flavor blends.[18] According to the 2017 Euromonitor International Global Consumer Trends Survey, consumers in the United States are looking for beverages that are valuable for the cost, great tasting, all natural, sugar-free, and do not contain artificial flavors or sweeteners.

Consumer's acceptance, beliefs, and perceptions are vital factors that can influence the functional food and beverage marketplace. Price and inferior palatability were indicated as the top 2 barriers for consumers purchasing functional foods and beverages.[2] Functional food or

beverage's with inferior palatability may affect long-term consumption and reduce its full potential to provide health benefits.[19]

The Functional Foods Consumer Survey indicated that less than half of consumers agree they have enough information to understand which foods provide added benefit.[2] The beverage industry's focus on new technology to enhance and improve taste, mouthfeel and nutritional benefits led the industry to ignore the way the beverage's advantages are communicated to consumers.[18] The addition of information presented as a health claim has shown to influence consumer's perceived value of a food product.[20] Communicating food or beverage's health benefits is an important marketing strategy because consumers cannot externally perceive the health benefit, unlike sensory characteristics.[21] Rozin and Fallon's taxonomy of motives for food rejection indicates that if food is perceived with negative sensory properties or health consequences, the food will be rejected.[22] Providing consumers with health information allows them to understand the health benefits that was unknown to them beforehand.[23] Promoting a food or beverage's health benefits differentiates the product from others and helps consumers make healthy food choices.[24]

Health claims have been shown to have a more significant effect on the acceptability of products with low sensory ratings than products with high sensory scores.[25, 26] Tuorila et al. study demonstrated the positive effects of health information on the acceptability of a juice with off-flavors. Consumers were more likely to consume the juice when they were given information about the beverage's health benefits related to exercise/energy and alertness/memory.[27] Mialon et al. findings indicated a positive effect on acceptance measures and sensory properties

for those receiving dietary fiber information before evaluating bread and English muffins.[28] A similar study confirmed health information's positive impact by assessing participants preference of bread when given information on its relationship of barley beta-glucan and a reduction in the risk of heart disease. [29] Bech-Larsen et al. suggested that health claims can provide added value, but not compensate the overall acceptability of foods with inferior taste.[30] Health information has been shown to influence food choices when a functional food contains a novel or unfamiliar ingredient.[20] Martins et al. determined factors of participants willingness to try unfamiliar foods and indicated that participants were more willing to taste unfamiliar nonanimal foods when they received nutrition plus availability information. It was suggested that food must be perceived as available outside of the lab because it makes participants feel like they are going to reencounter it.[31]

Consumer acceptability influenced by health claims is determined by the tradeoff between expected health benefits and sensory pleasure.[30] Factors that influence consumer's food choice is dependent on consumer's intentions for selecting a food product including; hedonic expectations, psychosocial variables, attitudinal or health-related motivation.[27, 32] According to the Satter eating competence model (ecSatter), food acceptance is maintained through intrinsic motivation and is supported by attitudes and food behavior.[33] Grubb et al. associate the "Self-Concept Theory" with food perception, in which he claims the stereotypical image of food is based on consumer's experiences with it.[15, 34] Food acceptance is influenced by consumer characteristics such as socio-demographic background, personal motivation, health consciousness and attitudes towards functional foods.[16, 35] Personal factors that are positively

linked to functional food consumption include high income, high education, familiarity and knowledge of functional foods, and health consciousness.[16]

According to Verbeke et al. 2006, the strongest influence on functional foods where consumers are willing to compromise taste is perceived health benefits.[16, 36] Consumer research suggests that consumers are willing to replace conventional foods with functional foods if they view it to be beneficial to their health.[37] Consumers with health-related attitudes are more likely to shift their food acceptance when given information on health benefits.[38] Nutrition and health information related to a food product may have a positive impact on the acceptability of a functional food if health intrinsically motivates the consumer. Positive health information with food can increase participant's willingness to try unfamiliar foods if the participant is interested in that aspect of health.[39] Consumer characteristics that are negatively linked to functional food consumption are those from ethnic minorities and who have neophobia.[40]

Acceptance of functional foods depends on external factors, such as functional ingredients, the communication mode of health effect, and the characteristics of the carrier product.[16, 41, 42] Increasing food acceptance by cognitive means is the conventional approach of making consumers believe nutritious food tastes good.[22] Pairing foods with a favorable condition will initiate a positive emotion with that food. In addition, the carrier of the functional ingredient has an effect on the perception of the food/beverage's total functionality. The occurring health benefits in the carriers are perceived to have more credible functional food messages than carriers that are not recognized as intrinsically healthy. Foods that are naturally enriched with vitamins and minerals are found to serve as positive carriers of the functional ingredient.[43, 44]

For an example, consumers might be more inclined to view a functional smoothie containing fruit intrinsically healthier than a functional milkshake containing ice cream. The source of information is a factor that consumers use to determine its credibility. Information coming from health professionals or dietitians are factors that support consumer's trust and confidence in the functional food.[37] The method of delivery related to the health benefits of a functional food/beverage influences its acceptability. A study indicated that nutrient *function* claims increase consumer's acceptability of a food product more than the nutrient *content* claim.[45] Vella et al. determined health claims related to disease risk reduction of heart disease, osteoporosis, and cancer were the three most influential claims of functional food. Results indicated that the biological roles in nutrient function claim that increased functional food acceptability was reduced cholesterol, maintenance of bone health and increased dietary antioxidants.[37] Vassallo et al. 2007 indicated consumers are more interested in health-promoting claims than disease prevention claims.[16, 46]

2.4 Food Choice Questionnaire

The Food Choice Questionnaire (FCQ) developed by Steptoe et al. determines the factors that influence individual's food choice.[47] The FCQ consists of 36 food items related to individual's food choices and are measured by nine subscales including health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity, and ethical concern.[47] Each factor is measured using a 4-point scale (1-not at all important, 4-very important). A systematic search on the FCQ showed its application on the measurement of consumer food motives across cultures including Britain, Finland, Japan, Taiwan, Malaysia, New Zealand, United States, Canada, Belgium, Italy, Hungary, Romania, Belgium, and the Philippines.[48, 49] The FCQ was found to

be valid and reliable in some populations and was later modified by Pula et al. for reliability in a US population.[48]

2.5 Turmeric

2.5.1 Trending Functional Ingredient

Turmeric is a trending functional ingredient added to foods and beverages.[50] The pharmaceutical uses of turmeric are currently increasing the growth of interest. Turmeric food products doubled from 2014-2016 and had a 123% growth in annual turmeric imports in the United States from 2007 to 2015.[50, 51] It has become a top 10 best-selling supplement in the US and reached \$108 million in 2012. Turmeric-based products grew 40% and reached \$30 million from May 2016 to May 2017.[52] According to the 2016 Google Food Trends, turmeric is listed as a top trending function food and had a 56% increase of “interest in turmeric.”[53]

2.5.2 History and Origin

Turmeric is a root that comes from the rhizome of the medicinal plant *Curcuma longa*. It belongs to the *Zingiberaceae* plant family and is cultivated in the tropical areas of Asia.[54] [6, 55]

Traditionally, turmeric was used as a food additive to color and flavor food during preparation such as rice pasta, meat, salads and vegetable dishes. It is a significant ingredient in curries and is commonly consumed in Malaysia, India, China, Polynesia, and Thailand. It was historically used in Ayurvedic and traditional Chinese medicine as an anti-inflammatory, and antibiotic to treat gastrointestinal disorders, skin diseases, and cancers among other medical conditions.[56-58]

Turmeric is primarily composed of curcuminoids (5%), essential oils (5%), protein, fat, carbohydrates, minerals and water moisture.[59] Today, turmeric is used as a dietary supplement

or functional ingredient to treat arthritis, inflammation, gastrointestinal disorders, cancer, skin and liver disorders.[60]

2.5.3 Health Related Activity of Turmeric

The efficacy of turmeric, usually in pill, extract, or gel form, has been demonstrated in clinical trials for many health conditions. The human studies conducted with turmeric have recently been described, and the most promising effects are observed in inflammatory conditions, diabetes, irritable bowel syndrome and other gut conditions, and multiple cancers. A wide range of doses of turmeric intake was used in these studies, ranging from 500 mg per day to 15 grams per day. Duration varied from 7 days to 3 months of supplementation. Turmeric supplementation is well tolerated with minimal toxicity.[6]

