INNOVATIVE METHODS TO MEASURE CONSUMER ACCEPTABILITY OF FRESH AND FORMULATED FOODS

by

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(Under the Direction of Robert L. Shewfelt)

ABSTRACT

Consumer preferences directly affect a consumer's decision to purchase and consume fresh and formulated foods. Understanding and measuring the quality characteristics specific for each commodity is the key to ensuring the continued consumption of fresh fruits and vegetables. Internet chats that consisted of both focus groups (5-6 participants) and one on one interviews were conducted in order to identify quality characteristics that determine consumer acceptable of fresh fruits and vegetables. Though specific quality attributes varied between commodities, consumers agreed that the quality of the fresh produce was very important. Harvesting produce items that are more mature could enhance satisfaction with fresh fruit and vegetables. Accurate information regarding proper handling and storage techniques would help diminish the amount of quality loss that occurs in the home environment. Additionally, adoption of more appropriate scales for consumer testing will provide more meaningful consumer data in evaluating new products and product concepts.

INDEX WORDS: Consumer Acceptability, Quality Characteristics, Fresh Fruit, Fresh Vegetables, Internet Chat, Focus Groups, Interviews, Acceptance Scales

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DEDICATION

To my family, I could not have made it this far without you.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Rate of Consumption of Fresh Produce

In the past several years, the worldwide production of fruit and vegetables has risen thanks to higher living standards and vigorous promotion of fresh produce consumption by government health agencies (Wills and others, 199). Due to their high vitamin and fiber content both the U.S. Dietary Guidelines and the Food Guide Pyramid recommend that people eat five or more servings of fruit and vegetables per day (U.S. Department of Agriculture and Health and Human Services, 1990; U.S. Department of Agriculture, 1992; Brug and others, 1995). Incorporation of fresh produce into the diet has been shown to help prevent several types of cancer and cardiovascular diseases. Despite an increased awareness of the benefits available from fresh produce and a trend in America to eat healthier, the level of fruit and vegetable consumption in this country is still below that of the recommended allowance (Brug and others, 1995).

Quality of Fresh Produce

Delivering high quality fruits and vegetables to consumers is important since food that isn't eaten is of little meaning to the human diet (Francis, 1980). Either regarded as a lack of defects or judged on a scale of excellence (Shewfelt, 1999), quality is defined as "the composite of those characteristics that differentiate individual units of a product, and have significance in determining the degree of acceptability of that unit by the buyer" (Kramer and Twigg, 1970). Assessment of the quality of fruits and vegetables is a challenging concept that is dependent on the viewer's perception (Shewfelt, 1999, Shewfelt, 2000) and is influenced by physical, chemical, physiological, psychological and sociological factors (Lipton, 1980). Understanding and measuring the quality

characteristics specific for each commodity is the key to ensuring the continued consumption of fresh fruits and vegetables.

The preference of measurement techniques and development of product standards for assessing quality depends on whether quality is viewed from the perspective of the product or the consumer (Shewfelt, 1994; Shewfelt, 1999; Shewfelt, 2000). Common to postharvest research (physiological and technological), a product orientation to quality (as reviewed by Shewfelt, 1999) is seen as a set of traits that are intrinsic to a product and can be easily quantified. Quality changes are often plotted as a function of time and used to develop an understanding of physiological effects on loss of quality. A product orientation to quality successfully measures the effectiveness of variation in a handling system but fails to relate the changes to consumer responses.

Consumer orientation characterizes quality in terms of consumer satisfaction and is focused on estimating product performance in the marketplace. Qualitative studies are used to identify quality characteristics that guide consumer acceptability at the time of purchase and at the time of consumption (Shewfelt, 1999). When determining whether or not to buy fresh produce, consumers use attributes such as appearance (color, size, absence of defects), firmness, aroma and price to aid them in their decision. At the time of consumption, flavor (combination of taste and aroma) and mouthfeel (texture) become the dominant traits from which consumers gauge quality. Additionally, hidden attributes such as nutrient composition and microbiological safety play an important part in measuring quality but these attributes are not readily determined by the consumer (Shewfelt, 1994). While consumers represent the only valid source of obtaining quality

measurements that relate to acceptability, these attributes are difficult to determine accurately and precisely (Shewfelt, 1999).

Consumer Research

Food is a powerful stimulus toward which consumers have a variety of attitudes and perceptions (Schutz, 1988). As companies move from product-oriented quality to consumer-oriented quality, the need to predict consumer acceptance of products increases (Shewfelt and others 1997). Land (1988) defines acceptability as the "level of continued purchase or consumption by a specified population." Because consumers are the final assessors of quality, predicting consumer acceptance of products before the products enter into the market is important. A key component to improving consumer acceptability of fresh produce is to first recognize the properties that consumers desire and expect and then translate them into feasible options that would help improve the product (Malundo, 1996). Bourne (1980) suggests dividing the assessment of consumer acceptability of fresh produce into three categories: "1) appearance (color, shape) is based on optical properties, 2) flavor (taste and odor) is the response of the receptors in the oral cavity to chemical stimuli, and 3) touch (texture) the response of the tactile senses to physical stimuli that results from contact between some part of the body and the food."

Unfortunately, it is not easy to precisely measure consumer acceptability. Consumer preferences vary depending on a person's cultural or demographic viewpoint, current frame of mind and their intended use for the product (Shewfelt, 1999). While consumers are able to point out what they do and do not like, they are not always able to explain why they prefer one product over another (Koster, 1990).

Most attempts to understand consumer attitudes rely on quantitative indices to measure consumer acceptance, which are then related with product properties that are also quantitatively calculated (Malundo 1996). Quantitative research relies closely on numbers to characterize opinions and concepts. The quantitative data, though easily obtained, is often used to make unwarranted assumptions about the relationship of the measurements to the perception of the end user (Krueger, 1994; Malundo, 1996). Even with large amounts of quantitative data, consumer desires are not a driving force for change in the fresh produce industry. Introducing qualitative research provides the depth and content that quantitative numbers cannot give (Goebert and Rosenthal, 2002). While quantitative research relies heavily on measuring specific attributes, qualitative research is more descriptive with less emphasis on measurements (Resurreccion, 1998). Qualitative research aids in better understanding the product perception process experienced by consumers (van Trijp and Schifferstein, 1995; Malundo, 1996). Common methods to obtain qualitative data include interviews and focus groups (Krueger, 1994; Resurreccion, 1998).

Interviews

Interviews are often used for collecting qualitative data during the initial phases of research in order to help gain a better perspective on the topic in question. Interviews can be compared to a conversation in which the purpose of the interaction is to obtain valuable feedback from the consumer. An interview can take place with just two people (one-on-one) or in a group setting. One-on-one interviews are more intimate and may be seen as more comfortable than that of a group setting. Some people who are shy or inhibited by others might be reluctant to share their ideas in a group setting. Though

there are no set limitations to the number of people required for a group interview, it is recommended that the size of the group is small enough to maintain order (Merton and others, 1990). Though somewhat harder to manage, interviewing several people at one time enables a researcher to collect a greater volume of data in a relatively small period of time. Despite the number of participants, to essential components to any interview are "1) The substantive part of the conversation consists of questions and answers and 2) The participants have defined, non- overlapping roles: one person asks the questions (the interviewer) and the other answers the questions (the respondent) (Fowler and Mangione, 1990)." The goal of the interviewer is to ensure that the proper questions were asked and to listen and to facilitate the respondent's answers.

Focus Groups

Though very similar, focus groups differ from interviews in that they are much less structured. In a focus group, information as well as various aspects of respondents' perception and reactions are used to gather consumer reaction to products and concepts. (Resurreccion, 1998). Focus groups usually consist of 8-11 people assembled to talk about a subject and are the ideal place to gain knowledge on what a product means to the consumer (Goebert and Rosenthal, 2002). Because of the size of participants, focus groups facilitate respondents to react and build upon response of other group members (Brug and others, 1995).

Discussions during focus groups are guided by a moderator who has been trained in group dynamics and group interviewing techniques (Malundo, 1996). The moderator has studied the topic being discussed enabling them to guide the questioning route in a way that promotes spontaneous verbal exchanges among the participants (Krueger,

1994). Instead of expecting group consensus on a given topic, the goal of a focus group is to "hear individuals express their viewpoints, to paraphrase their understanding, and to explain why and how they got to their position" (Kraft, 1981).

Internet Chats

The Internet, like the telegraph and telephone, has revolutionized the way people communicate. The Internet provides a medium for collaboration and interaction between individuals and their computers without regard for geographic location. It is estimated that worldwide as many as 580.7 million people are connected to the Internet (www.nua.ie/surveys/how_man_online/index.html). Common activities such as writing a letter to a friend, paying bills, applying for a loan, scheduling dinner reservations, and searching the local classified ads are now available through the internet.

