CONSUMER ACCEPTABILITY OF AROMATIC AND NON-AROMATIC RICE

by

MEERA DEVERIYA

(Under the Direction of ROBERT L. SHEWFELT)

ABSTRACT

Rice is among the most important staple crops consumed worldwide. Segmentation of consumer acceptability of rice flavor can be used as a tool to improve consumer satisfaction. Consumer tests were conducted to determine differences in the acceptability of aromatic and non-aromatic rice among different ethnicities. Consumer acceptability of rice was found to vary widely among different ethnicities and nationalities. Research directed towards improving rice flavor should highly be cognizant of differences among nationalities when determining acceptability of rice samples. Combination of sensory descriptive analysis with consumer testing yielded predictive equations that helped to identify key descriptors contributing to acceptability. Breeders can potentially use these specific characteristics to further enhance rice quality.

INDEX WORDS: Consumer acceptability, Segmentation, Sensory descriptive Analysis, Predictive Equations, Flavor, Rice.
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DEDICATION

This thesis is dedicated to my dearest hubby who made this possible for me.
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CHAPTER 1
INTRODUCTION AND LITERATURE REVIEW

Rice is the world’s most important staple food. The crop is tolerant to wide range of production conditions. There are 20 Oryza species, two of which are sativa, which originated in the humid tropics of Asia, and glaberrima, which originated from West Africa. Asian cultivated rice has evolved into three eco-geographic races (indica, japonica and javanica). Indica cultivars account for 80% of cultivated rice, and feed about three billion people, mainly in developing countries. Indica and japonica vary widely in grain shape, size, color and chemical composition. These cultivars have different quantities of amylose and amylo-pectin which affect cooking quality and possible uses (Chaudhary et al., 2001). Almost 90 per cent of the rice area is located in Asia, with India and China sharing 50 per cent of global rice production. The three main economies in Asia (India, China, and Indonesia) account for 60 per cent of the global rice production. The Japanese, with one of the highest per capita incomes in the world, consume rice at almost every meal.

Aromatic rice can be identified by its distinctive, nutty flavor, and a "popcorn-like" aroma. Jasmine, Della and Basmati are aromatic rice types that have increased consumer acceptance in recent years. Rice consumption is increasing in the United States, due in large part, to the growing ethnic populations, particularly the Mexican and Asian, that eat rice as a staple in their diets. There is little information of the factors that contribute to the acceptability of rice flavor and how consumer preferences differ among ethnic groups. The basic chemical composition of the rice grain, which forms the basis for the eventual cooked flavor, is genetically controlled and can be modified via breeding.
RICE TYPES

Rice can be divided into two main categories aromatic and non aromatic rice. Asia's aromatic rice includes Jasmine rice from Thailand and Basmati from India and Pakistan.

Non-aromatic rice types are neutral in flavor and usually short grained. Examples of rice forms include organic, boutique, brown, pigmented, sticky, parboiled and milled rice. Some rice types are valued for their color, which is determined by levels of anthocyanin pigment in different layers of the pericarp, seed coat and outer grain layer(Tajima et al., 1992). The endosperm color of rice ranges from white and various shades of translucent to red, purple and black (Chaudhary et al., 2001). Glutinous rice, also called the sticky rice, has different consistencies, which are determined by two kinds of starch in the kernels, amylose and amylopectin. The more amylopectin gives rice stickier structure. Glutinous rice is easily distinguished from other type by its milky color. Combining glutinous and aromatic characters creates "boutique" rice, which include many traditional Lao cultivar and others grown and consumed in Thailand and Cambodia. These rice types are considered to have the greatest potential for export markets, and breeding programs have focused on boosting their yield. In China, scientists have developed waxy-aromatic type, Shangganxiangnuo, from a local aromatic cultivar japonica. Surveys have shown that both developed and developing countries in Asia grow rice organically (Chaudhary et al., 2001).

RICE FLAVOR

Flavor perception is a response to compounds present in a particular food. It involves a complex series of reactions with the food and our nose, tongue and other parts of our mouth. The main ingredients that determine rice texture are rice starches, proteins and lipids which affect its
cooking and eating quality and the rice of good eating quality shows low amylose and low
protein contents and large breakdowns that can be measured by amylo graphs (Zhou et al., 2002).
It was found that aroma and appearance were the most important acceptance factors for cooked
rice, for Asian consumers living in the United States. Though the chemical composition of rice
grains varies widely, depending on environment, soil and variety but the net protein utilization
and digestible energy in rice are the highest amongst the common cereal grains (Zhou et al.,
2002). The rice grain comprises of the hull and the caryopsis (Champagne et al., 2004) and
removal of the hull during milling produces brown rice. Starch forms about 90% of milled rice
and endosperm cells are packed with amyloplasts that contain starch granules (Azhakanandam et
al., 2000). The headspace of fragrant rice varieties has shown that 2-acetyl-1-pyrroline is the
main cause of distinctive fragrance in aromatic rice like Jasmine and Basmati. Basmati grains
contain 0.09 parts per million of the chemical compound 2-acetyl-1-pyrroline, which is about 12
times more than concentrations found in unscented rice varieties and gives Basmati its distinctive
spicy fragrance. The aroma combined with fine, slender grains and a soft, fluffy texture after
cooking has made Basmati the world's most sought-after rice commanding prices up to 10 times
more than common rice on international markets (Chaudhary et al., 2001). The desirability of
fragrance has resulted in strong human preference and selection of aromatic rice. Non fragrant
varieties of rice contain much smaller amounts of 2-acetyl-1-pyrroline (Widjaja et al., 1996).
The palatability of cooked rice is mainly attributed to the sweetness, which is affected by free
sugars like glucose and sucrose. Studies carried on milled, Japonica and Indica brown rice to
detect changes in taste during storage revealed that the main taste components of cooked rice
sucrose, glutamic acid and aspartic acid were reduced during storage whereas sugars like glucose
and fructose were increased. Also the off taste of cooked stored rice may be contributed to the increase of fat acidity and decrease of the pH value of the cooking solution (Tran et al., 2005).