Curcuminoids are the biologically active compounds found in turmeric that make up the yellow pigment in the rhizome. Curcuminoids exist in three forms; curcumin (71.5%), demethoxycurcumin (19.4%), and bisdemethoxycurcumin (9.1%).[6] Curcumin is the most active form and is known to be the main compound to prevent or treat diseases.[6] Turmeric's derivatives can serve as antioxidants, anti-inflammatory, and anti-infectious agents, and assist with wound healing.[61] Curcumin is most commonly obtained by the crystallization of solvent extract from ground turmeric rhizomes mixed with curcuminoids.[62] Studies have indicated curcumin's ability to modulate multiple cell signaling molecules that impact pro-inflammatory cytokines, pro-inflammatory transcription factor NF- κ B, cyclooxygenase (COX)-2, apoptotic proteins, and C-reactive protein, among others predominantly by examining the direct effects on cell-based in vitro systems. A recent review of the clinical trial evidence for the therapeutic roles

of curcumin in humans described the likely impact on pro-inflammatory diseases including diabetes, diabetic nephropathy, inflammatory bowel disease, irritable bowel syndrome, and multiple forms of cancer.[5]

Although the majority of the activity of turmeric is credited to curcumin, recent research has shown that the curcumin-free portion of turmeric contains over 235 chemically diverse compounds with potent biological activities including anti-inflammatory and anti-cancer properties that act synergistically with the actions of curcumin.[5] Volatile oils are secondary metabolites with antioxidant potential that produce the aromatic flavor of turmeric. The essential oils are found in the meristematic region of the rhizome and oil cells and ducts.[63] Out of the 16 constituents in volatile oil, 6 of them make up 70%, including α -turmerone (25.3%), α -turmerone (18.3%), β -turmerone (12.5%), β -caryophyllene (2.26%), eucalyptol (1.60%) and α -phellandrene (.42%). [63]

2.5.4 Antioxidant properties

Curcumin, phenolic compounds, and α , β -unsaturated ketones are highly effective antioxidants in turmeric.[64] Turmeric's antioxidant activity plays a role against chronic pathological complications associated with oxidative damage of DNA, protein, and lipid membranes. [54, 65] Curcumin is known as a chain-breaking antioxidant at the 3' position and neutralizes free radicals by contributing in an intramolecular Diels-Alder reaction. The antioxidant mechanism of curcumin begins with curcumin radicals, which are formed by trapping free radicals at the phenolic group. Curcumin radicals form a coupling product by reacting with the peroxy radical of linoleate at the 3' position through a peroxy linkage. The

coupling product produces a Diels-Alder reaction and prevents further reactions due to its steric hindrance. The molecular structure that prevents further reactions is created by an alkyl substitution of the cis double bond on the linoleate.[66]

Guo et al. demonstrated curcumin's ability to protect against alcohol-induced damage in mice. Low doses of curcumin (19.7 mg/kg/d and 47.5 mg/kg/d) were supplemented to groups of mice who were administered ethanol (5 g/kg body weight) every day for six weeks. The mice who were treated with the curcumin doses of 19.7 mg/kg/d and 47.5 mg/kg/d had decreased levels of lipid peroxides by 33% and 40% respectively. The ethanol control group of mice displayed increased levels of lipid peroxidation induced by alcohol damage. Both doses of curcumin increased the activity of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and catalase activity (CAT). The effect of curcumin on antioxidant activity and lipid peroxidation displayed protective properties against mice with alcohol-induced damage.[67, 68]

2.5.5 Fresh Rhizomes vs. Dried Rhizomes

Research has investigated curcumin's sensitivity to high temperatures and degradation by thermal heating processes. Cousins et al. 2006 and Vankar et al. 2008. measured the antioxidant activity of fresh rhizomes with dry rhizomes to evaluate greater activity.[55, 69] Cousins et al. indicated that the methanol extracts following the drying process showed reduced free radical scavenging compared to the fresh methanol extracts.[69] Furthermore, Vankar et al. indicated that fresh varieties of *Curcuma longa* achieved more scavenging and antioxidant activities using the same methods, as well as beta-carotene bleaching.[55] The increased antioxidant activity in fresh

turmeric suggests that the non-curcuminoid derivatives from fresh turmeric play a vital role in antioxidant activity.

Human oral absorption of curcuminoids have been found to be significantly higher ($p < 0.001$) in fresh turmeric rhizomes than dry turmeric rhizomes. Results indicated a higher absorption of curcuminoids from the 100mg dose of fresh rhizome compared to dried rhizomes at equivalent concentrations. The relative absorption of curcuminoids found in 1000mg fresh rhizomes was about 46-fold higher than dried rhizome. Im et al. concluded that higher plasma curcumin levels were found in low doses (100mg) of fresh rhizome when compared to the dried rhizome.[70]

Singh et al. findings indicated a difference in antioxidant properties when comparing antioxidant levels of essential oils from fresh rhizomes versus dry rhizomes. Fresh and dry rhizomes (100g) were subjected to hydrodistillation, yielding yellow oil of 1.4% and 2.9% respectively. There were 38 identified compounds in fresh rhizome oil, representing 73.1% of total dry weight, whereas, the 38 identified compounds in dry rhizome oil represented 79.9% of the total dry weight. This can be due to the different yield percentages of the yellow oil after hydrodistillation. It was found that both alpha-turmerone (20.5%) and ethanol oleoresin (53.4%), were minor in essential oil (.6%) and oleoresin (6.5%) of the dry rhizome. It was noted that beta-turmerone (4.3%) was found to be less than half in the essential oil and oleoresin of dry rhizome than fresh rhizome (11.% in essential oil and 18.1% in the oleoresin). The essential oil and oleoresin from the fresh rhizomes resulted in more efficient scavenging properties and higher Fe^{2+} ability than dry rhizome.[71]

2.5.6 Safety and Bioavailability of Turmeric

The Food and Drug Administration has approved curcumin and turmeric as “generally regarded as safe” compound and it has been found to be tolerated in human clinical trials. Curcumin has been shown to be safe in ranges from 500-4000 mg per day with no toxicity.[72, 73] Doses up to 12g/day for 72 hours have been administered in a dose-escalation study without significant toxicity.[74] Mild adverse events have been experienced with intake including nausea, diarrhea, and headache.[72] Dose escalation trials have not been conducted on turmeric and should be considered in future studies.

The bioavailability of curcumin is a challenge when determining its medicinal use. It was found that curcumin’s undetectable serum levels can be due to its poor absorption, rapid metabolism, and rapid systemic elimination. For example, consumption of 2 grams of curcumin results in negligible serum levels. The discovery of the poor bioavailability of curcumin orally has led to efforts to modify the compound to increase the bioavailability.

Co-administration with piperine, a component of black pepper, results in a 2000% increase in curcumin bioavailability.[75] Other methods currently being used include the use of nanoparticles, phospholipid particles, liposomes, and micelles to increase absorption and slow metabolic degradation.[76-80]

The discovery that reconstituting curcumin with the non-curcuminoid components of turmeric greatly enhanced its bioavailability caused researchers to consider turmeric as a better vehicle for the administration of curcumin. The relative bioavailability of curcumin versus turmeric has

been investigated, with promising results. Curcumin fed in equivalent quantities, either as isolated curcumin or as turmeric powder showed a 20 fold increase in curcumin distribution in the intestine and an almost two fold increase in curcumin in the serum of animals fed turmeric vs. curcumin.[81] In addition to increased bioavailability of curcumin, supplementing with turmeric has the added benefit of the other bioactive constituents contained in turmeric which exhibit anti-oxidant, anti-inflammatory, hypoglycemic, anti-bacterial, and anti-cancer properties that act both independently and synergistically with curcumin.

It needs to be emphasized that while curcumin has been shown to have diverse and profound effects on multiple pathways examined in vitro as described above, the low bioavailability in vivo has prevented the establishment of a direct causal relationship between orally administered curcumin and the observed improvement in health parameters.