The Internet provides another alternative to in person interviews or focus groups (www.web-surveys.net/net.probe/index.html, 2002). The incorporation of Internet chats to consumer research enables the collection of data from people of varying geographic locations with minimal cost and equipment. Where some participants in live group conversations tend to either dominate the conversation while others remain very quite, the Internet places participants on a more even level. Having to type ones response tends to reduce the amount said by those that normally are very wordy where as people who don't generally contribute as much tend to feel compelled to give more input. Furthermore, instead of using an audio recorder to tape the interview or focus group and spending hours transcribing the discussion, the entire Internet chat is already typed and accurately recorded. Though the Internet offers many benefits to conventional consumer research, it does not allow the moderator to make eye contact or observe consumer's

body language. Also, Internet chats are limited to topics that don't require the participants to interact with a given product.

Physiological Aspects of Fresh Produce

Even after harvest, fresh fruits and vegetables remain alive and continue to persist in their customary processes (Hardenburg and others, 1986; Shewfelt, 1986). Though the majority of these processes still continue, some differences are found. The metabolic processes of harvested products differ from their parent plant in the fact that they have suffered from differing degrees of stress. Upon harvesting, fresh produce is removed from its natural nutrient supply and experiences an alteration of the process of photosynthesis causing the product to recycle the nutrients that are left (Kays 1997). After the initial removal from the parent plant, further strain is encountered from mechanical stress during packaging, handling, and transportation as the fruits and vegetables make their way to the retail market. During the handling and transportation of the fresh produce, the plant materials struggle as their natural light source is removed, the concentration of gases such as oxygen and carbon dioxide is altered, and there gravitational orientation is rearranged (Kays 1997). Combined, these changes create an artificial environment to which the items must adapt. After harvest, fresh produce is immediately cooled in order to minimize their level of stress and to slow down their metabolic activities.

Respiration

Respiration is one of the most important metabolic processes occurring in living plants. The absence of respiration is a key factor that separates processed plant products from living products (Kays 1997). During respiration, plant products convert stored

glucose along with surrounding oxygen (O_2) into carbon dioxide (CO_2), water, and energy (Kays, 1997; Peleg, 1985; Ryall and Lipton, 1979). The plant cell utilizes the water formed from respiration and the excess CO_2 is released into the atmosphere. When levels of O_2 have been depleted, the plant is no longer able to undergo complete respiration. The process of incomplete respiration brings about alcohol synthesis via anaerobic fermentation, which causes off-flavors in the fruits and vegetables (Peleg, 1985). Maintaining the concentration of O_2 and proper ventilation around fresh produce will prevent these problems.

Respiration is generally presented as the rate of respiration and is equivalent to the weight of CO_2 produced per unit fresh weight of the plant over time (mg. CO_2 per Kg-hr) (Ryall and Lipton, 1979). During storage, the rate of respiration helps determine the amount of O_2 needed per unit of time as well as the level of CO_2 and heat generated by the plant. In addition, the rate of respiration is used to help indicate the rate of other reactions within the plant such as sugar conversion to starch, vitamin loss, or deterioration from physiological changes (Ryall and Lipton, 1979).

Energy is an important product of respiration. A small portion of the energy formed during respiration is retained by the plant cells in a chemical form to be used later in synthesizing substances and structural cell parts including enzymes, protoplasms and cell walls (Kays, 1997; Peleg, 1985). The energy not absorbed by the plant escapes in the form of heat. The rate of respiration and the amount of heat released from the plant product varies in amount from one commodity to another depending on the cultivar, part of the plant in question, production area, growing condition, and growing season (Hardenburg and others, 1986). A general listing of respiration rates for most fruits and

vegetables have been compiled by Ryall and Lipton (1979). Low rates of respiration are typical for mature fruits and storage organs such as potatoes, onions, and beets while young tissue such as asparagus, sweet corn, broccoli, and green peas generally have high rates of respiration (Peleg, 1985). Products that have a higher rate of respiration generally give off more heat and require more refrigeration than products that respire slowly, in order to maintain the desired temperature.

After harvest, produce that retains field heat has a higher respiration rate than fruits and vegetables that have been cooled down (Peleg, 1985). The temperature of the surrounding environment also affects the rate of respiration of plant products. An increase in respiration for plants due to the change in temperature follows van't Hoff's rule in which "the rate of most chemical and biochemical reactions increases 2 or 3 times with every 10° rise in temperature" (Hardenburg and others, 1986). For instance, a head of lettuce stored at 10°C has a respiration rate 3 times faster than if it were held at O°C (Hardenburg and others, 1986). Therefore, a small increase in temperature has a huge effect on respiration of the fresh produce.

Transpiration

Weight loss is a significant problem with harvested produce. While a minor amount of weight is lost as carbons during respiration; the majority of weight loss comes from a loss of water. Water loss of stored fruits and vegetables reduces the quality of the product. On average, the weight of fruits and vegetables is 80 to 95 percent water (Hardenburg and others, 1986). An abundant amount of water from plant cells is lost through transpiration. During transpiration, water from the plant cells evaporates into the surrounding air. Over time, water loss leads to a wilted or shriveled appearance, loss of

texture, and a significant loss in weight. As with respiration, the rate of transpiration for plants varies. Key factors that affect the rate of transpiration include the type of protective tissue a plant has and the surface area that is exposed (Hardenburg and others, 1986). Commodities such as melons, apples, oranges, and squash have less surface area per volume as well as lower rates of respiration compared to leafy vegetables like celery, lettuce, and spinach that have greater surface area exposure (Kays, 1997). Similarly, carrots with there top leaves still attached have a higher rate of respiration than those with the tops cut off (Hardenburg and others, 1986).

Transpiration occurs because water vapor travels from areas of high concentration to areas of low concentration. Generally, the internal atmosphere of fruits and vegetables has a relative humidity greater than or equal to 99 percent which is generally higher than that of their surrounding environment, resulting in a loss of water from the plant into its surrounding environment (Hardenburg and others, 1986). To reduce the amount of water loss from fresh produce through transpiration, the environment in which the produce is stored in can be altered by increasing the relative humidity, reducing the air movement, lowering the air temperature, and by using a protective barrier.

Fruit and Vegetable Ontogeny

During their life, fresh fruit and vegetables undergo three important phases, categorized as growth, maturation, and senescence (Wills and others 1981). These major physiological stages often overlap making it difficult to identify clear distinctions between the three (Salunkhe and Desai,1984; Wills and others, 1981; Kays, 1997). Growth encompasses cell division and cell enlargement and is responsible for the final size of the commodity (Wills and others, 1998). The next stage, maturation, generally

begins during the growth period and includes a variety of activities that are dependent on the commodity in question. The maturation process of fresh produce is often evaluated by physical attributes such as size, color, or texture (Kays, 1997). Together, growth and maturation are part of the plants developmental process.

Senescence is "the period when anabolic (synthetic) biochemical processes give way to catabolic (degradative) processes leading to aging and final death of the tissue" (Wills and others, 1981). Characteristic to fruit, ripening takes place toward the end of maturation and signals the beginning of senescence (Salunkhe and Desai, 1984). Ripening is a hormonally controlled and converts a physiologically mature plant organ into one that is visually and aromatically appealing. During ripening, fresh fruit is subjected to several physical and chemical changes that ultimately determine the quality of the produce as seen by the consumer (Wills and others, 1998). While growth and maturation of fruit and vegetables occur only while attached to the parent plant, ripening and senescence can proceed either before or after harvest.

Ripening

When the ripening process begins, some fruits such as peaches, apples, bananas, and tomatoes experience a characteristic increase in respiration followed by a rate of respiration peak known as a climacteric (Peleg, 1985). The extent and length of the respiratory climacteric varies among the assorted fruit varieties. Along with the respiratory peak, climacteric fruits undergo an increased production of the hormone ethylene which precedes the characteristic signs of ripening including changes in color, texture, flavor, and sweetness (Salunkhe and Desai, 1984). Climacteric fruits generally become fully ripe after the respiratory climacteric, which may occur while attached or

separated from the plant. Similar to their counterparts, non-climacteric fruits including strawberries, cucumbers, and oranges, exhibit similar ripening changes only they occur much more slowly. In contrast, non-climacteric fruits must be harvested only after they are ready for consumption because they undergo little or no desirable change in composition after harvest (Wills and others, 1998).

Storage of Fresh Produce

The growth of international trading along with an increasing distance between production areas and population centers, results in a large time delay between produce leaving the farm and reaching the consumer. In addition, particular produce items are stored for longer periods of time in order to obtain a higher financial return from produce whose marketing periods have been extended to times of decreased supply (Wills and others, 1998). These factors that extend the time taken before fresh produce reaches the table increases the need to properly maintain the quality of fresh fruits and vegetables.

Proper storage of fresh produce, which is comprised of highly perishable commodities, depends on successful preservation techniques. Without proper preservation, the majority of harvested fresh produce would need to be consumed within a few days. Storage of fresh fruits and vegetables under the appropriate environmental conditions enables the produce to maintain positive quality attributes while diminishing deterioration. However, storage cannot improve the quality of fresh produce. Therefore, produce intended for storage should be of optimum maturity at time of harvest and needs to be in excellent condition.