**RICE CONSUMPTION**

Rice consumption is increasing worldwide due to growing population demands. Export markets in Europe and North America are expanding rapidly and local demand is also strong (Chaudhary et al., 2001). The two major types of aromatic rice; Jasmine of Thai origin and Basmati that of Indian origin are consumed heavily in the countries of origin. Australia is a major producer of Thai rice. Non-aromatic varieties including milled, parboiled, kokuho, brown and pigmented rice are also consumed widely in most Asian countries. In China, non-milled black rice is used as natural colorant in cakes, dumplings, porridge, New Year cakes and black wine. It is also considered highly nutritious, rich in B vitamins and is believed to contain many trace elements like manganese and calcium. Sticky or glutinous rice is mostly consumed mainly in dry areas of northern Thailand, Laos and Cambodia - it is often used as an ingredient in sweet dishes and snacks, and for brewing beer. Laos is the largest producer and consumer of glutinous rice, which accounts for about 85% of its rice production (Chaudhary et al., 2001). Rice is an important food for consumers in Ghana and West Africa (Tomlins et al., 2005). It’s a staple crop in Orient and is highly valued in Latin America and Caribbean. Brazilians prefer long grain milled rice and they are the most important consumers outside Asia. Also research has shown that tastes and differences of urban people are different from rural people because of different lifestyles and level of physical labor (Sabaa and Sharaf 2000). According to (Bouis, 1991) there is lower rice consumption in urban areas versus rural ones because usually urban population has higher incomes and they can substitute rice with more preferred foods. Also people involved in
physical labor indulge in more staple based foods as they are inexpensive means of providing energy. Previous research has shown that rice consumption is directly based on the per capita income of individuals (Bouis, 1991)

**PRICE ACCEPTABILITY AND CONSUMER PREFERENCE**

Behavioral pricing research has shown that many consumers select products primarily on price (Ofir, 2004). Individual consumers appear to have upper and lower thresholds (Monroe, 1973). A lower threshold is the one below which prices signal poor product quality and upper threshold above which the price of product is considered overpriced. Thus changes in the price of rice have an effect on consumption with lower prices stimulating consumption and higher prices suppressing consumption (Sabaa and Sharaf 2000).

**SENSORY ANALYSIS OF RICE**

Sensory analysis utilizes different tools or tests that involve humans in assessing the quality characteristics of foods or food ingredients (Drake, 2004). Mainstream tests can be divided into two categories- affective and analytical. Affective tests utilize consumers to assess their perceptions of acceptability and are useful in exploring the role of flavor, texture and appearance in choice, acceptability and response (Lawless and Heymann, 1998). Analytical tests involve use of trained panelists whose responses are treated as instrumental data. They include discriminatory tests such as difference, threshold and descriptive analysis. Descriptive analysis is widely used for qualitative and quantitative differentiation of food and to explore and define relationships between sensory and instrumental perception. An important aspect of
Descriptive analysis is in training a group of individuals to evaluate specific sensory properties analytically (Drake, 2004).

The three basic categories of sensory quality are texture, color and flavor. Flavor is further divided into aroma and taste. Taste is perceived by tongue receptors and classified primarily into sweet, sour, bitter, salty. Aroma involves the perception of volatile compounds by receptors in the nose both before and during the eating process and is perceived both orthonasally and retronasally. Flavor results from interaction of the palate with a complex mixture of organic and inorganic compounds. Textural properties such as crispness, crunchiness, stickiness and sliminess also form an important part of sensory perception of foods.

A study performed to check the sensory and instrumental relationships of cooked rice texture revealed that rice texture was influenced by a variety of factors such as cultivar characteristics, postharvest handling practices, milling degree, drying conditions, final moisture and cooking method. Combined sensory and instrumental data revealed that sensory attributes accounted for most variation and sensory descriptive analysis was more sensitive to subtle changes in initial texture perception parameters relating to stickiness and adhesiveness. (Lyon et al., 2000)

Subsequent sensory evaluation of cooked rice indicated that the intensity of sensory hardness was the most important characteristic of cooked rice (Srisawas and Jindal, 2007). The overall acceptability based on appearance, texture and flavor attributes reached peak levels corresponding to optimum water rice ratios for different rice cultivars, and was highly correlated with sensory hardness and stickiness. The study indicated that the acceptability ratings of cooked rice could be reliably predicted from the physicochemical properties like the apparent amylose content, protein content, gel consistency, alkali-spreading value and grain elongation ratio of
milled rice. Research conducted to determine sensory and chemical properties of aromatic and non aromatic rice indicated that 2-acetyl-l-pyrroline was positively correlated with the descriptive aromatic terms and hexanol negatively correlated.

CONSUMER ACCEPTABILITY OF RICE

Consumer acceptability is critical for survival of any product in the market. Consumer testing indicates liking or preference for a particular product. It can be measured directly by comparing two or more products or indirectly by comparing product scores (Stone and Sidel, 1992). As consumer research is expensive and time-consuming, researchers attempt to develop predictive models (regression) by linking sensory and consumer preference data to predict consumer behavior (Krishnamurthy et al., 2007). Several statistical methods like multiple linear regression (MLR), principal component regression (PCR), and partial least squares regression (PLS) are used for analysis of consumer research data. Data obtained from several comparable sources provide the basis for correlation analysis. Although correlations are not sensitive to absolute values, they can provide insight if the relative differences among products are comparable to other panels (Stone and Sidel, 1992). Consumer perception and acceptance of food quality depends on a number of factors like risk associated with different foods, ethical concerns and lack of consumer confidence (Frewer, 2003). Consumers may either turn to brands they trust more strongly or provide reassurance in terms of risk perception or they might switch to retailers with stronger images of trustworthiness (Aaker, 1991; Mitchell, 1998). Also consumers might prefer products involving less technology and processing as compared to the ones that require more (Bennet and Jones, 1999).
Consumer (affective) tests tend to be less controlled than other types of sensory testing. Consumers generally are not sufficiently reliable in determining specific quality characteristics such as those typically used in analytical tests however they are effective in determining acceptability. There are two types of consumer tests one involves the use of focus groups and other uses actual large consumer taste panels. Focus groups usually contain eight to twelve people that are interested in the product and are led by a group leader who attempts to elicit a wide range of responses. Focus groups provide ideas that can enhance understanding of consumer preference (Shewfelt, 1996). Consumer panels involve a group of consumers that are randomly selected for the study. The number of panelists required for a consumer panel is not clear. One recommendation indicates that 100 people are adequate for most problems handled in small consumer tests and 50-300 are adequate for central location tests (Chambers and Wolf, 1996.). However, other investigators recommend 75-300 consumers per city (Meilgaard et al., 1999), or 25-50 subjects per product in laboratory testing and 50-100 families for home use tests with 100 or more responses in central location tests (Stone and Sidel, 2004). Heinemann et al., (2006) observed that rejection of parboiled rice was not based on the sensory properties as consumers were unaware of its presence and nutritional benefits. They also noted that 35% of the respondents were unaware of parboiled rice. This study concluded that marketing efforts were required to inform consumers about the health benefits and convenience of eating parboiled rice.