2.5.7 Sensory Qualities of Turmeric

Turmeric's composition of polyphenols, ketones and sesquiterpene alcohols cause its flavor to be pungent and bitter when presented in large quantities.[82, 83] Silvia et al. examined turmeric's flavor after the removal of volatile oils before dehydration using a hydrodistillation method and found no significant difference between sensory characteristics of deodorized and non-deodorized turmeric.[82] Bitterness is a food quality that differs from other taste qualities (sweet, sour, salty, etc.). This rejection of bitter taste has evolved as an adaptation to protect against potentially harmful items. [7] Many bitter tasting foods contain phytochemicals that may reduce the risk of disease.[84, 85] The rejection of bitter tasting foods have the potential to prevent individuals from consuming bitter foods containing phytochemicals. Repeated exposure to bitter

flavors does not increase the rate of liking during a short duration.[86] However, functional foods consumed long-term provide more health benefits than those consumed short-term.[27] Ho Soo et al. study of improving functional properties by formulating five different yellow layered cakes using 0%, 2%, 4%, 6% and 8% turmeric powder resulted in a decrease in overall acceptability as the quantity of turmeric increased.[83] Turmeric's pungent and bitter flavor is more evident when paired with foods containing mild or sweet flavors, but is more desirable in foods such as pickles, mustard, mayonnaise, meat, pastries, and fish fillet coatings.[82] Draganchuk et al. approach when working with undesirable flavors of functional foods are to focus prototype efforts for functional foods on avoiding the off-flavor problems from the beginning.

2.6 Preliminary Study Conducted at Virginia Tech

2.6.1 Specific Aim

To determine sensory qualities and the acceptability of a fruit-based beverage with three quantities of fresh turmeric (7g, 14g, 22g).

2.6.2 Description of Preliminary Study

The preliminary study determined the acceptability and sensory qualities of a functional beverage without fresh turmeric and with three quantities of fresh turmeric, 7 grams, 14 grams, and 22 grams. Participants evaluated the samples in individual panelist booths designed for this purpose located in the Human and Agricultural Biosciences building located on Virginia Tech campus. Each participant randomly received the turmeric containing beverages following the control beverage. A paired t-test was conducted to evaluate the significant differences between the functional beverages with and without turmeric. The acceptability was evaluated by a 9-point

hedonic scale (1=dislike extremely, 9=extremely) and the sensory qualities (appearance, smell, taste, mouthfeel, and aftertaste) were evaluated using a 3-point scale, with “just right” as the selection between two opposite sensory extremes (Ex. Too light, Just Right, Too dark). Food products that are considered acceptable are scored at the top of the scale, 6-9.[87]

2.6.3 Results

A convenience sample of 47 individuals was recruited at Virginia Tech for the sensory evaluation via email. Results indicated a significant difference between the control beverage and beverages containing turmeric (Table 1). The beverage without turmeric was considered acceptable and had an average acceptability score of 7.3. The beverages containing turmeric were not regarded as acceptable and had decreased acceptability scores as the turmeric dosage increased.

Table 1. Acceptability Scores of Functional Beverage		
Amount of Turmeric (g)	Mean Acceptability Scores (1-dislike extremely, 5-neither like nor dislike, 9-like extremely)	SD
0	7.3	1.2
7	4.9*	1.8
14	4.3*	1.7
22	3.5*	1.7

*Significantly different from control at p<0.5, Wilcox rank sum

Sensory qualities for beverage samples containing turmeric showed a significant increase in quality above the “just right” score of 2 compared to the control. The mean score for each sensory quality for the beverage samples is shown in Table 2. Participants were asked to describe the appearance, smell, taste, mouthfeel, and aftertaste for each dosage of turmeric. The most frequent words used when describing each beverage containing turmeric were “bitter,” “too intense,” “strong,” “lingering aftertaste,” and “too sharp.”

Table 2. Sensory Scores of Functional Beverage

Amount of Turmeric (g)	Appearance (1-too light 2-just right 3- too dark)	Smell (1-none 2-just right 3-too much)	Taste (1-too low 2-just right 3-too much)	Mouthfeel (1-too thin 2-just right 3-too thick)	Aftertaste (1-none 2-just right 3-too much)
0	2.1	1.9	2.0	2.1	2.1
7	2.2*	2.2*	2.4*	2.1	2.3*
14	2.3*	2.2*	2.5*	2.3*	2.5*
22	2.3*	2.3*	2.7*	2.4*	2.7*

*Significantly different from control at $p < 0.5$, Wilcox rank sum

CHAPTER 3: OBJECTIVES AND SPECIFIC AIMS

Based on the findings in the literature that demonstrate the antioxidant and anti-inflammatory properties of fresh turmeric, and the positive impact of communicating the health benefits of a food/beverage on consumer acceptance, this study proposes the following objectives and specific aims:

3.1 Primary Aims

Specific Aim 1: Determine the minimum dose of turmeric that significantly increases the antioxidant capacity and phytochemical content of a fruit-based functional beverage.

Specific Aim 1.1: Evaluate and compare the ferrous equivalents and total polyphenolic content of the control and functional beverage.

Specific Aim 1.2: Determine the minimum dosage of fresh turmeric resulting in a significant increase in polyphenolic content compared to the control beverage.

Hypothesis 1: Increased turmeric dosage of the fruit-based beverage is positively associated with greater antioxidant capacity and phytochemical content.

Specific Aim 2: Conduct a sensory evaluation test of the acceptability and sensory qualities of a fruit-based beverage with (functional beverage) and without (control beverage) turmeric.

Hypothesis 2: The control beverage will be more acceptable and have significantly different sensory scores than the functional beverage.

Specific Aim 3: Evaluate the impact of the provision of health information on acceptability and sensory score of the functional beverage

Specific Aim 3.1: Compare the acceptability of the fruit-based beverage with (functional beverage) and without turmeric (control beverage) within and between the two conditions (with and without health information)

Specific Aim 3.2: Compare the sensory scores of the control beverage and functional beverage within and between the two conditions (with and without health information)

Hypothesis 3: The provision of health information will positively affect the acceptability and sensory scores of the functional beverage.

3.2 Secondary Aims

Specific Aim 4: Investigate personal (age, gender, turmeric familiarity and interest level of antioxidants) and psychological (health motivation) factors associated with food acceptance.

Specific Aim 4.1: Compare the acceptability scores of the functional beverage across health motivation groups

Specific Aim 4.2: Compare the acceptability scores across gender, age, turmeric familiarity and antioxidant interest groups

Hypothesis 4: Acceptability scores will be significantly associated with personal and psychological factors.

CHAPTER 4: METHODS

4.1 Control and Functional Beverage

A fruit-based smoothie was pre-tested and chosen as the vehicle for the inclusion of fresh turmeric. The fruit-based beverage without turmeric was used as the “control beverage,” and the fruit-based beverage with turmeric was used as the “functional beverage.” The ingredients are flexible and can be substituted with an individual’s preferences of fruit or milk choice. A fruit-based smoothie was selected as the carrier because it is convenient, readily prepared, and is perceived as an intrinsically healthy beverage. Smoothies require minimal preparation, requiring only a blender, and are a familiar food to the U.S. population. Nutritional analysis of the functional beverage was conducted using Nutritionist Pro, available through the Human Integrative Physiology Lab in the Department of Human, Nutrition, Foods, and Exercise (See Appendix A).

4.2 Measures

4.2.1 Acceptability and Sensory Scores

Each participant received identical response sheets to record his or her responses to each beverage. Acceptability scores were measured on a 9-point hedonic scale, and sensory attributes were measured on a 5-point “Just About Right” (JAR) scale per beverage (See Appendix B and C). The hedonic scorecard prompted participants to rate their liking of the beverage from 1 to 9 liking (1-dislike extremely, 9-like extremely).[88] Sensory attributes were scored based on the

beverage's appearance, taste, smell, aftertaste, and mouthfeel using a 5-point scale (1-too little, 2-somewhat too little, 3-just right, 4-somewhat too much, 5-too much).[88] Participants received written instructions before evaluating each sample. Each participant was informed that they were tasting a fruit-based smoothie when evaluating the control. Half of the participants were informed they were tasting a fruit-based smoothie with fresh turmeric when evaluating the functional beverage. The other half of the participants were provided health information about turmeric in addition to the expectations of tasting a fruit-based smoothie with fresh turmeric (See Appendix D). Long-term health/disease prevention was used as the internal motivator for the health information because it has been shown to be a primary motivator for healthier eating.[89]

4.2.2 Personal and Psychological Factors

Psychological factors were measured using the validated food choice questionnaire developed by Steptoe et al. and adapted by Pula et al. 2014 (See Appendix E). The questionnaire consisted of 36 questions related to an individual's food choice. Each question fell into one of 8 categories including, health, mood, convenience, sensory appeal, natural content, price, environmental protection, and familiarity. Each category contained 3-5 questions and were measured using a 4-point scale (1-not at all important, 4-very important). Respondents groups were then divided into three health and sensory food motive groups (weak, moderate and strong) using the 33rd and 66th percentile points as cut-off points for further characterization.