Consumer Handling of Chilled Foods Before They Reach Home

Great care is taken throughout the food distribution chain to ensure the quality of fresh produce. The USDA provides guidelines for fruits and vegetables during the supply chain to maintain quality (Hardenburg and others, 1986). These guidelines include specific storage temperatures and handling procedures and are designed to make sure that food producers, processors, distributors, wholesalers and retailers maintain acceptable temperatures for the fresh produce throughout most of the food distribution chain (Flynn and others, 1992). Nevertheless, once consumers remove the fruit and vegetables from the retail outlet, the commodities are less likely to be maintained at optimal conditions.

The optimal storage condition for fresh fruits and vegetables differs according to cultivar, climatic and soil conditions, cultural practices, maturity, and handling practices before storage (Hardenburg and others, 1986). After harvest, fruits and vegetables are cooled down to remove field heat and to slow down physiological changes. The fresh items are kept under controlled conditions and either stored or transported to distribution centers or stores. Throughout the food distribution chain, optimal temperatures are maintained to slow quality losses of fruit and vegetables. Unfortunately, the particular measures taken throughout the supply chain to maintain the quality of the fresh produce is often broken by the consumer. Handling of fresh produce by consumers is an important final stage of the distribution chain (Evans, 1992).

Evans (1992) performed a consumer survey in Great Britain in order to better understand consumer handling of chilled foods. The survey population consisted of 252 households. These households were divided into two groups, from which, 126

households participated in the survey from September to December 1989 and the second group participated between February and May 1990. From Evans' study, it was found that the overall mean time from the point the consumer left the store to when the food was placed in the refrigerator was 42.8 ± 18.7 minutes. During this time, 87.3% of the people surveyed used no means of protecting their chilled foods from temperature gains for the duration of the drive home. Product temperatures taken when the chilled food reached the car ranged from 4° C to over 20° C and the temperature of some of the items rose to nearly 40° C when measured again after arriving home. When placed in the domestic refrigerator, it took nearly five hours to reduce the temperature of the food below 7 ° C. Exposure to increased temperatures such as this escalates the rate of deterioration of the fruit and vegetables.

Home Refrigeration

Refrigeration removes heat from an item and then maintains the temperature at a desired level. Many commodities are stored under refrigeration in order to delay aging, undesirable metabolic changes, respiratory heat production, moisture loss, spoilage and undesirable growth (Hardenburg and others, 1986). During refrigeration of fresh produce, maintaining constant temperatures inside the refrigerator is very important. Slight variations above and below the desired temperature may lead to increased decay and undue ripening. For example, higher temperatures induce sprouting in potatoes while low temperatures cause the potatoes to become undesirably sweet (Hardenburg and others, 1986). Also, temperature fluctuations may cause condensation of moisture to accumulate on refrigerated products leading to a greater risk of surface mold and decay.

Refrigeration is the recommended method for storing the majority of fresh produce items in the home environment. Domestic refrigerators, unlike refrigeration systems throughout the rest of the food distribution chain, are not subject to temperature monitoring. The majority of thermostat controls for domestic refrigerators do not indicate specific temperature and are based on a numerical scale in which the higher the number, the colder the internal temperature. The recommended operating temperature for domestic refrigerators is 5 °C (Flynn and others, 1992). When Evans talked with consumers about their home refrigerators, most of the participants were not able to give the actual temperature inside their refrigerators. Merely 15% of the participants had a thermometer in their refrigerators and only 79% of those consumers used the internal readings of the thermometers to adjust the refrigerator temperature. Out of the refrigerators tested, over two thirds had average temperatures that measured above 5 °C. Lack of consumer knowledge and inappropriate thermostat adjustment is to blame for most of the refrigerators that exceeded 5°C. All these problems lead to a false sense of security that food is being properly stored.

Consumers need better information on proper storage of their fresh produce. During refrigerated storage, a balance needs to be met between temperatures. The fresh produce should be held at a temperature that is low enough to slow down physiological activities and microbial spoilage, yet high enough to prevent chilling or freezing injury.

Relative Humidity

The ratio of the water vapor pressure in the air to the saturation vapor pressure at the same temperature is referred to as Relative Humidity. Along with temperature, the humidity of the air around the commodities directly affects the quality of the stored

products. Generally it is recommended that produce is stored at high humidity. Low humidity causes fruits and vegetables to wilt while high humidity proves beneficial for many crops at initiating wound healing and periderm formation (Hardenburg and others, 1986). Except for onions, the majority of perishable horticultural products need to be stored at high relative humidity, 85-100 percent in order to retard softening and shriveling from moisture loss (Hardenburg and others, 1986). The ideal relative humidity will impede moisture loss while preventing excess formation of moisture which could become a favorable environment for growth of micro-organisms.

Other Factors That Effect Quality During Home Storage

There is very little published information regarding factors that affect the quality of fresh produce not stored under refrigeration. Produce items that are not kept in the refrigerator are generally stored either on the kitchen counter, in a pantry, or in the garage. The higher temperature of these environments increases the produces' metabolic activity and accelerates the loss of water. Additionally, light exposure from the home environment increases the temperature of the product and effects a commodities pigmentation. Detached plant tissues containing chlorophyll tend to fade when exposed to excess light while root crops such as tubers that are grown in the dark begin to produce chlorophyll (Kays, 1997). Other factors that might contribute to quality loss include insects and sanitation practices.

Shelf Life of Fresh Produce

Storage life (shelf life) of fresh produce, expressed as "time required to reach an unsalable condition" (Ryall and Lipton, 1972), is a subjective judgment which is dependent on the commodity in question. Physiological activity of a detached plant

organ helps determine the shelf life of the particular item (as reviewed by Haard and Salunkhe, 1975). Specific plant parts including seeds, fleshy roots, tubers and bulbs, are morphologically and physiologically designed to preserve the tissue in a dormant state until environmental conditions are advantageous for germination or growth. On the other hand, plant parts such as stems, fruits, leaves, petioles, etc. are physiologically prepared for senescence rather than dormancy.

The respiration rates of fruits and vegetables have proven an effective tool in assessing shelf life. There is an inverse relationship between rate of respiration and duration of shelf life in which the slower the respiration rate, the longer the commodity can be stored. Another key effect on shelf life is the products vulnerability to fungal decay (Wills and others, 1998). The growth of decay organisms quickly decreases the shelf life and ultimate quality of fresh produce. Low temperature storage helps slow down growth of microbial organisms, however, the natural resistance fruits and vegetables have against decay organisms decreases over time. Ultimately, the duration of time a product may be stored before consumption depends on the commodities composition, fungal and bacterial resistance as well as the environmental factors of temperature and various gases (Haard and Salunkhe, 1975). Even when all factors are taken into consideration, the ultimate shelf life of a product is dependent on who is evaluating the product and the end use in which they are evaluating the product for.

While many postharvest technologists see long-term storage as a victory, food scientists are concerned about ensuring that the end product meets consumer acceptability. Shewfelt (1999) observed that "for a given fruit or vegetable, the longer the shelf life the poorer the quality of the product as delivered to the consumer." A

product stored for long periods of time may look appealing, but the flavor is often compromised. Ultimately, the ability to extend the storage time of a product is futile if the consumer is not satisfied with the end results.

Objectives

The primary objective for this research was to develop a methodology of conducting interviews and focus groups using the Internet for studies related to produce quality and consumer preference. A series of informal Internet focus groups (electronic focus groups) and Internet interviews (electronic interviews) were conducted to identify how consumers judge quality and ripeness of ten different fresh produce commodities (apple, orange, banana, peach, cucumber, cantaloupe, lettuce, carrots, sweet corn, and onions) at the time of purchase and at the time of consumption. The objective of the electronic focus groups and interviews was to provide quality characteristics that determine acceptable quality of fresh produce at time of purchase and consumption. A second objective was to learn how consumers store fresh fruit in the home environment and to find out how long consumers expect the produce to last. The objective of the consumer acceptability study was to evaluate the effectiveness of three different scales for determining consumer acceptability in three commercial product categories.

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CHAPTER 2

INTERNET CHATS TO DETERMINE CONSUMER ACCEPTABILITY OF FRESH FRUIT[1]

[1] Henderson, J.D. and R.L. Shewfelt. To be submitted to *Journal of Food Quality*.