A similar study conducted to compare Australian fragrant, imported fragment and non fragrant rice aroma revealed that consumer panelists were able to distinguish between all the three varieties based on aroma, but there were differences in response based on age, gender and cultural backgrounds. The study indicated that aroma for Australian fragrant rice was preferred over other the two varieties. Simultaneous distillation extraction for volatile compounds
indicated that non fragrant rice contained approximately twice the amounts of 2-hexenal (E), nonal, 2-pentylfuran, and 2-octenal (E), and significantly more 2 nonenal (E) and hexanal, compared to the fragrant rices. Also 2-acetyl pyrrole was present in both fragrant rice and not in non-fragrant one (Wilkie et al., 2004).

Another study carried out in Ghana, to measure urban consumer preferences and sensory evaluation of locally produced and imported rice showed that majority of Ghanian consumers preferred imported raw and parboiled rice when compared to the local brand as the local brands were of poor quality. The results were influenced by location and gender and the regression model were based on either brown color or unshelled paddy in the uncooked form. Responses showed slight differences in the acceptability between men and women with women preferring imported rice over men. Older men tended to prefer the brown colored local rice. Individual consumer preferences revealed four consumer segments of which the largest segment (34%) were the least discriminatory and preferred all the samples, in particular the imported ones. The next largest segments (32% and 20%) were more discriminating and disliked the local rice samples to varying degrees. The smallest or niche segment (14%), liked the imported samples less than the other segments the local samples the most. The scores were inversely related to consumer preference for three segments. The study concluded that though consumer acceptability could be predicted both from the sensory scores of the uncooked rice or the cooked product, but the use of cooked rice is also important to confirm the absence of taints and off-flavors (Tomlins et al., 2005).

Suwansri et al., (2002) showed that consumers preferred imported over domestic products and the sensory characteristics most important to the acceptance of cooked Jasmine rice
were, in order of decreasing importance, color, flavor (that is, aroma, aromatics, feeling factors) aroma, stickiness, hardness and visual attributes.

Although many studies have been conducted on sensory quality and consumer acceptability of rice there is no definitive information on preferences of ethnicities for aromatic rice. This study involves four different ethnicities and their acceptance of eight different rice varieties using willingness to purchase scale.

OBJECTIVES:

The general objectives of this research were to determine consumer acceptability of aromatic rice, extending the predictive models developed for flavor to individual market segments, and testing the validity of mathematical models to predict consumer acceptability of flavor. The specific objectives were:

1) To identify the potential market segments for consumer acceptability of rice based on response of consumers of different ethnicities.

2) To determine the relationship among sensory characteristics of selected rice types and the acceptability by consumers from different ethnic populations.
REFERENCES:


CHAPTER 2

SEGMENTATION OF CONSUMER ACCEPTABILITY OF RICE FLAVOR

1Deveriya, M.and Shewfelt,R.L. To be submitted to Journal of Food Science
ABSTRACT

A lack of ready tools available to the plant breeder makes it difficult to select for flavor traits. A long-term goal of our laboratory is to develop a series of tools that permit rapid, accurate screening of selections for flavor. The main objective of the present study was to evaluate the effects of different types of rice selections (aromatic and non-aromatic) and consumer nationality on flavor acceptability of cooked rice. Our ultimate goal is to develop predictive models for flavor within individual market segments and further test the validity of mathematical models to predict consumer acceptability of flavor. Consumers (n=120) evaluated eight selections of rice representing a diverse cross-section of flavor types for willingness to purchase. A single page survey revealed that mostly participants purchased rice from Asian grocery stores. Flavor and appearance were the major criteria for buying rice in these ethnic groups. Dramatic differences were found in the acceptability of the rice selections assessed among ethnic groups. Indian participants preferred the Basmati types to non-aromatic rice, those of Chinese origin preferred Jasmine brands to Basmati and non-aromatic rice, Korean consumers favored a medium-grain Japanese brand to all other brands tested; and Mexican participants were less discriminating among the brands tested. This information will be useful in selecting breeding lines and developing new improved cultivars for specific ethnic populations.
INTRODUCTION

Aromatic rice varieties are of great interest because of their high quality, pleasant fragrance, soft texture and high market prices but there is little scientific information available on flavor quality and consumer acceptability of aromatic rice. 2-Acetyl-1-pyrroline has been reported as the most important aroma compound that contributes to the flavor notes in aromatic rice (Buttery et al., 1982). This compound is positively correlated with the descriptive terms for rice odor, pandan for the orientals and popcorn for the non-orientals used for aromatic rice (Sirisooontaralak and Noomhorm, 2006).