Personal factors including gender and age were gathered from participants through a demographics questionnaire. Additional questions evaluated participant's interest in antioxidants (1-none, 2-slight, 3-moderate, 4-high) and their familiarity with turmeric (yes/no). (See Appendix F).

4.3 Procedures

4.3.1 Antioxidant Capacity and Phytochemical Content

The antioxidant capacity analysis was conducted by Rafat Siddiqui at the Agricultural Research Station, located at Virginia State University. The Ferric Reducing Antioxidant Power (FRAP) assay as described by Benzie and Strain et al. (1996) and Folin Ciocalteu method described by Makkar et al. (1993) were used for analyses. Ferrous and total phenolic contents of the control and each functional beverage (7g, 14g, 22g) were analyzed in triplicate [90, 91]. The lowest dose of fresh turmeric resulting in a significant increase in ferrous and polyphenolic content from the control beverage was selected to be evaluated.

4.3.2 Sensory Evaluation Test

The sensory evaluation test was conducted over a two-day period at the Human and Agricultural Biosciences 1 building on the Virginia Tech campus. The sensory evaluation room contained ten individual panelist booths designed for this purpose. Participants were recruited via email distributed through the Agriculture and Life Science College listserv. Further recruitment was completed through Facebook postings distributed on the Human, Nutrition, Foods, and Exercise page. Participants showed up between the times of 9:00am-4:00pm without pre-registration. The total time for participating in the sensory evaluation was ten minutes. Participants were compensated with snacks after completion.

The order of distributing the samples to each participant was planned prior to the test to compensate Helson's theory of adaption level.[92] (See Appendix F). Participants evaluated a total of two samples (control and functional beverage) with table water crackers given in between for a pallet cleanser. Each beverage was given to the participant one at a time.

Participants with the “no health information” condition received the control and functional beverage without the provision of health information about the beverage. Participants with the “health information” condition received health information before evaluating the functional beverage. The following directions were given to participants in the “no health information” and “health information” condition before each sample.

For the **control** group, the instructions for each sample read as follows:

Control beverage

“You will be tasting a **fruit smoothie**. Please rank your liking of this beverage.”

(Evaluation of sample 1)

Functional beverage

“You will be tasting a **fruit smoothie with fresh turmeric**. Please rate your liking of this beverage.”

(Evaluation of sample 2)

For the **treatment** group, the instructions for each sample read as follows:

Control beverage

“You will be tasting a **fruit smoothie**. Please rank your liking of this beverage.”

(Evaluation of sample 1)

Functional beverage

“You will be tasting a fruit smoothie with fresh turmeric. Fresh turmeric is a root that adds a significant amount of antioxidants into the beverage. Antioxidants reduce the risk of certain diseases, such as heart disease and multiple forms of cancer, by protecting the body from damage caused by harmful molecules.”

(Evaluation of sample 2)

The study was exempted from the Virginia Tech IRB review and was reviewed by the Western-Copernicue Group (WIRB), a commercial IRB.

4.4 Statistical Analyses

IBM SPSS was the statistical program used for all data analyses.

4.4.1 Antioxidant Capacity and Phytochemical Content

A sample means test of the ferrous equivalents and total polyphenolic content of the control beverage and the functional beverage with three doses of turmeric (7g, 14g, 22g) was analyzed in triplicate. ANOVA test was conducted to compare ferrous equivalents and total polyphenolic content of the control beverage and each functional beverage containing 7g, 14g, and 22g of turmeric. Post hoc comparison to evaluate pairwise difference among group means of ferrous equivalents and total polyphenolic content were conducted with the use of Tukey HSD test.

4.4.2 Sensory Evaluation

Demographic characteristics of the control and treatment group were compared through descriptive statistics. A two-way mixed ANOVA was conducted to compare the acceptability scores of the control and functional beverage between participants with and without health

information. Related-Samples Wilcoxon Signed Rank Test was conducted to compare the acceptability scores between the control and functional beverage for each condition.

4.4.3 Healthy and Sensory Food Choice Construct

The health and sensory food choice constructs were conducted by Exploratory Factor analysis using principle components and orthogonal rotation (Varimax) The Kaiser-Meyer-Olkin measure was used to verify that the sample size was adequate for the analysis. Bartlett's test of sphericity was used to examine the inter-correlations between variables. Items that had factor loadings of less than .4 and items that loaded across factors $\leq .4$ were removed.

4.4.4 Food Motives and Personal Characteristics

Health and sensory food motives were measured in the questionnaire by adding up the scores falling into each category and dividing it by the number of questions. This results in the mean importance scores of health and sensory food motives and was used to compare differences between participants with and without health information.

Kruskal-Wallis Test was conducted to analyze the impact of personal and psychological characteristics on acceptability scores. Pearson's chi square was conducted for analysis of the associations between health food motive groups and demographic characteristics.

CHAPTER 5: RESULTS

5.1 Primary Aims

5.1.1 Antioxidant Capacity and Polyphenol Content

Ferrous equivalents and total polyphenolic content of the functional beverage were analyzed in triplicate (See Appendix A). A one-way analysis of variance was conducted to evaluate the difference in ferrous equivalents and polyphenol content on the different levels of fresh turmeric. The assumption of homogeneity of variances was found tenable for ferrous equivalents and total polyphenolic contents using Levene's Test; $F(3,8)=1.115$, $p=.398$, $F(3,8)=1.431$, $p=.403$, $F(3,8)=.806$, $p=.525$. Table 3 displays the mean ferrous equivalents and ascorbic acid equivalents of the control beverage and functional beverage containing 7g, 14g, and 22g turmeric. Table 4 shows the mean total polyphenolic content of the control beverage and functional beverage containing 7g, 14g, and 22g turmeric. The functional beverage resulted in a significant difference in ferrous ($F(3,8)=345.778$, $p<.001$) and total polyphenolic content ($F(3,8)=126.986$, $p<.001$) compared to the control beverage.

Table 3. Ferrous equivalents of functional beverage with 0g, 7g, 14g, and 22g of turmeric

		N	Mean
Ferrous Equivalents (mM Fe²⁺/g weight)	0 grams	3	.10 (SD=.05)
	7 grams	3	1.33 (SD=.03)
	14 grams	3	1.94 (SD=.03)
	22 grams	3	2.56 (SD=.03)

Table 4. Total polyphenolic content of functional beverage with 0g, 7g, 14g, and 22g of turmeric

Total Polyphenolic Contents (ug/mL)		N	Mean
	0 grams	3	.05 (SD=.00)
	7 grams	3	.07 (SD=.00)
	14 grams	3	.10 (SD=.00)
	22 grams	3	.14 (SD=.00)

Post hoc test revealed significant pairwise differences between the mean scores of ferrous equivalents (Table 5) and total polyphenolic content (Table 6) in the control and functional beverage containing fresh turmeric. The polyphenolic content of the functional beverage containing 7g did not significantly differ from the control beverage (0g), $p=0.202$. There was a significant difference ($p<0.05$) in the total polyphenolic content of the functional beverage containing 7g of turmeric and the functional beverage containing 14g and 22g of turmeric. The functional beverage with 14g of turmeric was used for the sensory test because it provided the minimum dose of turmeric that significantly increased the antioxidant capacity compared to the control beverage.

Table 5. Ferrous equivalents of control and functional beverage with 7g, 14g, and 22g of turmeric

Dependent Variable	(I) Grams of fresh turmeric	(J) Grams of fresh turmeric	Mean difference (I-J)	p-value
Ferrous Equivalents (mM Fe²⁺/g weight)	0 grams	7 grams	-.334*	p=0.001
		14 grams	-.920*	p < 0.0001
		22 grams	-1.560*	p < 0.0001

*Significantly differs from the control beverage (0g turmeric)
Post hoc comparison

Table 6. Total polyphenolic content of control and functional beverage with 7g, 14g, and 22g of turmeric

Dependent Variable	(I) Grams of fresh turmeric	(J) Grams of fresh turmeric	Mean difference (I-J)	p-value
Total Polyphenolic Contents (ug/mL)	0 grams	7 grams	-.011	p=0.202
		14 grams	-.049*	p < .0001
		22 grams	-.084*	p < .0001

*Significantly differs from the control beverage (0g turmeric)
Post hoc comparison