ABSTRACT

Understanding and measuring the quality characteristics specific for each fruit is the key to ensuring the continued consumption of fresh fruits. A series of electronic chats were conducted to identify quality characteristics that determine consumer acceptability of fresh fruit (apples, oranges, bananas, peaches, and cantaloupe) at time of purchase and consumption. A total of 72 consumers (67% female, 33% male), participated in informal electronic chats, which consisted of both focus groups (5-6 participants) and one on one interviews. Qualitative analysis of the electronic chats indicated that flavor, texture and appearance are the main attributes that lead to consumer dissatisfaction with fresh fruit. Satisfaction with fresh fruit could be enhanced by harvesting produce items that are more mature or by providing a variety of cultivars that more closely relate to the characteristics consumers seek. Future research should focus on combining sensory descriptive analysis with consumer acceptability testing to better understand consumer desires of fresh fruit

INTRODUCTION

The level of fruit consumption in the United States is still below that of the recommended allowance (Brug and others, 1995). Delivering high quality fruits to consumers is important since food that isn't eaten is of no meaning to the human diet (Francis, 1980). Either regarded as a lack of defects or judged on a scale of excellence (Shewfelt, 1999), quality is defined as "the composite of those characteristics that differentiate individual units of a product, and have significance in determining the degree of acceptability of that unit by the buyer" (Kramer and Twigg, 1970). Assessment of the quality of fruits is a challenging concept that is dependent on the viewer's perception (Shewfelt, 1999, Shewfelt, 2000) and is influenced by physical, chemical, physiological, psychological and sociological factors (Lipton, 1980). Understanding and measuring the quality characteristics specific for each commodity is the key to ensuring the continued consumption of fresh fruits.

While consumers represent the only valid source of obtaining quality measurements that relate to acceptability, these attributes are difficult to determine accurately and precisely. Qualitative studies are used to identify quality characteristics that guide consumer acceptability at the time of purchase and at the time of consumption (Shewfelt, 1999). Common methods to obtain qualitative data include interviews and focus groups (Krueger, 1994; Resurreccion, 1998). The Internet provides another alternative to in-person interviews and focus groups. It is estimated that worldwide as many as 580.7 million people are connected to the Internet (www.nua.ie/surveys/how_man_online/index.html, 2002). Employing the Internet as a tool for consumer research enables the collection of data from people of varying

geographic locations with minimal cost, equipment and time. The Internet is currently being used for consumer surveys in areas ranging from diet and nutrition to politics (www.webreferendum.co.uk, 2002). Where some participants in "real-time" group conversations tend to either dominate the conversation while others remain very quite, the Internet places participants on a more even level. Furthermore, instead of using an audio recorder to tape the interview or focus group and spending hours transcribing the discussion, the entire Internet chat is already typed and accurately recorded.

A series of Internet chats (electronic chats) were conducted to identify how consumers judge quality and ripeness of six different fruit commodities (apple, orange, banana, peach, cucumber, and cantaloupe) at the time of purchase and at the time of consumption. The objective of the Internet chats is to understand quality characteristics that determine acceptable quality of fresh fruits used by the consumer at time of purchase and consumption. A second objective is to learn how consumers store fresh vegetables in the home environment and to find out how long consumers expect the produce to last.

MATERIALS AND METHODS

A total of 72 consumers (67% female, 33% male) who's ages ranged from 21-82 with a mean age of 39, participated in informal Internet chats which consisted of both focus groups (5-6 participants) and one on one interviews. Panelists for the Internet chats were recruited via the Internet and by word of mouth based on their recurring purchase and consumption of fresh produce. Consumers participating in the study reported purchasing fresh produce either just during the peak season, all year long, or all year long with an increased purchase rate during peak season. Locations in which fresh

produce was purchased included grocery stores, farmers markets, co-ops, and roadside produce stands. Reasons fresh produce was preferred over the frozen or canned alternatives included nutrition, flavor, quality, texture, absence of preservatives, and flexibility in preparation.

Internet chats were held in the chat room www.uga.edu/fst/jabberchat/index.html. A moderator greeted the panelists as they entered the chat room and began guiding the discussion as soon as all participants were present. During the Internet chats five fruit items (apples, oranges, bananas, peaches and cantaloupes) were studied. The items were divided into three groups with two produce items per group. For each group of produce studied, a total of 15-19 consumers participated in either focus groups or one on one interview. Panelists who were asked questions about fresh fruit responded to questions regarding two of the fruit commodities being studied.

After each Internet chat, the transcript of the discussion was saved. When all chats had been held, the various discussions for the individual commodities in question were re-ordered and combined through a cut and paste process (i.e. all data collected for apples are presented together). Responses concerning individual commodities were each qualitatively analyzed and important issues and characteristics for each of the commodities were identified. An overall summary regarding each of the produce items studied was then compiled. Issues and characteristics were included in the general summary whenever two or more panelists mentioned them. Relative importance of individual quality characteristics for individual consumers were variable and are not listed in any particular order.

Figure 1. Questioning Route for Apples During Internet Chats.

1. How often do you shop for fresh apples?
2. What quality characteristics do you look for when buying fresh apples?
3. What quality characteristics do you look for when you consume an apple? Do these qualities change depending on if you are serving them to guest?
4. When using these characteristics, are you satisfied with the flavor of your apples?
5. If there is more than one person in your household, do you agree on what constitutes good quality for apples?
6. How do you store any leftovers after cutting up apples?
7. How important is quality of the apple to you? Would you rather have good quality or do without?
8. How do you know when the quality of the apple is too poor to consume?
9. How often are you surprised by how good your apples taste? How often are you disappointed by how your apples taste?
10. How do you store whole apples before you consume them? How long do you expect apples to last in your home environment?
11. Is there anything you would like to add to our discussion on apples?

RESULTS AND DISCUSSION

Apples:

The frequency in which consumers purchased apples ranged from once a week to rarely, and purchases took place throughout the year. At time of purchase, consumers selected apples based on external characteristics (Table 1) and included attributes such as

firm texture, absence of bruises, color (red, green, yellow), size (medium, small), and cultivar (Granny Smith, Fuji). After purchase, apples were generally stored in an open container on a kitchen counter or in a refrigerator. The qualities of the apples were expected to be maintained for one to two weeks during home storage.

When consuming apples, both external and internal characteristics were used to assesses quality (Table 1). Consumers preferred to eat apples with characteristics such as sweet, juicy, firm, crisp, and not mealy. When comparing overall satisfaction of apples using attributes desired at time of purchase to those attributes discovered during consumption, some consumers stated that they were generally satisfied with the quality of the apple while others felt that the apples were not always juicy enough.

Table 1. Product Attributes Central to The Purchase and Consumption of Fresh Apples.

Purchase	Consumption
Firm Texture	Sweet
No Bruises	Juicy
Color (red, green, yellow)	Firm Texture
Medium, Small in Size	Crisp
cultivar (ex. Granny Smith, Fuji)	Not Mealy

External characteristics were also used to determine when the quality dropped to a level in which the apples were unacceptable (Table 2). These characteristics: soft texture, mealy, bruises/ blemishes and faded color, related to products that were over ripe or had experienced physical damage.

Table 2. Quality Attributes Characteristic to Apples That are Categorized as Unacceptable.

Unacceptable
Soft Texture
Mealy
Bruises/ Blemishes
Faded Color

A few consumers made additional comments about apples such as “apples in the grocery store are never good enough” and “I’m very wary of aesthetically pleasing fruits, most of the time they have a lot less flavor and are spongy.”

Oranges:

Consumers reported shopping for oranges any where from once a week to twice a year. Oranges were generally purchased throughout the year. External characteristics important in the purchase decision for oranges (Table 3) included even orange coloration, absence of bruises, texture (not too firm/ not too soft, firm), size (large and medium) and aroma. In the home environment, oranges were stored in an open container on a kitchen counter or in a refrigerator and it was estimated that the quality of the oranges would last between three to fourteen days.

At the time of consumption, external and internal characteristics helped the consumer gauge the quality of the oranges (Table 3). Consumers wanted to eat oranges with such characteristics as sweet, tart, juicy, not dried out, with few seeds. When comparing overall satisfaction of oranges using attributes desired at time of purchase to those attributes discovered during consumption, some consumers stated that they were very satisfied with the quality of their oranges while others felt that oranges purchased from the store are too dry and have no flavor.

Table 3. Product Attributes Central to The Purchase and Consumption of Fresh Oranges.

Purchase	Consumption
Even Orange Coloration	Sweet
No Bruises	Tart
Texture (Not Too Firm/ Not Too Soft, Firm)	Juicy
Size (Large and Medium)	Not Dried Out
Aroma	Few/ No seeds

The quality of the oranges is considered unacceptable from external characteristics such as dryness, very soft peel, bruises, off color and fermented aroma Table 4). These characteristics generally relate to senescence, aging, physical damage or microbial contamination.

Table 4. Quality Attributes Characteristic to Oranges That are Categorized as Unacceptable.

Unacceptable
Dry
Very Soft Peel
Bruises
Off Color
Fermented Aroma

Consumers also stated that they "prefer Florida navels" and that preparation required in order to eat an orange is "a lot of work."

Bananas:

The rate in which consumers purchased bananas ranged from once a week to once a month and took place all year long. At the time of purchase, consumers stated they looked for bananas with such external characteristics as color (a little green, bright yellow), slightly firm texture, no spots/browning and no bruises (Table 5). During home storage, bananas were kept on a kitchen counter or placed in the refrigerator. The length

of time in which consumers expected bananas to last in their home environment ranged from two to fourteen days.