Characteristic odor in aromatic rice is due to volatile components released from rice and are vulnerable to change in the composition under diverse conditions (Sugunya et al., 2004). Postharvest conditions like temperature, drying, storage conditions, moisture content are reported to have effect on sensory, physical, chemical and pasting properties of rice (Daniels et al., 1998). Consumer preference for rice varieties is based on ethnicities and regions. Generally consumers prefer cooked grains to be firm and non-sticky (Priestly, 1994). Brazilian consumers prefer parboiled to milled rice. Philippines consumers preferred milled rice with soft texture. Sri Lankans consider shape, aroma, percentage of headspace and other such factors while considering rice. (Mundo and Juliano, 1981,Kotagama and Kumara, 1996). Also a high correlation between hedonic ratings by US consumers and sensory attributes like dryness, stickiness, rubberiness, starchiness, rice flavor and compactness were reported (Schutz and Damrell, 1974). No published reports were found on determining consumer acceptability of aromatic rice based on different ethnicities. The objective of this study is to identify the potential market segments for consumer acceptability of rice based on response of consumers of different ethnicities.
MATERIALS AND METHODS

Experimental Materials

All rice samples were obtained from Buford Farmers Market in Atlanta and stored in the containers until the final day of use. The main types of rice chosen were: imported Basmati (Arya), domestic Basmati (Texmati), imported Jasmine (Golden Elephant), domestic Jasmine (Asian Best), long grain (Mahatma), black rice (Asian Taste), sticky sweet (Three Rings), and Japanese medium grain (Kokuho Rose).

Preparation of Cooked Rice

The rice samples were prepared using SANYO ECJ-D100s 10Cup MICOM rice cooker and warmer (Chatsworth, CA 91311). The ratio used for rice to water was 1:1.5 by weight i.e. for 100 grams of rice 150 ml of water was used. All rice varieties were cooked for approximately 45 minutes before the cooker was turned off. Cooked rice were immediately transferred to Styrofoam cups and covered with lids. It was then kept in a heated thermos box to maintain desired temperature until served.

Consumer Testing

The consumer acceptability of the eight rice types was evaluated by participants of four ethnicities Chinese Indian, Korean and Mexican. The ethnicities were chosen based on their consumption of both aromatic and non- aromatic rice. Indians usually consume Basmati, whereas Chinese and Koreans prefer Kokuho rice and Mexicans consume both long grain and short grain rice. The panelists were recruited at an international coffee hour on the University of Georgia campus, a Mexican grocery store, as well as Korean and Chinese churches. A total of 120 consumers (61% males and 39% females) whose ages ranged from 18-60 participated in consumer testing studies. Thirty participants from each ethnicity were recruited and presented
with rice samples and a survey onsite. Sets of eight samples were labeled with 3-digit random numbers and were served in random order to the panelists. They were asked to evaluate each sample based on 5 point willingness to purchase scale (5= definitely would buy, 4=probably would buy, 3=might or might not buy, 2=probably would not buy, and 1= definitely would not buy) (Moskowitz, 1993). Participants were provided unsalted crackers and water to cleanse their palates between samples. Participants also completed questionnaires about demographic data based on age, gender, type of rice, as well as questions specifically related to quality expectations and purchase behavior for rice. Each participant was given a small food reward for their participation.

**Statistical Analysis**

Any rice type with a rating of 4 (probably would purchase) and 5 (definitely would purchase) was considered to be acceptable to the participant (Moskowitz, 1993). Superior acceptability was defined as a rating of 5 (definitely would purchase). Data from willingness to purchase scale from consumer tests were further analyzed using Statistical Analysis Software v.6.12 software package using analysis of variance and means separation (p<0.05) by Duncan’s Multiple Range Test.

**RESULTS**

Consumer acceptability of aromatic rice using the willingness-to-purchase scale revealed there were dramatic differences in flavor acceptability by ethnic origin (Table 1). Indian participants found the sweet sticky rice (76.7%), the domestic Basmati samples [Texmati (76.7%)] and the imported Jasmine types [Golden Elephant (66.7%), Asian Best (70.0%)] to be acceptable but rejected the Japanese medium grain (20.0), the imported Basmati [Arya (13.3%)]
and black glutinous (3.3%) rice. Chinese participants preferred the imported Basmati [Arya (66.7%)] and one Jasmine selection [Golden Elephant (60.0)], Japanese medium-grain (60%), black glutinous (56.6%), and sweet sticky (46.7%) types to the domestic Basmati [Texmati (23.3%)] and the other Jasmine [Asian Best (13.3%)] and long-grain [Mahatma (13.3%)] samples. Participants of Korean ethnicity highly preferred the Japanese medium-grain selection [Kokuho (63.3%)] over the imported Jasmine [Asian Best (6.7%)]. Mexicans found the Japanese medium grain (66.7%) and American Basmati [Texmati (66.7%)] and Jasmine Asian Best (56.7%) types to black glutinous (23.3%) and sweet sticky (20.0%) rice. The variability of differences in acceptability by ethnicity is emphasized by the observation that no sample was rated as the highest or lowest category by each of the four ethnicities. The smallest difference in acceptability across ethnicities was 40.0% (Mahatma). The largest difference in acceptability across ethnicities lowest was 63.3 % (Asian Best). Acceptability in the total sample ranged from a high of 52.5% for Kokuho down to a low of 30.0% for Asian Taste.

Consumer acceptability was very similar for superior acceptability, where consumers reported definitely buy for the desired varieties.(Table 2) Indians preferred American Basmati [Texmati (40%)], imported Jasmine [Asian Best (46.7%) and Golden Elephant (43.3%)] and sweet sticky rice [Three Rings (46.7%)] accounting more than 50% of the acceptable ratings. Chinese preferred domestic medium grain Japanese rice [Kokuho Rose (30%)] imported Basmati [Arya (43.3%)] and imported Jasmine [Golden Elephant (33.3%)]. Koreans preferred domestic Medium Grain Japanese rice [Kokuho Rose (40%)] and imported Basmati [Arya (20%)] and domestic Long grain [Mahatma(16.7%)] Mexicans preferred domestic Medium grain Japanese rice [Kokuho Rose (40%)] domestic American Basmati [Texmati (40%)], domestic Long grain [Mahatma (33.3%)] and imported Jasmine [Asian Best (33.3%)]. As shown in Tables 3 and 4
appearance, aroma, grain size and label were used as criteria in the purchase decision. Taste (more appropriately flavor), aroma and texture were used as criteria for consumption acceptability. Also, of the total 120 consumers 87% agreed that they were satisfied with the rice available in Georgia as compared to 13% who didn’t like it either due to price or flavor. Consumers participating in the studies showed variation in purchase preference based on ethnicity. Consumers of Indian, Chinese and Korean ethnicities preferred Asian grocery store as the number one purchase destination followed by supermarket, specialty shops. Mexicans participants reported supermarket as the number one purchase destination followed by specialty shops, mail order and Asian grocery stores (table 5). There were differences in both purchase and consumption criteria among different ethnicities (tables 3 and 4). Indians considered grain size to be the most important purchase criteria followed by aroma, appearance and label. Taste followed by aroma and texture were important consumption criteria. Chinese considered label as the number one purchase criteria followed by appearance aroma and grain size.