5.1.2 Sensory Evaluation Test

5.1.2.1 Participants

Table 7. Demographics of participants					
		No Health Information		Health Information	
		N	Percentage (%)	N	Percentage (%)
Gender	Male	9	30.0	11	37.9
	Female	21	70.0	18	62.1
Hispanic, Latino, or of Spanish Origin	Yes	1	3.3	3	10.3
	No	29	96.7	26	89.7
Race	American Indian or Alaskan Native	1	3.3	2	6.9
	Black or African American	0	0	1	3.4
	White	22	73.3	19	65.5
	Asian	7	23.3	5	17.2
	Other race	0	0	2	6.9
Virginia Tech Affiliation	Undergraduate Student	12	40.0	13	44.8
	Graduate Student (Masters/Ph.D.)	7	23.3	7	24.1
	Faculty/Staff	11	36.7	6	20.7
	Community Member	0	0	3	10.3
Age	15-29	17	56.7	19	65.5
	30-50	10	33.3	6	20.7
	>50	3	10.0	3	10.3

The study recruited a total of 61 participants, of which 31 received the “health information” condition and 30 received the “no health information” condition. The total participants included 20 men and 39 females, ranged in age from 18 to 63 years (men: $M=30.1$, $SD=14.2$; women: $M=28.9$, $SD=12.1$). Participants were undergraduate students (40.3%), faculty and staff (27.4%), graduate students (22.6%), and Blacksburg community members (4.85%). The majority of participants were Caucasian (66.1%), with a small proportion Asian (19.4%), American Indian or Alaskan Native (4.8%), African American (1.6%), and “other race” (3.2%). One participant

indicated themselves as Hispanic, Latino, or of Spanish origin (3.3%). Three participant’s data were excluded from the descriptive analysis due to incompleteness of the demographics questionnaire. Table 7 indicated no significant demographic differences between participant’s in the “health information” and “no health information” condition ($p>.05$).

5.1.2.2 Acceptability and Sensory Scores of Control and Functional Beverage

Acceptability and sensory scores for the control and functional beverage regardless of the condition are shown in Tables 8 and 9. The mean acceptability scores indicated that the control (M=6.98, SD=1.36) and functional beverage (M=6.82, SD=1.51) were considered acceptable (≥ 6). A Mann-Whitney test indicated that the acceptability score of the functional beverage was not significantly different from the control beverage ($U=507.00, p=.539$).

Table 8. Acceptability scores of the control and functional beverage		
	Mean Acceptability Score (1-dislike extremely, 5-neither like nor dislike, 9-like extremely)	N
Control Beverage	6.984 (SD=1.360)	61
Functional Beverage	6.820 (SD=1.511)	61

Mann-Whitney U Test

Wilcoxon Signed-Ranks Test was used to evaluate sensory scores for each beverage. The score of 3 was considered “just right” and any deviation above or below this value would be considered losing quality of the characteristic. The appearance of the control beverage was ranked significantly lower than the score of 3 ($Z=29.00, p=.002$). The functional beverage’s taste and aftertaste was significantly deviated from 3 for its taste ($Z=280.50, p<.001$) and aftertaste ($Z=358.50, p=.025$).

Table 9. Sensory scores of the control and functional beverage

	Mean Sensory Scores				
	Appearance (1-too light 3-just right 5- too dark)	Smell (1-none 3-just right 5-too much)	Taste (1-too low 3-just right 5-too much)	Mouthfeel (1-too thin 3-just right 5-too thick)	Aftertaste (1-none 3-just right 5-too much)
Control Beverage	2.535* (SD=.941)	2.931 (SD=.876)	2.914 (SD=1.064)	3.293 (SD=1.020)	3.138 (SD=1.017)
Functional Beverage	3.217 (SD=.846)	3.100 (SD=.817)	3.500* (SD=.814)	3.133 (SD=.812)	3.367* (SD=1.119)

*Significantly different ($p < .05$) in the deviation from 3 (“just right”) Wilcoxon Signed Rank Test

5.1.2.3 Provision of Health Information

5.1.2.3.1 Acceptability Scores

Table 10 compares the mean acceptability scores of the control and functional beverage from participants who received health information. Results indicated no significant difference in the acceptability scores between the control and functional beverage. Although not significantly different, the functional beverage was considered more acceptable ($M=7.387$, $SD=.844$) than the control beverage ($M=7.161$, $SD=1.393$).

Table 10. Acceptability scores of control and functional beverage from participants with health information

	Mean Acceptability Score (1-dislike extremely, 5-neither like nor dislike, 9-like extremely)			
	Control Beverage (N=31)	Functional Beverage (N=31)	Mean Difference	P-value
Health Information	7.161 (SD=1.393)	7.387 (SD=.844)	.226 (SD=1.871)	p=0.441

Wilcoxon Signed Rank Test

Table 11 compares the acceptability scores between the control and functional beverage from participants who did not receive health information. There was not a significant difference in the acceptability score between the control and functional beverage. Although not significantly

different, participant's mean acceptability score of the control beverage (M=6.800, SD=1.324) was higher than the functional beverage (M=6.233, SD=1.813).

Table 11. Acceptability scores of control and functional beverage from participants with no health information

	Mean Acceptability Score (1-dislike extremely, 5-neither like nor dislike, 9-like extremely)			
	Control Beverage (N=30)	Functional Beverage (N=30)	Mean Difference	P-value
No Health Information	6.800 (SD=1.324)	6.233 (SD=1.813)	.567 (SD=2.079)	p=0.140

Wilcoxon Signed Rank Test

The acceptability scores of the control and functional beverage between participants with and without health information is shown in Table 12. There was a significant interaction between beverage and the provision of health information, $F(1,59)=5.92$, $p<.05$. The group of participants who received health information considered the functional beverage significantly more acceptable than the group of participants who did not receive health information $F(1,59)=5.53$, $p<.05$ (Figure 1).

Table 12. Acceptability scores of the control and functional beverage between participants with and without health information

	Mean Acceptability Scores (1-9)		
	No Health Information	Health Information	p-value
Control Beverage	6.800 (SD=1.694)	7.161 (SD=1.285)	.251
Functional Beverage	6.233 (SD=1.964)	7.387(SD=1.548)	.035*

*=significant difference ($p<.05$) between the group with and without health information

Two-Way Mixed ANOVA

5.1.2.3.2 Sensory Scores

Sensory scores of the control and functional beverage were evaluated from participants who received health information (Table 13). The appearance of the functional beverage was ranked

significantly higher than 3 and was not considered “just right” ($Z=46.5$, $p=.046$). The taste and aftertaste of the functional beverage were not considered “just right” and were ranked significantly higher than “3” for its taste ($Z=55.0$, $p=.004$) and aftertaste ($Z=104.50$, $p=.009$).

Table 13. Sensory scores of the control and functional beverage from participants who received health information

		Mean Sensory Scores (1-5)	
		Control Beverage	Functional Beverage
Health Information	Appearance	2.667 (SD=.644)	3.33* (SD=.802)
	Smell	2.867 (SD=.730)	3.011 (SD=.718)
	Taste	3.233 (SD=.898)	3.433* (SD=.679)
	Mouthfeel	3.000 (SD=1.050)	2.967 (SD=.718)
	Aftertaste	3.133 (SD=1.224)	3.567* (SD=1.006)

*Significant difference ($p<.05$) in the deviation from 3 (“just right”) Wilcoxon Signed Rank Test

The sensory scores of the control and functional beverage from participants who received no health information are shown in Table 14. Participant’s ranked the control beverage’s appearance significantly below “just right” ($Z=8.00$, $p=.011$) and mouthfeel significantly above “just right” ($Z=69.00$, $p=.015$) The taste of the functional beverage was ranked significantly above 3 and was not considered “just right” ($Z=94.00$, $p=.007$).

Table 14. Sensory scores of control and functional beverage from participants who did not receive health information

		Mean Sensory Scores (1-5)	
		Control Beverage (N=27)	Functional Beverage (N=27)
No Health Information	Appearance	2.370* (SD=1.043)	3.111 (SD=.934)
	Smell	3.000 (SD=1.038)	3.148 (SD=.949)
	Taste	2.556 (SD=1.155)	3.519* (SD=.935)
	Mouthfeel	3.556* (SD=.973)	3.296 (SD=.912)
	Aftertaste	3.074 (SD=.675)	3.111 (SD=1.251)

*Significant difference ($p<.05$) in the deviation from 3 (“just right”) Wilcoxon Signed Rank Test

5.2 Secondary Aims

5.2.1 Personal and Psychological Factors

To determine if health information influenced the acceptability score from consumers with health-related attitudes, the mean scores of food motives from participants with and without health information are shown in Table 15. Health was scored as the most important food motive from participants with the “no health information” condition (M=3.48, SD=.478) and “health information” condition (M=3.29, SD=.641). Participants who received the health information scored the sensory food motive significantly higher (M=3.10, SD=.512) than participants without the health information (M=2.73, SD=.514), U=644.50, p=.001.