The external and internal characteristics used to measure the quality of bananas at the point of consumption include color (a little green, yellow with no green), slightly firm texture, some brown spots on the peel, sweet flavor and not mushy (Table 5). When comparing overall satisfaction of bananas using attributes desired at time of purchase to those attributes discovered during consumption, consumers were satisfied with the quality of the bananas.

Table 5. Product Attributes Central to The Purchase and Consumption of Fresh Bananas.

Purchase	Consumption
Color (A Little Green, Bright Yellow) Slightly Firm Texture No Spots/Browning, No Bruises	Color (A little green, Yellow with no green) Slightly Firm, Some Brown Spots On The Peel Sweet Flavor Not Mushy

The quality of bananas with such external characteristics as mushy texture, discolored peel/ peel covered with brown spots, dark bruises on the fruit (inside) were regarded as unacceptable (Table 6). These characteristics generally relate to bananas that are overripe or those that have endured physical damage.

Table 6. Quality Attributes Characteristic to Bananas That are Categorized as Unacceptable.

Unacceptable
Mushy Texture Discolored peel/ Peel covered with Brown Spots Dark Bruises on the Fruit (Inside)

Peaches:

Peaches were mainly purchased during the summer months with a rate that ranged from once a month to rarely. Decisions to purchase peaches were based on external characteristics like firmness (soft but not too soft, firm), juicy, sweet, pleasant aroma, and color (yellow-orange with deep red) (Table 7). During home storage, peaches were stored either on the kitchen counter or placed in the refrigerator. Consumers estimated that peaches would maintain desired quality levels between three and seven days from the time of purchase.

At the time of consumption, consumers determined the quality of the peaches using the external qualities of texture (soft, some softness but not too soft), strong aroma and the internal qualities of flavor (sweet, tart) and crispness (Table 7.) When comparing overall satisfaction of peaches using attributes desired at time of purchase to those attributes discovered during consumption, consumers were generally satisfied with the peaches during the summer months. Consumers stated that peaches consumed out of the summer months generally had the desired external attributes but lacked flavor.

Table 7. Product Attributes Central to The Purchase and Consumption of Fresh Peaches.

Purchase	Consumption
Texture (Soft but not too Soft, Firm)	Texture (Soft, Some Softness but not too Soft)
Juicy	Strong Aroma
Sweet	Flavor (Sweet, Tart)
Pleasant Aroma	Crisp
Color (Yellow-Orange with Deep Red)	

When describing unacceptable peach quality, consumers used both external and internal characteristics such as texture (too soft, too hard), discoloration/ bruises, mealy,

not sweet (Table 8). These characteristics generally relate to peaches that are either under ripe, overripe, or those that have shown signs of physical damage.

Table 8. Quality Attributes Characteristic to Peaches That are Categorized as Unacceptable.

Unacceptable
Texture (Too Soft, Too Hard)
Discoloration/ Bruises
Mealy
Not Sweet

With regards to storing fresh peaches, consumers seemed concerned about the delicate nature of peaches.

Cantaloupe:

Cantaloupes were mainly purchased when in season during the summer months at a rate that ranged from weekly to rarely. The external characteristics important in purchasing cantaloupes included no blemishes, good sound when thumped, sweet aroma, soft stem scar, size, firmness (firm, a little soft) (Table 9). After purchase, whole cantaloupes were either stored on a kitchen counter or in the refrigerator. Consumers expected the fresh whole cantaloupes to have a shelf life that ranged from three to ten days.

At time of consumption, the external and internal characteristics sweet flavor, texture (firm, soft), not mealy, sweet aroma, flesh color, juicy were mentioned as important indicators of quality (Table 9). When comparing overall satisfaction of cantaloupes using attributes desired at time of purchase to those attributes discovered

during consumption, some consumers were satisfied while others were often disappointed with either the lack of flavor and/or texture.

Table 9. Product Attributes Central to The Purchase and Consumption of Fresh Cantaloupe.

Purchase	Consumption
No Blemishes	Sweet Flavor
Good Sound When Thumped	Texture (firm, soft)
Sweet Aroma	Not Mealy
Soft Stem Scar	Sweet Aroma
Size	Flesh Color
Firmness (firm, a little soft)	Juicy

Characteristics common to cantaloupes considered unacceptable included texture (too soft/mushy, mealy), presence of mold, fermented aroma, and over ripe flavor (Table 10). These characteristics generally relate to cantaloupes that are over ripe or those that have experienced microbial spoilage.

Table 10. Quality Attributes Characteristic to Cantaloupes That are Categorized as Unacceptable.

Unacceptable
Texture (Too Soft/ Mushy, Mealy)
Presence of Mold
Fermented Aroma
Over Ripe Flavor

When given the opportunity to add any additional comments regarding cantaloupes, Consumers stated that "Restaurants rarely serve ripe, flavorful cantaloupes" and "I recall cantaloupes tasting better 20 years ago."

Implications for Home Handling and Storage:

Though specific quality attributes varied between commodities, consumers agreed that the quality of the fruit was very important. In most cases, consumers stated that a

lack of quality would prevent them from consuming a product, which was illustrated by the statement "I would rather go without than have bad quality." Lower levels of quality were only tolerated for bananas and peaches by a few consumers who planned to use them when cooking. The expectation for high quality remained the same whether talking about fruit served at a family meal or while entertaining guest.

Consumers reported storing the five fruit commodities (apples, oranges, bananas, peaches and cantaloupe) on both the kitchen counter and in the refrigerator. Produce was stored on the counter to allow fruit to ripen or so that it would be in plain view. Holding fruit out in the open at room temperature increases its rate of respiration and transpiration as well as exposing it to extraneous ethylene and insects. Consumers who either wanted to extend the shelf life of the fruit or those who enjoyed eating cold fruit stored their produce in the refrigerator. Refrigeration may help slow down the fruits metabolic activity, but it also prevents unripe climacteric fruit from developing the desired attributes characteristic of fully ripe produce. Furthermore, some fruit commodities such as bananas are susceptible to chilling injury when stored under refrigeration.

CONCLUSION

Consumers look for produce with consistently high quality. Products that do not meet their quality standards are often thrown away. Flavor and texture are the main areas that lead to consumer dissatisfaction with fresh fruit. Repeated exposure to a commodity with unacceptable quality attributes leads to consumers who are unlikely to return to purchase that item. Satisfaction with fresh fruit could be enhanced by harvesting produce items that are more mature or by providing a variety of cultivars that more closely relate

to the characteristics consumers seek. Additionally consumers should be provided with accurate information on proper handling and storage techniques of fresh fruits to help diminish the amount of quality loss that occurs in the home environment. Future research should focus on combining sensory descriptive analysis with consumer acceptability testing to better understand consumer desires of fresh fruit.

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CHAPTER 3

INTERNET CHATS TO DETERMINE CONSUMER ACCEPTABILITY OF FRESH VEGETABLES[2]

[2] Henderson, J.D. and R.L. Shewfelt. To be submitted to the *Journal of Food Quality*.

ABSTRACT

A series of informal Internet chats (electronic chats) were conducted to identify quality characteristics that determine consumer acceptability of fresh vegetables (lettuce, carrots, cucumbers, sweet corn, and onions) at time of purchase and consumption. A total of 72 consumers (67% female, 33% male), participated in informal Internet chats, which consisted of both focus groups (5-6 participants) and one-on-one interviews. Qualitative analysis of the Internet chats indicated that consumers look for vegetables with consistently high quality. Poor texture, flavor and appearance are the main areas that lead to consumer dissatisfaction with fresh vegetables. Information on proper handling and storage techniques for fresh vegetables would help quality-conscious consumers reduce the amount of quality loss that occurs in the home environment.

INTRODUCTION

A key component to improving consumer acceptability of fresh vegetables is to first recognize the properties that consumers desire and expect and then translate them into feasible options that would help improve the product (Malundo, 1996). Unfortunately, it is not easy to measure consumer acceptability. Consumer preferences vary depending on a person's cultural or demographic viewpoint, current frame of mind and their intended use for the product (Shewfelt, 1999). While consumers are able to point out what they do and do not like, they are not always able to explain why they prefer one product to another (Koster, 1990).

Consumer orientation characterizes quality in terms of consumer satisfaction and is focused on estimating product performance in the marketplace. Qualitative studies are used to identify quality characteristics that guide consumer acceptability at the time of purchase and at the time of consumption (Shewfelt, 1999). When determining whether or not to buy fresh vegetables, consumers use attributes such as appearance (color, size, absence of defects), firmness, aroma and price to aid them in their decision. At the time of consumption, flavor (combination of taste and aroma) and mouthfeel (texture) become the dominant traits from which consumers gauge quality. Additionally, hidden attributes such as nutrient composition and microbiological safety play an important part in measuring quality (Shewfelt, 1994). While consumers represent the only valid source of obtaining quality measurements that relate to acceptability, these attributes are difficult to determine accurately and precisely (Shewfelt, 1999)

A series of informal Internet chats (electronic chats) were conducted to identify how consumers judge quality and ripeness of five different vegetable commodities

(lettuce, carrots, cucumbers, sweet corn, and onions) at the time of purchase and at the time of consumption (Henderson and Shewfelt, 2002). The objective of the Internet chats is to understand quality characteristics that determine acceptable quality of fresh vegetables used by the consumer at time of purchase and consumption. A second objective is to learn how consumers store fresh vegetables in the home environment and to find out how long consumers expect the produce to last.