Taste followed by texture and aroma was important consumption characteristics for Chinese. Korean participants considered Label followed by appearance aroma and grain size to be important purchase criteria and taste followed by aroma and texture as the important consumption criteria. Mexican consumers considered appearance to be the number one purchase criteria followed by grain size and aroma. Taste followed by aroma and texture were important consumption criteria.

**DISCUSSION**

The present study compared acceptability of aromatic (Texmati, Asian, Arya Golden and Black) with non-aromatic (Kokuho, Mahatma, and Sticky) rice. The main focus of the study was
the response of different ethnicities towards consumption of eight different rice varieties. Globalization has led to changes in consumer demands and has affected consumer evaluation (Torjusen et al., 2001). Consumer preference of foods is highly diverse and the important quality aspects are related to flavor, nutrition value, attractive appearance, safety, health and quality is perceived differently by each individual (Mannion et al., 2000). Results demonstrated were wide variations in the acceptability based on different nationalities, which indicated that consumer acceptance for a particular product highly depends on their mindsets and flavor perceptions.

As expected, consumers preferred rice types that they generally consumed over those that were unfamiliar to them. These results were similar to the study carried out on acceptability and consumer attitude towards parboiled rice were majority of consumers rejected it because of their unfamiliarity towards the rice and not the sensory properties (Heinemann et al., 2006). Indians preferred one of the Basmati rice, which are common in the country and did not find pigmented rice, which is not readily available in India, to be acceptable. The negative response to the imported Basmati selection was not expected.

The Chinese participants found pigmented rice, frequently consumed in China for desserts, puddings and various sweet snacks, to be more acceptable while rejecting some Jasmine and Basmati types. Korean consumers clearly preferred the medium-grain Kokuho rice, typical of types widely consumed in Korea, to all other brands. Those of Mexican ethnicity found the lowest acceptability for pigmented and sticky rice, rarely found in North America. These results were similar to the previous study carried out in West Africa on locally produced and imported rice where consumers liked the samples from their own regions over the ones that were unfamiliar to them (Tomlins et al., 2003). Also purchase and consumption criteria clearly showed consumer preference based on their perception and preference.
The most interesting result was the clear separation of preference segments by ethnic origin. Only one of the brands (Kokuho) was rated in the top two categories (probably or definitely would purchase) considered acceptable by more than 50% of the participants. All brands were preferred by at least 50% of the participants from at least one ethnicity. Only two brands (Mahatma and Asian Taste) did not reach 60% acceptability by any ethnic group. With respect to the aromatic rice, Indians preferred one Basmati brands and both Jasmine brands, Chinese liked one Jasmine brand and one Basmati type which was similar to the study in the past where Asian consumers preferred imported jasmine rice based on color flavor and aroma (Suwansri et al., 2002). Korean participants did not like either Basmati or Jasmine, and those of Mexican ethnicity showed no generalizable differences between aromatic and non-aromatic types. Superior acceptability results were similar to acceptability results except they emphasized the real willingness of individuals to buy particular rice brands. Indian nationals rated Asian Best and Golden Elephant highest among others. Chinese participants rated Basmati Arya as the highest, Korean consumers rated Kokuho Rose as the highest and Mexicans participants rated Kokuho Rose and Texmati among others.

These results show that it is important to note differences between nationalities when determining acceptability of rice samples. Representatives of different ethnicities living in Georgia were used to demonstrate differences between different countries as logistics and funding prevented investigation in Mexico and Asia. The value of this study is to show that there are distinct differences between ethnicities and not the specific differences within these countries. We suspect that the trends we observed would hold in these countries but that there would be regional preferences within each of these countries. In addition to segmenting by
ethnicity which worked well with aromatic and non-aromatic rice types, segmentation can also be performed by specific quality characteristic (Moskowitz, 1993; Shewfelt, 2000).

**CONCLUSION**

Indian participants preferred Basmati and one Jasmine brand, Chinese consumers liked Jasmine over Basmati, and those of Korean ethnicity preferred Japanese medium grain Kokuho rice and Mexican nationals did not show any considerable difference in acceptability. Thus it could be concluded that consumer acceptability of rice highly depends on differences in national origin. Both purchase and consumption criteria like aroma, appearance, grain-size, label and texture varied by ethnicity. It is evident that consumer acceptability plays a very important role in product screening as it reduces the number of alternatives by eliminating poorly performing products. Rice breeders attempting to improve flavor acceptability of aromatic rice should take into consideration the preferences of the target population segment rather than a general population(Kotagama and Kumara, 1996).
Table 2.1: Effect of ethnic origin on acceptability rated “probably would purchase” or “definitely would purchase” of eight different brands of rice. **Aromatic rice types are shown in bold.** Each ethnic group was represented by 30 participants.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Type</th>
<th>Brand</th>
<th>Indian</th>
<th>Chinese</th>
<th>Korean</th>
<th>Mexican</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>Medium grain (Japanese)</td>
<td>Kokuho Rose</td>
<td>20.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>63.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>66.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>52.5</td>
</tr>
<tr>
<td></td>
<td>Long grain</td>
<td>Mahatma</td>
<td>46.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>53.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>American Basmati</td>
<td>Texmati</td>
<td>76.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>66.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.4</td>
</tr>
<tr>
<td>Imported</td>
<td>Basmati</td>
<td>Arya</td>
<td>13.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>66.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.3&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>Jasmine</td>
<td>Asian Best</td>
<td>70.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>56.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>Jasmine</td>
<td>Golden Elephant</td>
<td>66.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>60.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>33.3&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>Black glutinous rice</td>
<td>Asian Taste</td>
<td>3.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>56.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>23.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Sweet sticky rice</td>
<td>Three Rings</td>
<td>76.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>45.0</td>
</tr>
</tbody>
</table>

<sup>abc</sup> Values followed by the same letter in a column are not significantly different (p<0.05) as determined by Duncan’s Multiple Range Test.
Table 2.2: Effect of ethnic origin on superior acceptability (definitely would purchase) of eight different brands of rice.