Table 15. Food motives of participants with and without health information		
	Mean Scores (1-not at all important, 2-a little important, 3-moderately important, 4- very important)	
Food Motive	No Health Information	Health Information
Health	3.48 (SD=.478)	3.29 (SD=.641)
Price	3.12 (SD=.571)	3.07 (SD=.875)
Sensory	2.73 (SD=.514)	3.19* (SD=.512)
Convenience	2.70 (SD= .809)	2.83 (SD=.743)
Familiarity	2.633 (SD=.775)	2.67 (SD=.673)
Natural Content	2.50 (SD=.918)	2.33 (SD=.928)
Mood	2.40 (SD= .872)	2.50 (SD=.698)
Environment	2.39 (SD=1.20)	2.16 (SD=.836)

* Significant difference (p<.05) between conditions
Mann-Whitney U Test

5.2.1.1 Health and Sensory Food Motive Constructs

Four of the questions related to health food motives and three of the questions related to sensory food motives are loaded together on one factor as presented in Table 16. The Kaiser-Meyer-Olkin measure of sampling adequacy for the health and sensory food motive questions were .635 and .568. Bartlett’s test of sphericity was significant (p<.001) for both motives verifying that the

sample was appropriate for factor analysis. Cronbach’s alpha for the health food motive questions was acceptable (.788) but was poor for the sensory food motive questions (.552).

Table 16. Mean scores and factor loadings of health and sensory food motive groups

Health Food Motive		
It is important that the food I eat....	Mean	Factor loadings
It is nutritious	3.58 (SD=.623)	.845
It keeps me healthy	3.56 (SD=.623)	.827
It provides enough energy	3.36 (SD=.638)	.639
It contains a lot of vitamins and minerals	3.07 (SD=.962)	.557
Sensory Food Motive		
It is important that the food I eat....	Mean	Factor loadings
It smells nice	2.66 (SD=1.03)	.754
It looks nice	2.56 (SD=.896)	.622
It has a pleasant texture	2.95 (SD=.879)	.587

Respondent groups were then divided into three health and sensory food motive groups (weak, moderate and strong) using the 33rd and 66th percentile points as cut-off points for further characterization (Table 17).

Table 17. Mean health and sensory motive scores within categories for health information and no health information groups

	Health Food Motive				Sensory Food Motive			
	Health Information		No Health Information		Health Information		No Health Information	
	Mean (SD)	N	Mean	N	Mean (SD)	N	Mean (SD)	N
Weak motivation	2.65 (SD=.626)	10	2.813 (SD=.222)	8	2.19 (SD=.163)	7	1.70 (SD=.292)	15
Moderate motivation	3.31 (SD=.116)	8	3.44 (SD=.116)	8	2.89 (SD=.167)	9	2.43 (SD=.163)	13
Strong motivation	3.86 (SD=.131)	11	3.89 (SD=.128)	14	3.56 (SD=.250)	13	3.05 (SD=.125)	2

Total	3.29 (SD=.641)	29	3.48 (SD=.478)	30	3.00 (SD=.630)	29	2.46 (SD=.628)	30
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5.2.1.1.1 Acceptability Scores

The acceptability scores of the functional and control beverage were evaluated across the health and sensory food motive groups and are shown in Table 18. Participants with “moderate” health food motives scored the acceptability of the functional beverage significantly lower (M=4.33, SD=1.89) than participants with “strong” health food motives (M=7.00, SD=1.30), (H=6.50, p=.039). There were no other significant differences between the sensory food motive groups.

Table 18. Comparison of acceptability scores of the control and functional beverage between health and sensory food motive groups for participants with and without health information

Health Importance	“No Information” Condition			“Information” Condition		
	Control Beverage	Functional Beverage	N	Control Beverage	Functional Beverage	N
Weak	6.00	6.25	8	7.00	7.30	10
moderate	6.75	4.88*	8	7.75	7.75	8
strong	7.29	7.00	14	7.09	7.46	11
Sensory Importance	Control Beverage	Functional Beverage	N	Control Beverage	Functional Beverage	N
weak	7.00	6.00	6	7.40	7.90	10
moderate	7.14	6.71	7	6.83	7.33	6
strong	6.85	6.23	13	7.31	7.23	13

*Significantly different (p<.05) across the health food motive groups
Kruskal-Wallis Test

5.2.1.2 Age and Gender

5.2.1.2.1 Acceptability Scores

The acceptability scores of the control and functional beverage were compared between participants age group and gender for participants with and without health information (Table 19). The acceptability scores of the functional and control beverage were not significantly associated with participant’s gender and age.

Table 19. Comparison of acceptability scores of the control and functional beverage between age and gender for participants with and without health information

		Mean Acceptability Scores			
		No Health Information		Health Information	
		Control Beverage	Functional Beverage	Control Beverage	Functional Beverage
Gender	Male	6.11 (SD=1.45)	5.67 (SD=2.06)	7.00 (SD=1.20)	7.45 (SD=.82)
	Female	7.2 (SD=1.18)	6.48 (SD=1.69)	7.39 (SD=1.42)	7.50 (SD=.786)
Age	18-29	6.53 (SD=1.46)	6.41 (SD=1.73)	7.37 (SD=1.11)	7.47 (SD=.772)
	30-50	7.00 (SD=1.15)	5.600 (SD=2.01)	7.00 (SD=2.20)	7.50 (SD=.837)
	>50	7.67 (SD=.58)	7.33 (SD=1.15)	7.00 (SD=1.00)	7.67 (SD=1.15)

Kruskal-Wallis test

5.2.1.2.2 Healthy Food Choice Motives

Analysis of the associations between health food motive groups and demographic characteristics were carried out using Pearson's chi square (Table 20). Health food motive groups were not significantly associated with gender ($X^2(2)=3.761$, $p=.152$), or age ($X^2(2)=.816$, $p=.665$).

Table 20. Number of participants across health food motive groups classified by age and gender

		Health Food Motive Group	N
Gender	Male	Weak	9
		Moderate	3
		Strong	8
	Female	Weak	9
		Moderate	13
		Strong	17
Age	18-29	Weak	14
		Moderate	11
		Strong	14
	30-50	Weak	2
		Moderate	4
		Strong	8

	>50	Weak	2
		Moderate	1
		Strong	3

Pearson's chi square

5.2.1.3 Turmeric Familiarity and Interest Level of Antioxidants

The relationship between acceptability scores and participant's interest level of antioxidants were evaluated in each condition to determine if acceptability scores were higher from consumers interested in that health aspect. Participants who scored their interest in antioxidants as "high" ranked the functional beverage significantly higher than participants with no interest in antioxidants ($H=27.52, p=.039$).

Table 21. Acceptability scores from participant's interest level of antioxidants

Interest level of antioxidants	Control Beverage	Functional Beverage
None	5.33 (SD=1.53)	4.33 (SD=1.53)
Slight	7.11 (SD=.93)	6.33 (SD=2.12)
Moderate	7.00 (SD=1.22)	7.00 (SD=1.15)
High	7.23 (SD=1.45)	7.23 (SD=1.34)*

*Significantly different ($p<.05$) from 1, "none"
Kruskal-Wallis Test

Most participants were familiar with turmeric (50 out of 59). Participant's familiarity of turmeric did not significantly affect the mean acceptability scores of the functional beverage, although participants who were familiar with turmeric had a higher acceptability score of the functional beverage ($M=6.92, SD=1.47$) than participants who were unfamiliar with turmeric ($M=6.44, SD=1.88$).