MATERIALS AND METHODS

A total of 72 consumers (67% female, 33% male) who's ages ranged from 21-82 with a mean age of 39, participated in informal Internet chats which consisted of both focus groups (5-6 participants) and one on one interviews. Panelists for the Internet chats were recruited via the Internet and by word of mouth based on their recurring purchase and consumption of fresh produce. Consumers participating in the study reported purchasing fresh produce either just during the peak season, all year long, or all year long with an increased purchase rate during peak season. Locations in which fresh produce was purchased included grocery stores, farmers markets, co-ops, and roadside produce stands. Reasons fresh produce was preferred over the frozen or canned alternatives included nutrition, flavor, quality, texture, absence of preservatives, and flexibility in preparation.

Internet chats were held in the chat room www.uga.edu/fst/jabberchat/index.html. A moderator greeted the panelists as they entered the chat room and began guiding the discussion as soon as all participants were present. During the Internet chats five vegetables items (lettuce, carrots, cucumbers, sweet corn, and onions) were studied. The items were divided into two groups with two produce items per group. For each group of

produce studied, a total of 15-19 consumers participated in either focus groups or one on one interview. Panelists who were asked questions about fresh vegetables responded to questions regarding two of the vegetable commodities being studied.

After each Internet chat, the transcript of the discussion was saved. When all chats had been held, the various discussions for the individual commodities in question were re-ordered and combined through a cut and paste process (i.e. all data collected for lettuce are presented together). Responses concerning individual commodities were each qualitatively analyzed and important issues and characteristics for each of the commodities were identified. An overall summary regarding each of the produce items studied was then compiled. Issues and characteristics were included in the general summary after two or more panelists mentioned them. Relative importance of individual quality characteristics for individual consumers varied widely and are not listed in any particular order.

RESULTS AND DISCUSSION

Lettuce:

The rate in which consumers purchased lettuce (both whole heads and pre-cut packages) ranged from once a week to once a month and took place all year long. At the time of purchase, consumers stated they looked for lettuce that had the external characteristics crisp leaves, no odor, even green coloration/ no browning, and no wilting (Table 1). During home storage, lettuce was placed in the refrigerator either in the "crisper" drawer or on a middle shelf. Whole heads of lettuce were kept in a plastic container or plastic bag while pre-cut lettuce was kept in the original packaging. All of

the lettuce was kept in the refrigerator. The length of time in which consumers expected lettuce to last in their home environment ranged from three to seven days.

At the time of consumption, external and internal characteristics helped the consumer gauge the quality of the lettuce (Table 1). Consumers wanted to eat lettuce with crisp leaves, no browning, clean of any debris, no off odor, no wilting and not slimy. When comparing overall satisfaction of lettuce using attributes desired at time of purchase to those attributes discovered during consumption, consumers stated they were very satisfied with the quality of their lettuce.

Table 1. Product Attributes Central to The Purchase and Consumption of Fresh Lettuce.

Purchase	Consumption
Crisp Leaves No Odor Even Green Coloration/ No Browning No Wilting	Crisp Leaves No Browning Clean Of Debris No Odor No Wilting Not Slimy

The quality of lettuce with such external characteristics as limp/wilted leaves, dry leaves, and discoloration/ browning were regarded as unacceptable (Table 2). These characteristics generally relate to lettuce that has lost a large amount of water or suffered mechanical damage.

Table 2. Quality Attributes Characteristic to Lettuce That is Categorized as Unacceptable.

Unacceptable
Limp/Wilted leaves
Dry Leaves
Discoloration/ Browning

Consumers expressed varying opinions regarding pre-cut bags of lettuce. Panelists who purchased pre-cut lettuce appreciated the convenience stating "I usually buy it pre-cut, it is easier to eat." Consumers that did not like the pre-cut lettuce alternative were disappointed with the quality and made comments such as "I hate the lettuce already cut up in a bag… it is almost always of poorer quality."

Carrots:

The frequency in which consumers purchased carrots (both peeled baby carrots and whole carrots) ranged from once a week to once a month and purchases took place throughout the year. At time of purchase, consumers selected carrots based on external characteristics (Table 3) and included attributes such as bright color, no cracks/ white dry areas, no spots, not limp, and small in size. After purchase, carrots were stored in a plastic bag in the crisper drawer of the refrigerator. The quality of the carrots was expected to be maintained for one to three weeks during home storage.

When consuming carrots, both external and internal characteristics were used to assess quality (Table 3). Consumers preferred to eat carrots that possessed the characteristics: firm/ crisp texture, sweet flavor, even coloration, not dry, not limp, no spots. When comparing overall satisfaction of carrots using attributes desired at time of purchase to those attributes discovered during consumption, consumers were generally satisfied with the quality of the carrots.

Table 3. Product Attributes Central to The Purchase and Consumption of Fresh Carrots.

Purchase	Consumption
Bright Color	Firm/ Crisp Texture
No Cracks/ White Dry Areas	Sweet Flavor
No Spots	Even Coloration
Not Limp	Not Dry
Small in Size	Not Limp
	No Spots

External characteristics were also used to determine when the quality dropped to a level in which the carrots were considered unacceptable (Table 4). These characteristics: limp texture, dry cracks (white), faded color and slimy, related to products that were dry or experienced microbial spoilage.

Table 4. Quality Attributes Characteristic to Carrots That are Categorized as Unacceptable.

Unacceptable
Limp Texture
Dry Cracks (White)
Faded Color
Slimy

Cucumbers:

Consumers reported shopping for cucumbers throughout the year at a rate that ranged from weekly to rarely. Characteristics important in the decision to purchase cucumbers included such external attributes as size (small, large), thickness (fat, thin), firm texture, dark green coloration, no wax outer coating, and absence of blemishes

(Table 5). Domestically, cucumbers were stored in the refrigerator with an expected shelf life that ranged from one to three weeks.

When consuming cucumbers, the external and internal characteristics color, mild flavor, small seeds, size (small, large), absence of blemishes and bruises, and crisp texture were used to asses quality (Table 5). When comparing overall satisfaction of cucumbers using attributes desired at time of purchase to those attributes discovered during consumption, consumers were generally satisfied with the quality of cucumbers. Consumers commented that since cucumbers don't have much flavor, texture played a more dominant role in determining acceptability.

Table 5. Product Attributes Central to The Purchase and Consumption of Fresh Cucumbers.

Purchase	Consumption
Size (Small, Large)	Color
Thickness (Fat, Thin)	Mild Flavor
Firm Texture	Small Seeds
Dark Green Coloration	Size (Small, Large)
No Wax	Absence of Blemishes and Bruises
Absence of Blemishes	Crisp Texture

When cucumbers developed such external and internal characteristics as soft texture, bitter flavor, dry or waxy skin, rancid smell, and discoloration, the quality was categorized as unacceptable (Table 6). These characteristics for unacceptable cucumbers generally occur from senescence, physical damage, or microbial spoilage.

Table 6. Quality Attributes Characteristic to Cucumbers That are Categorized as Unacceptable.

Unacceptable
Soft Texture
Bitter Flavor
Dry or Waxy Skin
Rancid Smell
Discoloration

Sweet Corn:

Sweet corn was mainly purchased during the summer months with a rate that ranged from once a week to rarely. Decisions to purchase sweet corn was based on external characteristics plump kernels, green-hydrated husk, light colored silks, firm kernels, large size, no insects, and full kernels (no empty spaces) (Table 7). During home storage, sweet corn was stored in the refrigerator. Consumers estimated that sweet corn would maintain their desired quality levels between two and seven days from the time of purchase.

At the time of consumption, consumers determined the quality of sweet corn the external qualities: full kernels (no empty spaces), no insects, light colored silks and the internal qualities: sweet flavor, juicy kernels (Table 7.) When comparing overall satisfaction of sweet corn using attributes desired at time of purchase to those attributes discovered during consumption, consumers were generally satisfied with the quality of sweet corn during the summer months. Consumers expressed dissatisfaction with sweet corn consumed out of the summer growing season saying, "sometimes it's not sweet at all or it's too dry".

Table 7. Product Attributes Central to The Purchase and Consumption of Fresh Sweet Corn.

Purchase	Consumption
Plump Kernels	Full Kernels (No Empty Spaces)
Green-Hydrated Husk	No Insects
Light Colored Silks	Light Colored Silks
Firm Kernels	Sweet Flavor
Large Size	Juicy Kernels
No Insects	
Full Kernels (No Empty Spaces)	

When determining if the quality of sweet corn is unacceptable, consumers used both external and internal characteristics such as presence of insects, dry kernels/ husk, mold, starchy kernels, blemished kernels, and small kernels (Table 8). These characteristics generally relate to corn that is either dry, has been picked either too early or too late, or that has undergone microbial spoilage.

