Preferences for Commercial Strawberry Drinkable Yogurts Among African American, Caucasian, and Hispanic Consumers in the United States

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ABSTRACT

The drinkable yogurt marketplace is a competitive and growing category in the dairy industry. Understanding sensory differences is critical for understanding the product, and ultimately, consumer preference. The objective of this study was to identify and define the sensory characteristics of commercial drinkable yogurts and link these specific sensory attributes to consumer preferences among Caucasian, African American, and Hispanic consumers in the United States. Focus groups with each ethnic group ($n = 10$ for each group) were conducted to gain insights into perceptions of drinkable yogurts. A descriptive sensory language was identified to document the sensory properties (visual, flavor, and mouthfeel) of drinkable yogurts. Thirteen commercial drinkable yogurts (strawberry flavor) were subsequently evaluated by a trained sensory panel using the developed sensory language. Five representative yogurts were chosen for consumer testing by each ethnic group (minimum of 75 consumers per group). Both internal and external preference mapping was conducted to identify key drivers of liking. Drinkable yogurts were differentiated by descriptive analysis in visual, flavor, and mouthfeel attributes. Variability was observed in consumer acceptability across the 3 ethnic groups, but these differences were small compared with differences observed among 3 identified consumer preference clusters regardless of ethnicity. Key drivers for all 3 clusters were natural strawberry flavor/aroma and sweet taste. The influence of intensity changes in these 3 drivers along with the presence or absence of other attributes differentiated the 3 clusters. Acceptability varies widely among consumers, and drinkable yogurts with specific flavor and physical properties could be marketed to specific target market segments. The results indicate that these consumer clusters are not defined solely by ethnicity.

Key words: preference, yogurt, drinkable yogurt, ethnic foods

INTRODUCTION

Yogurt possesses 50% of the cultured product market sales, which comprises cottage cheese, fermented beverages (drinkable yogurts and kefir), refrigerated dips, sour cream, and yogurt. Drinkable yogurt is defined as a dairy-based yogurt that is drinkable and in a liquid form that may or may not include fruit or fruit flavoring. Drinkable yogurts are a relatively new yogurt category in the United States. Many products that are drinkable yogurts are positioned as yogurt smoothies. Manufacturers do not have rigid distinctions between the 2 types of beverages. The term “smoothie” can help bridge the gap for consumers who are familiar with yogurt, but not with its drinkable format (Anonymous, 2006). Drinkable yogurts meet consumer demand for portable, hand-held meals or snacks that fit an on-the-go lifestyle. Additionally, they are perceived to deliver all the health and nutritional benefits of regular yogurt (Eder, 2003). Cultured dairy beverages were a \$12.6 million industry in the United States in 1997 and grew to \$86.2 million in 2001 (Eder, 2003). Annual global sales of drinkable yogurt rose 18.4% to \$7.76 billion from mid-2005 to mid-2006 (Anonymous, 2007b). Drinkable yogurt was the fastest growing food and beverage category purchased by consumers worldwide from 2005–2006 and consumption of drinkable yogurt increased by 18% and exhibited growth in 40 of 45 markets measured (Anonymous, 2007a).

Previous sensory studies have addressed sensory properties and consumer acceptance of yogurt. Barnes et al. (1991a) conducted descriptive analysis and consumer testing of strawberry, raspberry, lemon, and unflavored yogurts and sought to determine if overall consumer acceptability was affected by sweetness and sourness intensity. Overall acceptability was significantly correlated with sweetness intensity and sweetness:sourness ratio for strawberry and raspberry yogurt. A few studies have been conducted regarding the

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perception of different consumer groups for yogurt. Ward et al. (1999) conducted a strawberry yogurt market analysis on acceptance drivers for children in Spain. Kalvianinen et al. (2003) investigated the relative importance of texture, taste, and aroma on preferences of a yogurt-type snack food in the young and elderly. Even fewer studies have been conducted regarding the sensory properties of liquid or drinkable yogurt. In one such study, Tsuchiya et al. (2006) compared the satiating power of semisolid and liquid yogurts with fruit beverages and dairy fruit drinks. They found no difference in satiety rating between drinkable and semisolid yogurt. Bogue and Ritson (2005) integrated marketing and sensory methodologies to understand consumer perception of strawberry yogurt of varying fat contents. They determined that consumers preferred lower fat dairy products and that the use of marketing and sensory methodologies together gave a more complete picture of product preference.