**Aromatic rice types are shown in bold.** Each ethnic group was represented by 30 participants.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Type</th>
<th>Brand</th>
<th>Indian</th>
<th>Chinese</th>
<th>Korean</th>
<th>Mexican</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>Medium grain (Japanese)</td>
<td>Kokuho Rose</td>
<td>10.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>30.0&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>40.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Long grain</td>
<td>Mahatma</td>
<td>26.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>10.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>16.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>33.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td>American Basmati</td>
<td>Texmati</td>
<td>40.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>10.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.8</td>
</tr>
<tr>
<td>Imported</td>
<td>Basmati</td>
<td>Arya</td>
<td>6.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>43.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Jasmine</td>
<td>Asian Best</td>
<td>46.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>33.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>Jasmine</td>
<td>Golden Elephant</td>
<td>43.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>10.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>Black glutinous rice</td>
<td>Asian Taste</td>
<td>3.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>23.3&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Sweet sticky rice</td>
<td>Three Rings</td>
<td>46.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.7&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.0</td>
</tr>
</tbody>
</table>

<sup>abc</sup> Values followed by the same letter in a column are not significantly different (p<0.05) as determined by Duncan’s Multiple Range
Table 2.3: Variation of Purchase criteria by ethnicity expressed as percentage of the specific population

<table>
<thead>
<tr>
<th>Purchase Criteria</th>
<th>Indian</th>
<th>Chinese</th>
<th>Korean</th>
<th>Mexican</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>70</td>
<td>33</td>
<td>20</td>
<td>50</td>
<td>43</td>
</tr>
<tr>
<td>Aroma</td>
<td>77</td>
<td>33</td>
<td>17</td>
<td>20</td>
<td>37</td>
</tr>
<tr>
<td>Grain Size</td>
<td>80</td>
<td>20</td>
<td>7</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td>Label</td>
<td>43</td>
<td>53</td>
<td>30</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>13</td>
<td>37</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>
Table 2.4: Variation of consumption criteria by ethnicity

<table>
<thead>
<tr>
<th>Consumption Criteria</th>
<th>Indian</th>
<th>Chinese</th>
<th>Korean</th>
<th>Mexican</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste*</td>
<td>87</td>
<td>73</td>
<td>63</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>Aroma</td>
<td>83</td>
<td>27</td>
<td>23</td>
<td>17</td>
<td>38</td>
</tr>
<tr>
<td>Texture</td>
<td>67</td>
<td>43</td>
<td>20</td>
<td>17</td>
<td>37</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>7</td>
<td>13</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

*consumers are generally referring to flavor (taste plus retronasal aroma) when responding with “taste” on an open-ended questionnaire)
Table 2.5: Variation of purchase preference by ethnicity

<table>
<thead>
<tr>
<th>Purchase preference</th>
<th>Indian</th>
<th>Chinese</th>
<th>Korean</th>
<th>Mexican</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supermarket</td>
<td>23</td>
<td>13</td>
<td>7</td>
<td>57</td>
<td>25</td>
</tr>
<tr>
<td>Asian Grocery</td>
<td>80</td>
<td>87</td>
<td>60</td>
<td>3</td>
<td>57</td>
</tr>
<tr>
<td>Specialty shop</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Mail Order</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>
REFERENCES:


CHAPTER 3

CONSUMER ACCEPTABILITY OF RICE AS A FUNCTION OF SENSORY DESCRIPTIVE NOTES

ABSTRACT

Eight rice brands obtained from the international farmers market were evaluated for twenty two descriptors by trained panelists using 150 mm unstructured line scales. Consumers (120) of four different ethnicities evaluated these brands using a willingness-to- purchase scale ranging from “will definitely buy” to “will definitely not buy”. Pearson correlation and regression backward elimination were used to link consumer acceptability to sensory descriptors. Starchy, sweet and buttery notes were positively related to acceptability by Mexican consumers, whereas astringent was negatively related. Chinese consumers showed a negative reaction to bitter taste notes and responded positively to starchy, sweet, metallic and corn. Flavor notes of popcorn, metallic, and bitter were popular with Indian consumers who disliked sweet, corn, and buttery. Korean participants liked rice with a grainy note but not those with bitter and woody notes. In evaluating rice acceptability, it is critical that results are segmented by ethnicity of participants.
INTRODUCTION

Rice is an important food commodity both domestically and internationally. Aromatic rice is characterized by a particular aroma which forms an integral part of its sensory and physical properties. 2 Acetyl 1 pyrroline has been shown to be the compound responsible for characteristic rice flavor (Buttery et al., 1982). Although both consumer acceptability and sensory studies help in understanding product acceptance both have very different functions. Consumer or affective tests determine liking or preference for a product whereas sensory descriptive studies partition flavor into specific components called descriptive notes (Stone and Sidel, 2004). Factors unrelated to sensory quality appear to drive acceptability of rice products. Brazilian consumers found parboiled rice to be acceptable based on sensory characteristics but tend to prefer milled rice despite the nutritional claims and ease of cooking for parboiled rice (Heinemann et al., 2006). In Ghana most consumers preferred imported brands over the local ones based on sensory properties but acceptability was affected by demographic factors such as location and gender (Tomlins et al., 2005). Asian consumers from the state of Arkansas preferred imported Jasmine rice over domestic rice types with color, flavor, aroma, and stickiness listed as the most important sensory characteristics (Suwansri et al., 2002). The differences between responses of consumers from different ethnic populations to similar rice products are dramatic (Deveriya and Shewfelt, 2007). Although numerous studies have been performed on rice (Lyon et al., 2000; Suwansri et al., 2002; Wilkie et al., 2004; Tomlins et al., 2005; Heinemann et al., 2006), there is little information available on what sensory characteristics drive acceptability of aromatic rice in different ethnic populations.
Drake (2002) indicated that sensory and consumer testing alone cannot provide information on the “drivers” of acceptability within a market segment (Drake and Civile, 2002). Thus it is important to link consumer responses and their perceptions with sensory descriptive data to lead to the successful development of products. The main objective of this study is to determine the relationship between sensory characteristics of selected rice types and the acceptability by consumers from different ethnic populations.