Table 8. Quality Attributes Characteristic to Sweet Corn That is Categorized as Unacceptable.

Unacceptable
Presence of Insects
Dry Kernels/ Husk
Mold
Starch Flavor
Blemished Kernels
Small Kernels

A few consumers were concerned about the time of day their corn was harvested stating, “I prefer corn that was picked in the morning before sugars have turned to starch.”

Onions:

Onions were purchased throughout the year at a rate that ranged from once a week to once every two months. The external characteristics important in purchasing onions included: size (large, medium, small), no germination, firm, dry outer skin, no blemishes, and brand or regional identification (Vidalia's) (Table 9). After purchase, whole onions were either stored at room temperature. Consumers expected onions to have a shelf life that ranged from two weeks to two months.

At time of consumption, the external and internal characteristics flavor (sweet, pungent), absence of rot/ mold, strong odor, dry clear skin, and crunchy texture were mentioned as important indicators of onion quality (Table 9). When comparing overall satisfaction of onions using attributes desired at time of purchase to those attributes discovered during consumption, consumers stated that they were very satisfied with the quality.

Table 9. Product Attributes Central to The Purchase and Consumption of Fresh Onions.

Purchase	Consumption
Size (Large, Medium, Small)	Flavor (Sweet, Pungent)
No Germination	Absence of Rot/ Mold
Firm texture	Strong Odor
Dry Outer Skin	Dry Clear Skin
No Blemishes	Crunchy Texture
Cultivar (Vidalia's)	

Characteristics common to onions categorized as unacceptable included presence of mold/rot, soft texture, germination, off odor and slime (Table 10). These characteristics generally relate to onions that have begun to senesce or have succumb to microbial spoilage.

Table 10. Quality Attributes Characteristic to Onions That are Categorized as Unacceptable.

Unacceptable
Presence of Mold/ Rot
Soft Texture
Germination
Off Odor
Slime

When given the opportunity to add any additional comments regarding onions, it was mentioned that onions are an important ingredient when cooking. This sentiment was further expressed by the comment "I use them [onions] in almost every food I make."

Implications for Home Handling and Storage:

As with fresh fruit (Henderson and Shewfelt, 2002), consumers wanted high quality vegetables. Except for onions, the texture of the vegetables was the most important quality attribute desired in fresh vegetables. As long as the desired texture of the vegetables was present, consumers were willing to compromise on the flavor of lettuce, carrots, cucumber, and corn particularly with the addition of salad dressing or extra butter. Due to the significant flavor that onions contribute to a dish; consumers were willing to salvage onions that possessed the desired flavor by removing defected areas.

Consumers stored all of the five vegetables studied (lettuce, carrots, cucumber, sweet corn, and onions) in the refrigerator. Some consumers preferred the convenience of pre-cut lettuce and pre-peeled carrots despite the fact that they had undergone mechanical damage, which would shorten their shelf life.

CONCLUSION

Consumers look for vegetables with consistently high quality. Vegetables that do not meet consumers' quality standards are thrown away. Poor texture, flavor and appearance are the main areas that lead to consumer dissatisfaction with fresh vegetables. Minimizing the amount of water loss by vegetables during home storage could enhance consumer satisfaction of fresh vegetables. Information on proper handling and storage techniques for fresh vegetables would help diminish the amount of quality loss that occurs in the home environment. Future research should focus on combining sensory descriptive analysis with consumer acceptability testing to better understand consumer desires of fresh vegetables.

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CHAPTER 4

EVALUATION OF SCALES TO MEASURE CONSUMER ACCPETABILITY[3]

[3] Henderson, J.D. and R.L. Shewfelt. To be submitted to the *Journal of Food Science*.

ABSTRACT

The Hedonic scale has been widely used for its simplicity, accuracy, and precision while being criticized for end effects and lack of equal intervals. Our objective was to evaluate the appropriateness of three scales for determining consumer acceptability. A total of 276 consumers (45% male, 55% female), primarily 20-29 years of age evaluated three samples each of peanut butter (PB), potato chips (PC), and carbonated beverages (CB) by using three scales [3-point unbalanced consumer acceptability (3CA), 5-point willingness-to-purchase (5WP), and 9-point Hedonic liking (9HL)]. The 9HL does not measure acceptability and was not always comparable to the other two scales. End effects were not observed in 3CA, while 5WP and 9HL were essentially reduced to three-point scales. Designed to mirror the "gut-response" of consumers to products, 3CA offers clearer insight into consumer desires than 5WP or the traditional 9HL. Adoption of more appropriate scales of consumer preference will provide more meaningful consumer data in evaluating new products and product concepts than the now widely used 9HL.

INTRODUCTION

As companies move from product-oriented quality to consumer-oriented quality, the need to predict consumer acceptance of products increases (Shewfelt and others 1997). Land (1988) defines acceptability as the "level of continued purchase or consumption by a specified population." Because consumers are the final assessors of quality, predicting consumer acceptance of products before the products enter into the market is important.

The methods used to determine consumer acceptability tend to be high in either internal or external validity. Internal validity refers to "the extent to which variation in sensory evaluation can be traced back to variations in product composition," whereas external validity is "the extent to which the variation in sensory evaluation contributes to explanation and prediction of actual food choice behavior in the market" (van Trijp and Schifferstein, 1995). Studies that focus on product quality are internally valid; those that change the emphasis from product to consumer increases the external validity. When performing consumer studies, it is useful to select consumers that are naïve (without specific training), represent target segments of the consuming population, adapt terminology from the consumer, and mimic the typical eating conditions in the test environment to increase external validity (van Trijp and Schifferstein, 1995, West 2000).

The Hedonic scale developed by Peryam and Giraridot (1952) is the most often used category scale for consumer research even though it has several flaws (West 2000, Margaria 2001, Dubost and others 2002). This scale has been widely used for its simplicity, accuracy, and precision while being criticized for end effects [consumer reluctance to use the extreme ends of the scale (Pangborn 1980, O'Mahony 1991, Faller

and Faller 2000)] and lack of equal intervals (O'Mahony 1991, Moskowitz 1994). The most serious and frequent abuse of the scale is the reporting of results as statistical means when the scale clearly violates the assumption of linearity (O'Mahony 1991, Moskowitz 1994). Generally ranging from dislike extremely to like extremely, the Hedonic scale makes assumptions about consumer acceptability by interpreting levels of "liking" due to its internal validity (Meilgaard and others 1991, Lawless and Heymann 1998, Resurreccion 1998), but liking does not necessarily relate to consumer acceptability. A 5-point willingness-to-purchase scale (Moskowitz, 1994) provides a more direct answer to intended consumer behavior. The 3-point consumer acceptability (West, 2000; Margaria, 2001; Dubost and others, 2002), while unbalanced, is designed to force consumers to make a choice similar to those made during normal consumption of foods.

Our objective was to evaluate the effectiveness of three scales (the 3-point unbalanced consumer acceptability scale, the 5-point willingness-to-purchase scale, and the 9-point Hedonic liking scale) for determining consumer acceptability in three commercial product categories.

MATERIALS AND METHODS

A total of 276 naive consumers (45 % male, 55 % female), primarily 20-29 years of age were recruited from the University of Georgia. The consumers evaluated three brand name samples of peanut butter (PB), potato chips (PC), and carbonated beverages (CB) for a total of nine samples per panelist. The products were evaluated using the 3-point unbalanced consumer acceptability scale (3CA), the 5-point willingness-to-purchase scale (5WP), and the 9-point Hedonic liking scale (9HL). Each panelist used all three scales to evaluate all three products, but the matching of products with scales and

the presentation order were systematically randomized using a table of random numbers (Ott, 1993) to provide roughly equivalent product/scale matches and presentation order. Although it is statistically invalid, the Hedonic mean was calculated to provide a comparison to other consumer studies. The 5WP and 3CA scales are represented as percentages. Consumers scoring a product as a 4 or 5 on the 5WP scale contributed to the % Purchase. The 3CA scale was denoted by % Acceptable (includes samples rated "Tastes Great" and "Acceptable" by the consumers) and % Tastes Great. Evaluations were analyzed statistically using PROC GLM in the SAS statistical package v. 8.1 (SAS Institute Inc., Cary, NC.)

RESULTS

Consumer scores for the three products tested are shown in Tables 1-3. Panelists rated the PB sample 252 highest and PB sample 180 lowest on all three scales (Table 1). Although 252 appears as the brand of choice by the panelists, 845 also scored very high on % Acceptable (97), which suggests that a segment of the population found 845 comparably acceptable to 252. A significant percentage of consumers were willing to purchase 252 over the other two brands, while a significant percentage rated 180 less acceptable than the other samples.

Table 1. Consumer scores on 3 rating scales for the three brands of peanut butter.

Peanut Butter	252	180	845
Hedonic Mean	7.3a	6.6b	7.0ab
% Purchase	77a	51b	63b
% Taste Great	51a	40a	43a
% Acceptable	94a	83b	97a

Of the three potato chip brands tested, sample number 271 scored highest on all three scales (Table 2). Samples 922 and 836 received similar Hedonic mean and acceptability scores; however, 922 was significantly higher than 836 in willingness to purchase (Table 2).