Today, almost 70 million of the United States population, which numbers over 300 million, identify themselves with an ethnic group other than Caucasian. Minorities now control almost \$900 billion in annual spending, which is an increase in more than \$420 billion since 1990. Among minorities, the Census Bureau estimates that the African American population grew between 16 and 22% through the 1990s compared with 13% for the total population (Raymond, 2001). The US Hispanic population has increased 17% in the past 4 yr to 41.3 million. Hispanics are the country's fastest growing ethnic minority and are projected to account for 46% of all US population growth over the next 20 yr (Decker, 2004). To our knowledge, there is no published research about preferences and attitudes toward drinkable yogurt among different consumer ethnic groups. The current study sought to identify key sensory drivers for drinkable yogurts in the United States. Strawberry flavor was chosen as the focus of this study because it remains the most popular yogurt flavor. Our specific objectives were to identify and define the sensory characteristics of commercial drinkable yogurts and link these specific sensory attributes to consumer preferences among Caucasian, African American, and Hispanic consumers in the United States. The study was accomplished by descriptive analysis of drinkable yogurts followed by focus groups and quantitative consumer testing with each ethnic group.

MATERIALS AND METHODS

Descriptive Sensory Analysis

All sensory testing was conducted in compliance with the North Carolina State University (NCSU) Institutional Review Board for Human Subjects Approval. A

Table 1. Strawberry drinkable yogurts evaluated in the study¹

Product	Product type ²	Fat % (wt/vol)
1	National brand smoothie; fat free	0
2	National brand smoothie	1
3	National brand smoothie; low fat	1
4	National brand smoothie; light	0
5	National brand smoothie; vitamin fortified	0
6	National brand probiotic dairy beverage	1
7	Store brand smoothie; lowfat	1
8	Store brand smoothie; nonfat	0
9	National brand drinkable yogurt; lowfat	2
10	National brand smoothie	0
11	National brand smoothie	1
12	National brand probiotic dairy drink	1.5
13	National brand smoothie	0

¹All products contained live lactic acid bacteria (per label), and milk or cultured milk was the first ingredient on the label.

²Products in boldface were selected for consumer testing.

broad spectrum of commercial drinkable yogurts (n = 13) including national, regional, and local brands was selected based on fat content, availability, and strawberry flavor (Table 1). All products contained live and active cultures, and milk or cultured milk was the first ingredient. Twelve panelists were selected based on experience with sensory analysis of dairy flavors, interest, and availability. Each panelist (1 male, 11 female) had at least 120 h of previous experience in sensory analysis of dairy products including yogurts using the Spectrum descriptive analysis technique (Meilgaard et al., 1999). Four 2-h training sessions were conducted to focus on the sensory properties of strawberry drinkable yogurts. Flavor, texture, and color terms identified by the panelists are listed (Table 2). Throughout training sessions, panelists evaluated and discussed an array of commercial strawberry drinkable yogurts to clarify descriptor concepts and to consistently rate product attributes. An ANOVA of data collected from the last part of training indicated that the panel and panelists could consistently use the attributes to differentiate the products.

Descriptive analysis was conducted by each panelist in triplicate on each yogurt in a randomized block design. Samples (45 mL) were served in 59-mL plastic cups fitted with plastic lids (Sweetheart Co., Owings Mills, MD) and labeled with random 3-digit codes. Samples were served at 5 ± 2°C. Panelists evaluated yogurts individually using paper ballots in an odor-free room dedicated to sensory analysis. Five samples were evaluated per session with a 3-min break between each sample. Deionized water at ambient temperature was available for palate cleansing.

Instrumental Measurements

Instrumental color, viscosity, and pH values were determined for the 13 strawberry drinkable yogurts.