Table 22. Acceptability scores from participant's familiarity of turmeric

Turmeric Familiarity	Control Beverage	Functional Beverage
----------------------	------------------	---------------------

Unfamiliar (N=9)	6.89 (SD=1.17)	6.44 (SD=1.88)
Familiar (N=50)	7.04 (SD=1.35)	6.92 (SD=1.47)

*Significant difference ($p < .05$) in familiarity
Kruskal Wallis Test

CHAPTER 6: DISCUSSION

The minimum dose of turmeric that resulted in a significant change in antioxidant capacity and total polyphenolic content of a fruit-based beverage without turmeric (control beverage) was determined. The fruit-based beverage with 7g, 14g, and 22g yielded significant increases in ferrous equivalents compared to the control at each dose of turmeric. However, comparison between the control and functional beverages for total polyphenolic content yielded a significant difference starting at 14 grams of fresh turmeric. The functional beverage with 14g of turmeric was chosen for the sensory evaluation test because it contained the minimum dose of turmeric that significantly increased the total polyphenolic content. Polyphenols are recognized for their antioxidant properties and potential role in prevention of diseases associated with oxidative stress, such as cancer, cardiovascular disease, and neurodegenerative disease.[93]

Overall, the sensory evaluation test resulted in no significant differences in acceptability scores between the control and functional beverage when we looked at the results of the combined cohort. However, turmeric's pungent properties negatively affected the taste and aftertaste of the functional beverage and was perceived as "too much." In contrast, the functional beverage's yellow color attributed to the presence of the 3 curcuminoids (curcumin, demethoxycurcumin, and bisdemethoxycurcumin) was more preferred than the color of the control beverage.[94] The acceptability scores between the control and functional beverage differed from what was

indicated in the preliminary study. Results from the preliminary study indicated that the functional beverage at each dose of turmeric (7g, 14g and 22g) was considered significantly less acceptable than the control beverage, whereas, results from the present study indicated no significant differences in acceptability scores between the control and functional beverage. The context and expectations differed between the preliminary and present sensory evaluation test, which can affect hedonic judgements.[88] Participants from the preliminary study had expectations to evaluate a fruit smoothie, but did not know the samples contained different doses of turmeric. However, in the present study, all participants were aware that they were testing one beverage that contained turmeric, and half of the participants were given context related to the functional beverage's health benefits in addition to the expectations of tasting turmeric in the fruit-based beverage.

The preliminary study and a study conducted by Ho Soo et al. served as a motivation to develop an innovative functional beverage with turmeric that would be considered acceptable by consumers and produce physiological benefits.[83] Our method followed Draganchuk's et al. approach for dealing with off-flavors in functional foods by focusing on the benefits from the very beginning.[95] The acceptability scores was compared between the control beverage and the functional beverage with the provision of health information. Although there was not a significant difference in the acceptability scores between the functional and control beverage, the mean acceptability score was higher for the functional beverage. This supports Bech-Larsen et al. study that proposed health information cannot compensate overall acceptability, but provide added value to the product.[30]

Food acceptance is influenced by consumer characteristics such as socio-demographic characteristics, psychological factors, cultural and social factors, and factors related to the functional food product.[16, 35] Multiple studies indicated that the effect of health information on acceptability scores varies from consumers and is dependent on their background and attitudes.[28, 38, 96] The mean scores of each food motive from the Food Choice Questionnaire were used to measure the factors that influence food choices between participants with and without health information. Participants with and without health information ranked the health food motive first in their decision making about what foods to choose, followed by price and sensory qualities. This supported the 2017 Food and Health survey indicating taste, price, and healthfulness as the top drivers for food purchases.[89]

Nutrition and health information related to a food product can positively impact the acceptability of a functional food if health intrinsically motivates the consumer. The tradeoff between expected health benefits and sensory pleasure determines consumer acceptance influenced by health claims. Our findings indicated that participants who received health information considered the functional beverage significantly more acceptable than participants who did not receive health information. It is expected that consumers with health-related attitudes are more likely to shift their food acceptance when given information on health benefits.[38] The “weak” health food motive group scored the functional beverage lower than the “moderate” and “strong” health food motive group when given health information. The group with “strong” and “moderate” sensory food motives considered the beverage less acceptable than the “moderate” and “strong” health food motive group when given health information. This confirms that

consumers who are more health motivated are mostly likely going to consider the functional beverage more acceptable than consumers who are less health motivated.

Results from the present study replicated the findings of multiple studies of increased acceptability of functional foods influenced by health information.[19, 27, 28]. This supports the studies that suggested health claims have a greater effect on the acceptability of products with low sensory ratings than products with high sensory scores.[25, 26]

The provision of health information significantly affected the sensory scores between the control and functional beverage from each condition. According to the 2017 Food and Health Survey, 84% of consumers say taste is a top (4-5 of 5) driver of food purchases.[89] Participants who did not receive health information considered the taste to be the only sensory attribute of the functional beverage that was not right. However, participants who received health information did not consider the functional beverage's appearance, taste and aftertaste to be acceptable. These findings suggest that the health information did not positively affect the sensory properties of the functional beverage. Consumers who are motivated by sensory as their factor for food choices are less willing to sacrifice taste over a perceived health benefit than consumers who are motivated by health factors.[19, 36] The group who received health information had more participants with "strong" sensory food motives (N=13) in comparison to the group who did not receive health information (N=2).

Results from the present study indicated that the mean acceptability scores of the functional beverage from the "moderate" health motive group were significantly lower than the "weak" health food motive group within the "no health information" condition. Four out of the five

participants (80%) who were not familiar with turmeric were classified in the “moderate” health food motive group, which may have impacted the acceptability scores. Participants who were familiar with turmeric had a higher acceptability score of the functional beverage than participants who were unfamiliar with turmeric. These results supported the findings from Luckow et al. 2006 study, suggesting consumer’s familiarity of a functional food affects consumer attitudes, therefore influencing acceptability.[97]

With respect to age and gender, our findings demonstrated no significant associations with acceptability scores of the functional beverage. Evidence in the literature varied in the case of gender and age. Studies have reported female consumers as the most likely users of functional foods and are more influenced by health when making food choices than men.[36, 47, 98] However, Ares et al. suggested that males and females have different perceptions of healthiness and that different products might be more appealing to one gender compared to the other. [99] Some studies indicated that young consumers tend to use functional foods more, whereas, other studies reported that older consumers are more likely to consumer foods with a perceived health benefit.[38, 100]

Evidence from the literature have shown that health information related to a functional food can increase consumer’s attitudes or behaviors towards the food if the consumer is interested in that aspect of health.[39] Our findings revealed that participants who had a “high” interest level of antioxidants scored the functional beverage significantly higher than participants who did not have any interest in antioxidants. Our data demonstrated a trend between participant’s interest

level of antioxidants and acceptability scores of the functional beverage. The acceptability scores of the functional beverage increased as the participant's interest level of antioxidant increased.

Overall, a functional beverage with 14 grams of turmeric resulted in a significant increase in antioxidant capacity and polyphenolic content and was considered significantly more acceptable with the provision of health information. The acceptability scores of the functional beverage were scored higher from participants who were health motivated and were familiar with turmeric. Participants with a strong interest in antioxidants considered the functional beverage significantly more acceptable than participants who had no interest in antioxidants. Other personal factors (age, gender, turmeric familiarity) were not significantly associated with the acceptability scores of the functional beverage.

6.1 Limitations

The insignificant findings of the relationships between the mean acceptability scores and personal factors (age, gender, turmeric familiarity) may be due to the relatively small sample size. The study was conducted on the Thursday and Friday before Easter Sunday, which may have impacted participation.

Limitations from the sensory evaluation procedures could have affected the acceptability and sensory scores. Although half of the participants received the functional beverage first and the other half of participants received the control beverage first, a sensory test that measures the acceptability of a food product independently may have different scores than a sensory test when other foods are presented. The evaluation of two or more products in the same tasting session can

cause context effect and shift the sensory judgment of a product when the stimulus in a food product is stronger than the other. Consumers are prone to compare products rather than independently evaluate them when presented simultaneously. Consumers relate familiar product experiences when trying new products. When a frame of reference is given in a sensory evaluation test, it is perceived as the average level of stimulation. The Helson's theory of adaption level proposed that the frame of references is the most recent product tested in a sensory test.[92]

6.2 Future Research

It is noted that long-term consumption provides greater health benefits than short-term consumption, which is dependent on food behavior. Findings from multiple studies indicate that food choice practices, such as purchase intentions or likelihood of consumption, are stronger measurements than acceptability scores when evaluating the effect of health information.[27, 101] Further research on actual consumer usage of functional foods within the context of health information is needed to clarify the factors influencing their long-term choices. In addition, research studies can evaluate differing levels of fresh turmeric to maximize antioxidant and polyphenolic content that is considered acceptable with the provision of health information. Different beverage formulations should be developed that increases acceptability and sensory scores.

CHAPTER 7: CONCLUSIONS

The development of a functional beverage with 14 grams of turmeric was considered acceptable with the provision of health information and resulted in a significant increase in antioxidant

capacity and polyphenolic content. Participant's interest level in antioxidants was significantly associated the acceptability scores of the functional beverage. The functional beverage was considered more acceptable from participants who were health motivated and familiar with turmeric. Other personal factors (age and gender) were not significantly associated with the acceptability scores of the functional beverage.