Table 2. Consumer scores on 3 rating scales for the three brands of potato chips.

Potato Chip	271	836	922
Hedonic Mean	7.4a	6.3b	6.4b
% Purchase	62a	38b	59a
% Taste Great	45a	27b	38ab
% Acceptable	95a	80b	78b

Of the carbonated beverages tested, 569 received the highest Hedonic mean score of 6.3 followed by 682 with 6.0 and 442 receiving a 5.7 (Table 3). Significant differences were not observed for willingness to purchase or superior (tastes great) flavor, but 682 was significantly superior to 442 in acceptability.

Table 3. Consumer scores on 3 rating scales for the three brands of carbonated beverages.

Carbonated Beverage	442	682	569
Hedonic Mean	5.7b	6.0ab	6.3a
% Purchase	38a	47a	41a
% Taste Great	16a	28a	22a
% Acceptable	71b	85a	75ab

The effects of gender and presentation order are listed in Tables 4-7. There was a significant difference for gender using the Hedonic scale with potato chips and carbonated beverages (Table 4). Similarly, there was significant difference for gender that rated PC superior using the 3-CA scale. Further analysis of the PC data showed that the difference observed for 3-CA was due to a significantly greater percentage of female panelists (46%) rated one brand (a baked chip) compared to male panelists (22%). Presentation order made a significant difference with potato chips for the Hedonic mean score (Table 4) and for potato chips and carbonated beverages that were scored as superior in the 3-CA scale (Table 7). The lowest scores for superior flavor where reserved for the middle presentation order (Table 7). When the panelists where presented the chips last, the hedonic mean and superior flavor were scored lower than if they were presented second (Table 4 and Table 7). This observation suggests that those panelists who received the chips last were becoming fatigued or were losing interest in the test.

Table 4. Effect of gender and presentation order of test on Hedonic means.

		Chips	*Peanut Butter*	*Carbonated Beverage*
Gender	M	6.4b	7.0a	6.5a
	F	6.9a	6.9a	5.7b
Order	1st	6.8a	6.8a	6.2a
	2nd	7.0a	7.1a	5.9a
	3rd	6.1b	6.8a	5.8a

Table 5. Effect of gender and presentation order of test on percentage of consumers willing to purchase products.

		Chips	*Peanut Butter*	*Carbonated Beverage*
Gender	M	53a	60a	42a
	F	54a	66a	39a
Order	1st	47a	68a	43a
	2nd	60a	62a	45a
	3rd	53a	63a	33a

Table 6. Effect of gender and presentation order of test on percentage of consumers rating products acceptable or taste great.

		Chips	*Peanut Butter*	*Carbonated Beverage*
Gender	M	86a	90a	84a
	F	81a	93a	75a
Order	1st	86a	94a	82a
	2nd	85a	90a	73a
	3rd	78a	90a	82a

Table 7. Effect of gender and presentation order of test on percentage of consumers rating products taste great.

		Chips	*Peanut Butter*	*Carbonated Beverage*
Gender	M	29b	43a	25a
	F	42a	47a	21a
Order	1st	38ab	46a	25ab
	2nd	46a	37a	13b
	3rd	30b	49a	32a

The percentage of consumers who rated a specific sample in a category for each scale is given in Table 8. End effects did not appear to be a problem with the 3CA scale with 50% of consumers using the two end points. Three categories of the 5WP scale comprised 76% of the responses, while three categories of the 9HL scale contributed 64% of the responses.

Table 8. Percent of consumers who rated a specific sample in a category for each scale.

3 Point Acceptability Scale	% Scored
Tastes Great	34
Acceptable	50
Unacceptable	16

5 Point Willingness To Purchase Scale	% Scored
5-definitely would	22
4-probably would	31
3-might or might not	23
2-probably would not	17
1-definitely would not	7

9 Point Hedonic Liking Scale	% Scored
9-like extremely	12
8-like very much	25
7-like moderately	25
6-like slightly	14
5-neither like nor dislike	7
4-dislike slightly	8
3-dislike moderately	5
2-dislike very much	3
1-dislike extremely	1

DISCUSSION

The majority of the samples received high rankings since only brand name products were used. Overall, the scores for CB were generally lower then those collected for PB or PC. Although the CB samples were chilled and poured as close to testing as possible, only a short period of time at room temperature could lead to a loss of carbonation and acclimation to room temperature.

The most important observation from the data is that consumers are using different criteria of evaluation with the three scales. There does not appear to be a direct relationship between the three scales. Since 9HL scale measures liking and not acceptability, it is difficult to compare it to the other scales. Furthermore, the numbers used in the 9HL scale do not easily translate into usable information for companies (Malundo and others 1997, O'Mahony 1991). Of the scales tested, 3CA was the only scale that directly measures acceptability instead of inferring acceptability from other measurements. Although the two other scales tested suffered from end effects, 3CA did not have these problems. Also, the direct consumer relationship provided by the 3CA scale provides greater external validity (West 2000).

The 3CA scale was designed to mimic the "gut response" of consumers at the expense of decreasing internal validity. Untrained consumers are not likely to distinguish beyond a superior/ acceptable/ unacceptable evaluation. The three points (taste great/ acceptable/ unacceptable) were chosen over the more balanced scale (does not meet expectations / meets expectations/ exceeds expectations) after early one-on-one interviews with consumers found the latter scale to be confusing (personal unpublished observation). Since the 3CA data are not presented as means, unequal intervals do not

pose a problem. Although the 5 WP scale does not directly measure acceptance, the scores represent intended behavior. In this study, the results from the 5WP scale were similar to those obtained from 3CA, providing a useful alternative for those who are concerned about the lack of balance in the 3CA scale.

Although major advances have been made in sensory descriptive analysis in the last two decades, consumer testing has seen little or no change. When conducting consumer panels using a scale that accurately measure consumer acceptability is important.

CONCLUSION

When consumers evaluate products, the scale used can affect the results and thus the conclusion. Designed to mirror the "gut-response" of consumers to products, the 3CA scale offers clearer insight into consumer desires than 5WP or the traditional 9HL. Adoption of more appropriate scales will provide more meaningful consumer data in evaluating new products and product concepts.

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CHAPTER 5

SUMMARY AND CONCLUSION

Consumer preferences directly affect a consumer's decision to purchase and consume fresh produce. Understanding and measuring the quality characteristics specific for each commodity is the key to ensuring the continued consumption of fresh fruits and vegetables. Qualitative research aids in better understanding the product perception process experienced by consumers (van Trijp and Schifferstein, 1995; Malundo, 1996). Common methods to obtain qualitative data include interviews and focus groups (Krueger, 1994; Resurreccion, 1998). The incorporation of Internet chats to consumer research enables the collection of data from people of varying geographic locations with minimal cost and equipment.

In Chapter 2 it was shown that consumers look for fruit with consistently high quality. Flavor and texture are the main areas that lead to consumer dissatisfaction with fresh fruit. Repeated exposure to a commodity with unacceptable quality attributes leads to consumers who are unlikely to return to purchase that item. Satisfaction with fresh fruit could be enhanced by harvesting produce items that are more mature or by providing a variety of cultivars that more closely relate to the characteristics consumers seek. Additionally consumers should be provided with accurate information on proper handling and storage techniques of fresh fruits to help diminish the amount of quality loss that occurs in the home environment.

In Chapter 3 we found that vegetables that do not meet consumers' quality standards are thrown away. Poor texture, flavor and appearance are the main areas that lead to consumer dissatisfaction with fresh vegetables. Minimizing the amount of water loss by vegetables during home storage could enhance consumer satisfaction of fresh

vegetables. Information on proper handling and storage techniques for fresh vegetables would help diminish the amount of quality loss that occurs in the home environment.

When evaluating different scales used to determine consumer acceptability in Chapter 4, it was observed that the 9HL does not measure acceptability and was not always comparable to the other two scales. End effects were not observed in 3CA, while 5WP and 9HL were essentially reduced to three-point scales. Overall, the 3CA offers clearer insight into consumer desires than 5WP or the traditional 9HL. Adoption of more appropriate scales of consumer preference will provide more meaningful consumer data in evaluating new products and product concepts than the now widely used 9HL.

Despite several advances made with technology and in the scientific community, consumer research has not changed much in the past 50 years. Utilizing the Internet and developing better scales to measure consumer preferences can help ensure that consumer desires are being heard. Data collected from consumers via the Internet was similar to the responses that would be expected from in-person interviews or focus groups. Although this research focused on fresh produce, the techniques described in this thesis can be applied to any other food product to better determine the needs, wants, and desires of the consumer. This information collected from consumers can then be used by growers, handlers, and manufacturers to improve the attributes, competitiveness, and marketability of fresh and formulated foods. Future consumer research should focus on combining sensory descriptive analysis with consumer acceptability testing to better understand consumer desires.