Table 2. Descriptive sensory language for strawberry drinkable yogurts

Term	Definition	Reference
Visual terms		
Visible viscosity ¹	Visible thickness upon swirling 3 times in the sample cup	Water = 1; heavy cream = 3
Visible homogeneity	Degree to which the visible color is homogeneous and consistent, lacking fruit bits, pieces and/or seeds, color swirls	
Color intensity	Saturation of color	
Orthonasal aroma terms		
Sweet aromatic	Sweet aromatic, not strawberry	Fresh-cut strawberries
Strawberry aromatic	Aromatics associated with fresh or artificial strawberry flavor	
Dairy sour aromatic	Aromatics associated with fermented dairy products	
Terms evaluated in mouth		
In-mouth viscosity ¹	Force required to draw the sample from a spoon with the lips	Water = 1; heavy cream = 3
Milkfat/lactone	Aromatics associated with milkfat	
Dairy/sour	Sour aromatics associated with fermented dairy products	
Artificial strawberry	Aromatics associated with artificial strawberry flavor	Hershey's strawberry syrup
Natural strawberry	Aromatics associated with fresh cut or frozen strawberries	Fresh-cut strawberries
Other fruit	Aromatics associated with fruits other than strawberries such as bananas, peaches from natural or artificial sources	
Herbal/minty	Aromatics associated with fresh cut vegetation such as mint and green grass	Fresh mint
Old ingredient	Aromatics associated with old dairy ingredients such as stored milk powder	Skim milk powder stored for 36 mo, reconstituted at 10% (wt/vol) solids
Vitamin	Aromatics associated with vitamins or mineral supplements	
Overall aftertaste intensity	Intensity of any aftertaste (up to 1 min after expectoration or swallow)	Enfamil-liquid polyvisol vitamins
Sweet ¹	Fundamental taste sensation elicited by sugars	5% Sucrose solution
Salty ¹	Fundamental taste sensation elicited by salts	5% NaCl solution
Sour ¹	Basic taste associated with acids	0.08 Citric acid solution
Bitter ¹	Basic taste associated with caffeine and alkaloids	0.08% Caffeine solution
Astringent ¹	Drying, drawing, or puckering of the mouth surfaces	0.5% Alum solution
Metallic	Chemical feeling factors associated with metals	

¹Taken from Meilgaard et al. (1999).

Color (Hunter values, L^* , a^* , b^*) was measured in duplicate for each yogurt using a Minolta Chromameter CR-300 (1991 Minolta Camera Co., Ramsey, NJ). Product was strained through cheesecloth before testing to remove seeds and fruit pieces. A 20-mL sample of each filtered product was placed in the large side of a 60- × 15-mm polystyrene Petri dish (Falcon brand, Becton Dickinson Labware and Co., Franklin Lakes, NJ) and placed on the machine for analysis.

Viscosity measurements were determined in duplicate using a StressTech controlled stress Rheometer (ATS Rheosystems, Bordentown, NJ/Rheologica Instruments AB, Lund, Sweden) with a CC 25 Searle assembly. All samples (15 mL) were presheared for 60 s at 30 s^{-1} . Apparent viscosity was measured at 5°C as shear rates were increased from 0.1 to 100^{-1} over 300 s. Shear rate data were fitted to a power law model to obtain K (viscosity in $\text{Pa}\cdot\text{s}^N$) and n (consistency index, unitless); K indicates viscosity ($\text{Pa}\cdot\text{s}^N$) at a shear rate of 1, and n measures flow behavior (Newtonian vs. non-Newtonian). An n value of 1 indicates Newtonian flow behavior. As n decreases (values between 0 and 1), non-Newtonian flow behavior is observed (shear thinning). The pH of yogurts was measured using a Mettler-Toledo Seven-

Easy pH meter (Mettler-Toledo Inc., Columbus, OH). Samples (100 mL) were analyzed in duplicate at 5°C .

Qualitative Consumer Testing

Focus groups were conducted with African-Americans, Caucasians, and Hispanics to gain a better understanding of attitudes toward drinkable yogurts, usage, and consumption patterns and to guide in developing the consumer ballot. Three focus groups were conducted, one with each ethnic group. African Americans (10 females, 18 to 34 yr), Caucasians (10 females, 18 to 34 yr), and Hispanics (10 females, 18 to 45 yr) were selected based on ethnicity and interest. Participants were consumers of dairy products who consumed regular yogurt at least a few times per month and were the primary shopper for the household. Focus groups lasted approximately 1.5 h.