MATERIALS AND METHODS

Experimental Materials

All rice varieties were obtained from Buford Farmers Market in Atlanta and stored in the containers in a refrigerator until the final day of use. The varieties of rice chosen were: Arya (an imported Basmati rice), Texmati (a domestic Basmati rice), Golden Elephant and Asian Best (imported Jasmine types), Mahatma (long-grain, non-aromatic), Kokuho (medium grain from Japan, non-aromatic), Asian Taste (black glutinous rice) and Three Rings (sweet sticky rice).

Consumer Testing

Recruiting of panelists and consumer testing was conducted at a Mexican Grocery store, a Korean church, a Chinese church and an international coffee hour at the University of Georgia as described by Deveriya and Shewfelt (2007). Thirty participants from each ethnicity were recruited and presented with rice samples and a survey onsite.

Sensory Evaluation

Attributes for rice samples were evaluated using Spectrum technique for descriptive analysis (Meilgaard et al., 1999). Eight trained panelists for sensory descriptive analysis were recruited from the University of Georgia. Partitioned booths at the Food Research and
Development Lab in the Food Science Department were used for evaluation purposes. Panelists were trained using descriptors found in aromatic rice and commercial rice samples in ten one hour training sessions over a two-month period. The panelists were trained using reference standards for descriptors generally found in aromatic rice. Twenty two descriptors used for training included sweet, salty and bitter for taste and astringent, metallic for mouth feel. Additional descriptors included popcorn, starchy, woody, cooked grain, grain, and hay- like, earthy, sweet aromatics, corn, buttery, floral, dairy, barny, rancid, sulfury, smoky, earthy, and nutty. Participants were asked to sniff, taste the samples and mark their responses on the 150 mm unstructured scales. Visual differences between the samples were masked using a sodium lamp. Panelists were provided with small food treats for their participation.

**Statistical analysis**

Correlation testing was conducted by linking attribute scores from sensory descriptive analysis and acceptability scores from consumer testing by multiple linear Regression using SAS procedure. Predictive models were further obtained using Pearson Correlation and Proc Regression (backward elimination) using SAS (Statistical Analysis Software).

**RESULTS AND DISCUSSION**

Correlation analysis showed a significant positive relationship for acceptability with the sweet aromatic note and a negative relationship for bitter taste in the Chinese subset. Acceptability for the Indian ethnicity participants was positively related to the popcorn note and negatively to sweet and metallic and sweet aromatic. Acceptability for Korean consumers was directly related to the grain descriptor and inversely related to bitter taste and woody. The starchy note was positively correlated to acceptability by Mexican panelist with astringency and metallic
negatively correlated. Note that the only descriptor showing a significant coefficient in more than one ethnicity was bitter taste (by Chinese and Korean participants). The spider web figures (Fig 1-4) revealed an interesting link between descriptors and rice types. Popcorn was reported highest among Texmati and Golden Elephant and was also seen in Asian Best. Woody and Bitter descriptors were higher in Arya as compared to Texmati. Popcorn, starchy and cooked grain and sulphury were higher in Mahatma as compared to Kokuho Rose. Also haylike descriptor was higher in Asian Taste as compared to Three Rings.

More descriptors appeared in predictive models generated through the backwards elimination procedure of linear regression (Table 2). The presence of starchy, metallic and corn notes contributed to increased acceptability by Chinese participants. An increase in bitter taste and decrease in corn and buttery notes led to higher acceptability values in the Indian model, but the effect of the metallic note went from a negative impact to a positive one. Sweet and buttery notes added to the acceptability of the model for the Mexican group. There are major differences in the model for the entire sample and each ethnicity. It is unlikely that an aromatic rice sample optimized for the overall population would be highly acceptable within any country represented or would be a commercial success. Products are more likely to be acceptable if tailored to national or regional preferences (Shewfelt, 2000, 2006).

Such mathematical models can provide some insight into the different notes that contribute to acceptability by different populations. One of the difficulties of developing these models is that there is usually covariance associated with the different descriptors, and changes in the variables selected can lead to equally valid models (Siebert, 1999). The relatively low sample size of each ethnic group in this study limit the use of these models as marketing tools for rice types in these countries. Different models would be expected if the tests were conducted in
the specific countries with a larger sample size. Regional differences within each country would also be expected. The large differences in acceptability between these ethnic groups as demonstrated previously (Deveriya and Shewfelt, 2007) suggests, however, that there are distinct sensory characteristics associated with different types of aromatic rice that appeal to certain segments of rice consumers and are unacceptable to other segments. Development of detailed models of consumer acceptability by target country and regions within countries should lead to a more rational approach to selection of aromatic rice types that will appeal to large segments of selected populations (Shewfelt, 2006). The results support the conclusions of Suwansri (2002) that sensory characteristics of rice are important in rice acceptability within a given population. It must be recognized that factors beyond sensory quality affect acceptability of rice products (Tomlins et al., 2005; Heinemann et al., 2006).

SUMMARY AND CONCLUSIONS

The differences in acceptability of aromatic rice brands by different nationalities living in the state of Georgia were explained by the differences of flavor notes present in these brands. Mathematical models developed for each ethnic group were markedly different from each other. An understanding of the descriptors appealing to a specific population allows market segmentation. To streamline the process of breeders selecting for rice flavor, the flavor notes will need to be tied to chemical composition of specific rice cultivars.
Table 3.1 Pearson correlation coefficients of sensory descriptors with consumer acceptability by different ethnicities. Significant coefficients (p<0.05) are shown in bold numerals.