Turmeric is trending ingredient that is used in functional foods to provide additional benefits such as antioxidants and anti-inflammatory agents. The rise of functional food and beverages has increased consumer's awareness of foods and beverages with health-promoting nutrients in the United States. The beverage industry is meeting consumer's demand for healthier products by using a whole food approach to improve overall health. Entrepreneurs are faced with the challenge of creating a beverage that not only provides sufficient health benefits but contains positive palatability. This challenge is caused by nutraceuticals that impart unfamiliar or bitter flavors to functional foods high in antioxidants. Understanding how to increase the acceptance of a functional beverage will benefit the beverage industry as consumers are becoming more interested in learning more about foods and beverages that provide additional health benefits beyond basic nutrition.

Increasing the acceptability of a functional beverage can influence consumer's purchase intention and increase frequency consumption. The high correlations between informed liking and likelihood of consumption suggests that hedonic scores can be a predictor of consumption frequency.[27] Long term consumption of functional beverages is a whole food approach to control and maintain long term health. Further research on actual consumer usage of functional

foods within the context of health information is needed to clarify the factors influencing their long-term choices.

APPENDIX A Additional Tables

Table 1. Nutritional Analysis of Fruit Based Beverage	
Ingredient	Amount
Pineapple, frozen	2 oz
Mango, frozen	2 oz
Banana	2 oz
Apple cider vinegar	1 tbsp
Almond milk	¼ cup
Nutrient Content	
Total calories	132 kcal
Carbohydrates	30 g
Protein	2 g
Fat	4 g
Dietary Fiber	4 g
Natural Sugars	17 g

Table 2. Measurement of Ferrous Equivalents					
Samples	Ferrous equivalents				
	1	2	3	Mean	SD
Sample0-1	1.035185	1.144444	1.116667	1.098765	0.023017
Sample0-2	0.97549	0.948674	0.968281	0.964148	0.010336
Sample0-3	0.887972	0.927806	0.973632	0.929804	0.0259
Sample7-1	1.24693	1.316228	1.330263	1.297807	0.016277
Sample7-2	1.308707	1.328496	1.312665	1.316623	0.008239
Sample7-3	1.317449	1.435584	1.387292	1.380109	0.03017
Sample14-1	1.924593	2.030566	2.05903	2.004729	0.027161
Sample14-2	1.826878	1.960321	1.930798	1.905999	0.027195
Sample14-3	1.850945	1.917096	1.936426	1.901489	0.017502
Sample22-1	2.51348	2.651646	2.550067	2.571731	0.053501
Sample22-1	2.425417	2.5025	2.552917	2.493611	0.031984
Sample22-3	2.465016	2.604503	2.739056	2.602859	0.078163

Table 3. Measurement of Total Polyphenolic Compounds

Sample	1	2	3	1	2	3	Mean	SD
Sample0-9	0.095	0.094	0.096	0.05286	0.05106	0.05296	0.0523	0.000964
Sample0-2	0.100	0.103	0.102	0.05716	0.06026	0.05946	0.05896	0.000655
Sample0-3	0.088	0.096	0.100	0.04576	0.05296	0.05756	0.0521	0.002938
Sample7-1	0.108	0.105	0.106	0.06536	0.06216	0.06356	0.0637	0.000849
Sample7-2	0.105	0.102	0.106	0.06196	0.05966	0.06306	0.06156	0.001703
Sample7-3	0.109	0.109	0.120	0.06596	0.06666	0.07736	0.07	0.005475
Saple14-1	0.143	0.157	0.161	0.10016	0.11486	0.11796	0.111	0.003490
Sample14-4	0.140	0.151	0.136	0.09776	0.10826	0.09306	0.0997	0.007620
Sample14-4	0.135	0.146	0.143	0.09216	0.10296	0.10046	0.09853	0.002222
Sample2-2	0.166	0.176	0.178	0.12346	0.13326	0.13526	0.13066	0.002306
Sample2-2	0.182	0.190	0.193	0.13936	0.14786	0.14996	0.14573	0.002116
Sample2-2	0.177	0.185	0.186	0.13466	0.14206	0.14306	0.13993	0.001600

APPENDIX B Hedonic Scorecard

Sample _____

Please evaluate based on taste of the sample in front of you. Take the full sample into your mouth and then swallow.

Taste: Indicate how much you like this sample by checking the term that best describes your response to the product.

- Like extremely _____
- Like very much _____
- Like moderately _____
- Like slightly _____
- Neither like nor dislike _____
- Dislike slightly _____
- Dislike moderately _____
- Dislike very much _____
- Dislike extremely _____

Please rinse your palate with the water provided.

When you are finished, pass your tray through the slot to receive your next sample. Rinse your mouth with water, take a bite of cracker, and rinse your mouth again.

APPENDIX C Sensory Attributes Scorecard

Panelist # _____

Sample Code # _____

Instructions:

Please make sure that the code on your sample matches that on the ballot. Next, please evaluate the sample and indicate your opinion about the following characteristics:

Appearance (Color)

Too light Just Right Too Dark

Smell

None Just Right Too Much

Taste

Too low Just Right Too high

Mouthfeel

Too thin Just Right Too Thick/Gritty

Aftertaste

None Just Right Too Much

APPENDIX D Instructions for “Health Information” Condition

Instructions: You will be tasting a fruit smoothie with fresh turmeric. **Fresh turmeric is a root that adds a significant amount of antioxidants into the beverage. Antioxidants reduce the risk of certain diseases, such as heart disease and multiple forms of cancer, by protecting the body from damage caused by harmful molecules.** Take the full sample into your mouth and then swallow. On the next page, please indicate how well you like the sample based on taste.

APPENDIX E Food Choice Questionnaire

Assume that you want to buy food. Rate the following statements according to the importance you give them for this choice.

1= Not at all Important

2= A Little Important

3=Moderately Important

4= Very Important

I buy food because:

1. It contains a lot of vitamins and minerals
2. It helps me cope with stress
3. It is easy to prepare
4. It smells nice

I buy food because:

5. It contains no additives
6. It is not expensive
7. It is what I usually eat
8. It has been prepared in an environmentally friendly way

I buy food because:

9. It would be met with approval by relatives
10. It keeps me healthy

11. It helps me to cope with life

12. It can be cooked very simply

Assume that you want to buy food. Rate the following statements according to the importance you give them for this choice.

1= Not at all Important

2= A Little Important

3=Moderately Important

4= Very Important

I buy food because:

13. It looks nice

14. It contains natural ingredients

15. It is cheap

16. It is familiar

I buy food because:

17. It has been produced in a way which has not shaken the balance of nature

18. It gives people the right impression of me

19. It is nutritious

20. It helps me relax

I buy food because:

21. It takes no time to prepare

--

- 22. It has a pleasant texture
- 23. It has undergone minimal processing
- 24. It is good value for money

Assume that you want to buy food. Rate the following statements according to the importance you give them for this choice.

- 1= Not at all Important**
- 2= A Little Important**
- 3=Moderately Important**
- 4= Very Important**

I buy food because:

- 25. It is like the food I ate when I was a child
- 26. It is packaged in an environmentally friendly way
- 27. It portrays a positive image of me
- 28. It provides enough energy

I buy food because:

- 29. It cheers me up
- 30. It tastes good
- 31. It is free of chemical preservatives

I buy food because:

- 32. It reduces pollution of soil and water

--

33. It makes a statement about me

34. It is free of residues from chemical sprays and pesticides

APPENDIX F Demographics Questionnaire

Thank you for sharing your personal information. It will help us better understand your experiences.

Please identify the appropriate category within each question.

1. Gender

Male

Female

2. Age: _____

3. Are you of Hispanic, Latino, or of Spanish origin?

Yes

No

4. How would you describe yourself? (Select all that apply)

American Indian or Alaskan Native

Black or African American

White

Asian

Native Hawaiian and Other Pacific Islander

Other race

5. Which is your affiliation with Virginia Tech?

Undergraduate student

Graduate student (Masters/PhD)

Faculty/Staff

Community member

For each beverage that is evaluated, questions specific to the targeted purpose will be asked.

Below is the list from which questions may be drawn.

6. What is your level of interest in including a beverage that may provide antioxidants?

none

slight

moderate

high

7. How confident are you at cooking/preparing foods/meals at home?

Not confident

_____Average
_____Very confident

8. Are you familiar with turmeric/curry?

_____yes
_____no

(If yes, answer question below)

Why do you consume turmeric/curry? [choose all that apply]

_____flavor
_____health benefits
_____coloring agent
_____I do not consume turmeric
_____other [describe]

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