An experienced moderator led the participants through a predetermined discussion guide (Figure 1). Subjects were first asked about their consumption habits of drinkable yogurt (frequency, on what occasions, likes, dislikes, etc.). Questions then focused on attitudes and flavor preferences followed by tasting of 5 commer-

- Moderator introduction – purpose of focus group
 - Respondent introductions – your name, country your family is from (Hispanics), and who lives in your household.
- Now let's talk about yogurt-type products that you drink:**
- What do you call this kind of product?
 - Who has tried these kinds of products?
 - Who drinks them regularly? How often? On what kinds of occasions do you drink them? (e.g., breakfast, as a meal replacement, to accompany meals, as a snack) Where do you typically drink them?
 - When you drink these products, why are you choosing this instead of something else to drink?
 - Why do you not drink these products more frequently?
 - Compared to other products you drink, what do you particularly like about these products?
 - Are these products good for you? In what ways? (probe for nutritional benefits, knowledge about active cultures, calorie content, etc.)
 - Are there things about these products you don't like?
 - There are many differences in how these products look and taste. I want to know what it is that you like.
 1. How thick or thin do you like these products? (try to get them to name another product that has the desired viscosity they want)
 2. Sometimes these products have small bits of something in them, such as fruit. Is that something you like or dislike in these products?
 3. What flavors do you particularly like? Why do you prefer these flavors?
 4. What color should this type of product be? (if it depends on flavor, get examples of flavor/color combinations that they like or dislike)
 - Are there other flavors that would taste really good to you in these products? Again, think of other foods and beverages, including those from your family's country of origin that you think would taste good in this type of product.
 - How interested would you be in these other types of flavors? (name flavor under consideration)
 - Now I want to get your reaction to some actual products (bring out products):
 - First let's talk about the way each of these products looks (probe for color, viscosity, presence/absence of inclusions, etc.).
 - Now I'd like you to taste each of these and tell me what you think
 - How well do you like this flavor? (use 5-point scale)
 - Why do you say that?
 - Thank you for your input. You've been very helpful!

Figure 1. Drinkable yogurt discussion guide used for focus groups.

cial strawberry drinkable yogurts and discussion of each product. Participants were given the samples in clear plastic cups with assigned 3-digit codes. Appearance and visible thickness in the cup were discussed before tasting. Upon tasting, participants were asked

to discuss the flavor intensity, sweetness, and thickness in mouth for each product. Video and audio recordings were made of the focus groups, and notes were taken by 2 observers. After the groups, the moderator and observers convened to discuss main themes from the

group. Key points (those issues mentioned by two-thirds or more of participants) from focus groups were used to develop the consumer questionnaire and ballot.

Quantitative Consumer Testing

Based on the descriptive sensory results, including examination of principal component biplots, product mean intensities, presence or absence of fruit bits, and rankings of sweet taste, color intensity, strawberry flavor, and viscosity, 5 representative yogurts were selected for consumer testing with the 3 ethnic groups. Consumer testing with African American, Caucasian, and Hispanic consumers took place on 3 separate days. Caucasian consumers were recruited through personal communication, paper flyer advertisements, and e-mails. Testing was conducted in the Department of Food Science (NCSU, Raleigh) in temperature-controlled booths dedicated to consumer testing. Responses were collected using Compusense Five (v4.6, Compusense, Guelph, Ontario, Canada). African American and Hispanic consumers were recruited through e-mails and personal communication, and testing took place at local churches (Raleigh, NC) in rooms temporarily dedicated to consumer testing. Paper ballots were used to collect responses. Specific efforts were made to ensure that testing conditions at the church locations were consistent with the university testing location in terms of sample temperature, presentation, and noise level.

Consumers were screened for allergies before tasting and were self-reported consumers of yogurt, drinkable yogurt, or both. Consumers were provided with consent forms consistent with NCSU Human Subjects approval and a usage and attitude form for collection of demographic information before product evaluation. Each consumer evaluated the 5 drinkable yogurts in one session. Yogurts (60 mL) were dispensed into 147.5-mL (5-oz) clear plastic cups (Sweetheart Cup Co.) numbered with 3-digit codes. Yogurts were presented individually in a randomized balanced order. During testing with Hispanic consumers, 3 native Spanish speakers were used as translators as needed and assisted participants with the screening form and ballot. Screeners and ballots were available in English and Spanish and use was at the choice of the consumer. All Hispanic consumers spoke at least some English and had lived in the United States at least 2 yr. Each consumer evaluated each drinkable yogurt for overall liking, appearance liking, color liking, texture/thickness liking, sweet taste liking, and strawberry flavor liking using a 9-point hedonic scale with 9 = "like extremely" and 1 = "dislike extremely." Consumers received food treats and grocery store gift cards as incentives.