<table>
<thead>
<tr>
<th>Descriptors</th>
<th>Chinese</th>
<th>Indian</th>
<th>Korean</th>
<th>Mexican</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astringent</td>
<td>0.33</td>
<td>0.24</td>
<td>-0.02</td>
<td>-0.80</td>
</tr>
<tr>
<td>Bitter</td>
<td>-0.70</td>
<td>0.04</td>
<td>-0.56</td>
<td>0.13</td>
</tr>
<tr>
<td>Grain</td>
<td>-0.04</td>
<td>0.09</td>
<td>0.58</td>
<td>0.01</td>
</tr>
<tr>
<td>Metallic</td>
<td>0.49</td>
<td>-0.64</td>
<td>0.26</td>
<td>-0.58</td>
</tr>
<tr>
<td>Popcorn</td>
<td>-0.21</td>
<td>0.63</td>
<td>-0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>Starchy</td>
<td>-0.46</td>
<td>0.80</td>
<td>0.21</td>
<td>0.65</td>
</tr>
<tr>
<td>Sweet</td>
<td>0.18</td>
<td>-0.53</td>
<td>0.17</td>
<td>0.23</td>
</tr>
<tr>
<td>Sweet Aromatic</td>
<td>0.69</td>
<td>-0.69</td>
<td>0.31</td>
<td>-0.30</td>
</tr>
<tr>
<td>Woody</td>
<td>-0.18</td>
<td>0.56</td>
<td>-0.67</td>
<td>-0.27</td>
</tr>
</tbody>
</table>
Table 3.2 Prediction models linking consumer acceptability (% of population rating a sample as “definitely would buy” or “probably would buy”) for different ethnicities as a function of sensory descriptive notes

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Prediction Model</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINESE</td>
<td>( \text{CHINESE} = 11.55 + 0.93 \text{Starchy} + 1.5 \text{Sweet Aromatics} + 1.85 \text{Metallic} - 2.25 \text{Bitter} + 0.96 \text{corn} )</td>
<td>1.0</td>
</tr>
<tr>
<td>INDIAN</td>
<td>( \text{INDIAN} = 4.1 + 3.33 [\text{Popcorn}] - 4.66 [\text{Sweet}] + 1.63 [\text{Metallic}] + 1.54 [\text{Bitter}] - 0.97 [\text{Corn}] - 5.5 [\text{Buttery}] )</td>
<td>1.0</td>
</tr>
<tr>
<td>KOREAN</td>
<td>( \text{KOREAN} = 42.55 + 1.58 [\text{Grain}] - 1.07 [\text{Bitter}] - 0.928 [\text{Woody}] )</td>
<td>0.96</td>
</tr>
<tr>
<td>MEXICAN</td>
<td>( \text{MEXICAN} = 12.96 + 1.81 [\text{Starchy}] + 0.92 [\text{Sweet}] - 1.87 [\text{Astringent}] + 2.09 [\text{Buttery}] )</td>
<td>0.99</td>
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</tbody>
</table>
Fig. 3.1: Values of Sensory descriptors for Basmati Arya and Texmati
Fig 3.2: Values of Sensory descriptors for Asian Best and Golden Elephant
Fig 3.3: Values of Sensory descriptors for Kokuho Rose and Mahatma
Fig 3.4: Values of Sensory descriptors for Black glutinous rice and Thai Sweet Three rings
REFERENCES


CHAPTER 4
CONCLUSIONS

Rice is the most important staple crop for a large part of the world population. The limiting factor in developing the desired rice flavor is the lack of an understanding of consumer behavior and the ability to apply this knowledge to commercial situations. Providing both breeders and consumers with better flavored rice is one of the key objectives of this research. This research investigates consumer acceptability of both aromatic and non aromatic rice and links it with sensory descriptors to determine its impact on rice flavor.

In chapter 2 the main objective of the study was to identify the potential market segments for consumer acceptability of aromatic rice based on consumer responses of different ethnicities. It was found that consumers were very clear about their rice preference based on their ethnic origin. Indians preferred Basmati and one Jasmine brand, Chinese liked Jasmine over Basmati, and Koreans preferred Japanese medium grain Kokuho rice and Mexicans did not show any considerable difference in acceptability. Both purchase and consumption criteria like aroma, appearance, grain size, label and texture varied for different ethnicities which clearly indicated that consumer acceptance was based on their perception and preference Thus it could be concluded that consumer acceptance of rice highly depends on differences in ethnicities and nationalities and any attempt to improve flavor acceptability of aromatic rice should take into consideration the differences between nationalities when determining acceptability of rice samples.

In chapter 3 the main objective of the study was to determine the relationship between sensory characteristics of selected rice types and the acceptability by consumers from different
ethnic populations. Predictive models were further obtained using Pearson Correlation and Proc Regression (backward elimination). Results showed that showed a significant positive relationship for acceptability with the sweet aromatic note and a negative relationship for bitter taste in the Chinese subset. Acceptability for the Indian participants was positively related to the popcorn note and negatively to sweet and metallic and sweet aromatic. Acceptability for Korean consumers was directly related to the grain descriptor and inversely related to bitter taste and woody. The starchy note was positively correlated to acceptability by Mexican panelist with astringency and metallic negatively correlated. Thus it could be concluded that the large differences in acceptability between these ethnic groups are due to responses to distinct sensory characteristics associated with different types of aromatic rice that appeal to certain segments of rice consumers and are unacceptable to other segments.

Overall the research provided some insight into sensory and consumer acceptability of both aromatic and non-aromatic rice. Consumer testing should be expanded to large sample sizes and different ethnicities to understand consumer attitudes and preferences in different regions of these and other rice consuming nations. Though predictive models were developed linking sensory descriptors and particular ethnicities results could not be generalized for all brands available and different ethnic populations.

Further research should be carried out to determine the chemical components of rice that would contribute to its flavor perception. Also linking consumer acceptability with instrumental analysis will provide better understanding for acceptability of both aromatic and on aromatic rice.