Statistical Analysis

Descriptive analysis results and instrumental measurements were evaluated by ANOVA with Fisher's least significant difference (**LSD**) as a post-hoc test to determine product differences (SAS software, version 9.2, SAS Institute Inc., Cary, NC). Selected descriptive attributes and instrumental means were evaluated by correlation analysis (SAS Institute) to determine if linear relationships existed. Descriptive analysis data were also evaluated by principal components analysis to visualize overall differences among products (SAS Institute). Consumer data were initially evaluated by 2-way ANOVA with means separation (least squares means) to determine if differences existed between the treatments and ethnic groups. Main effects and interactions were evaluated. All analyses were conducted at the 95% confidence level unless otherwise indicated.

For preference mapping, consumer data were first segmented. Two-step cluster analysis (**TCA**) was performed on each consumer liking ratings for all attributes (overall liking, aroma liking, texture liking, color liking, sweet taste liking, and strawberry flavor liking). The TCA was performed using log-likelihood as a distance measure and the number of segments was automatically determined using the combination of changes in Akaike's information criterion and greatest changes in the distance when clusters were divided sequentially (SPSS, 2001; Banfield and Raftery, 1993; Zhang et al., 1996; Chiu et al., 2001). Discriminant analysis (**DA**) with cross-validation confirmed and determined final segmentation with TCA solutions with at least 90% correct allocation. In addition, DA also determined discriminating liking scores that significantly maximized the differences between the segments. The TCA and DA were performed using SPSS (version 12.0; SPSS, 2001).

After segmentation, partial least squares regression 2 (**PLS2**) was used to construct external preference maps for each consumer segment. The PLS2 focuses on explaining the variation in consumer overall liking patterns (Y-matrix; product = row; overall liking of consumers within each segment = column) by using only the portion of the information obtained from descriptive analysis (X-matrix; product = row; sensory attribute means = column; Biasioli et al., 2001; Martens and Martens, 2001). Important attributes were selected using the jackknife method. The PLS2 and jackknife optimization methods were performed using the Unscrambler version 9.2 (CAMO, Oslo, Norway).

After segmentation, liking profiles of all liking attributes for each segment were generated. Means of liking attributes were estimated using repeated measurement ANOVA. Tukey's highly significant difference multiple comparison test was performed on significant sample

effects for each liking attribute at the 95% confidence level. The same analysis was performed to test the differences between ethnicities. The profile plots (X = samples, Y = estimated liking scores) between segments and ethnicity were compared visually. Repeated-measures ANOVA was performed using SPSS (version 12.0; SPSS, 2001). Frequency counts were tabulated, and reports for all demographic and purchasing habit information were generated. The Pearson χ^2 test was used to identify significant associations and trends between preference segments/ethnicities and demographic and purchasing habits (SPSS, 2001).

RESULTS AND DISCUSSION

Descriptive Analysis

The 13 strawberry drinkable yogurts were differentiated using the identified descriptive language (Table 3, Figure 2). Four principal components (PC) explained 86% of the variability; 68% on the first 2 components (Figure 2). Based on the eigenvector loadings (not shown), PC1 (44%) differentiated drinkable yogurts by sour and bitter tastes, sour aromatic (orthonasal aroma) and dairy sour flavors (positively loading), color, sweet aromatic (orthonasal aroma) and sweet taste (negatively loading). Principal component 2 (23%) separated products by artificial strawberry flavor and astringency (positively loading) and strawberry aroma (orthonasal aroma), natural strawberry flavor, and milkfat flavor (negatively loading). Principal component 3 (12%) consisted of visible homogeneity (positively loading) and old ingredient and vitamin flavors and aftertaste intensity (negatively loading). Principal component 4 (7%) differentiated product by visual and in-mouth viscosity and other fruit flavor (positively loading), and herbal/minty (negatively loading) (results not shown). Some attributes were only noted in a few products (Table 3). Other fruit flavor (i.e., flavor other than strawberry) was present in half of the products evaluated. Herbal/minty flavor was detected in 2 of the products and old ingredient and bitter taste were only detected in different single products. Wide variability in the sensory characteristics of strawberry drinkable yogurts was observed and the products chosen for consumer testing were representative of this variability.

Instrumental Measurements

The viscosity, pH, and color of strawberry drinkable yogurts were differentiated ($P < 0.05$). A wide range of viscosities (0.09 to 4.22 Pa·s^N) and Newtonian vs. non-Newtonian flow behavior ($n = 0.38$ to 0.85) were observed among the products (results not shown). Instrumental viscosity was positively correlated with visual

($r^2 = 0.81$, $P < 0.05$) and in-mouth ($r^2 = 0.78$, $P < 0.05$) viscosities. Visual and in-mouth viscosities were also positively correlated ($r^2 = 0.90$, $P < 0.05$). Similar correlations were reported by Pollen et al. (2004) when evaluating sensory and rheological relationships among a variety of fluid and semifluid foods. A wide range of color values (Hunter color) were also observed (results not shown). The pH of the strawberry drinkable yogurts ranged from 3.76 to 4.34 and was not correlated to sour taste intensity ($r^2 = 0.15$, $P = 0.194$). Recent studies have suggested that sour taste perception is not a function of pH (Johanningsmeier et al., 2005).

Focus Groups

Hispanic participants tended to consume drinkable yogurt more frequently (2 to 4 times per week) than African Americans or Caucasians, and drinkable yogurt (as well as regular yogurt) was clearly a more common part of their diet. The Hispanic population's yogurt consumption is 33% higher than that of the general population (Arnott, 1994). In the Hispanic population, 31% consume yogurt at least once a day compared with 17% in the general US population. One reason for higher yogurt consumption may be that Hispanic consumers eat yogurt as a dessert, breakfast item, with lunch, and often as a snack (Arnott, 1994).

Drinkable yogurts were most often consumed by all participants as an on-the-go meal or snack, particularly at breakfast. When asked what they liked about drinkable yogurt, "more vitamins and minerals than other beverages (including milk)", "healthy", and "contain beneficial protein" were most frequently mentioned. These perceptions are consistent with the marketing image of these products: drinkable yogurts and cultured dairy products provide a convenient, delicious, and healthy option that meet consumer needs for portable, on-the-go foods with the health benefits of yogurt, such as vitamins and minerals (Berry, 2003; Eder, 2003). Additionally, participants thought the products were flavorful and that there was a variety of interesting flavors. African American and Caucasian groups noted the presence of active cultures in drinkable yogurts, whereas Hispanics did not. Complaints about drinkable yogurt included that they were often too sweet, packaged in containers that were too small, were high in calories or sugar, and were expensive relative to solid yogurt and other dairy beverages.

When asked if fruit bits (small to medium in size) were appealing, most participants thought they were desirable, acceptable, or both, and contributed to a natural appearance. In general, all participants preferred natural, not-too-sweet products with fruit flavors/colors and bits of fruit. All participants wanted/expected a

Table 3. Descriptive means of drinkable yogurts¹

Product code	Visual viscosity	Homogeneity	Color	In-mouth viscosity	Strawberry aroma	Sour aroma	Sweet aromatic	Milkfat	Dairy sour	Artificial strawberry flavor
1	3.7	10.8	5.7	2.7	3.1	2.3	2.8	1.8	2.1	2.2
2 ²	3.3	12.4	4.6	2.3	2.5	2.4	2.4	1.6	2.3	1.6
3	3.2	12.9	3.6	2.3	2.2	2.1	2.7	1.7	2.2	1.5
4 ²	3.8	14.9	4.1	2.9	2.1	1.8	3.0	1.6	2.0	3.3
5	6.3	9.9	3.1	4.7	2.1	2.6	2.0	1.8	2.2	1.0
6 ²	6.6	14.9	1.6	5.4	0.7	3.5	1.3	2.2	3.9	0.7
7	4.8	10.4	2.4	3.0	2.6	2.8	2.1	2.1	2.2	1.1
8 ²	3.0	13.0	6.9	2.3	2.2	2.4	2.4	0.5	2.4	2.1
9	4.7	13.1	4.1	3.3	2.6	2.4	2.9	1.9	2.4	1.6
10	3.7	14.7	7.7	3.2	2.4	1.8	2.8	1.5	2.0	2.4
11 ²	6.1	13.1	2.2	4.0	3.4	2.8	2.4	2.5	2.1	0.9
12	4.1	13.3	2.7	2.9	1.7	2.6	1.9	1.2	2.4	1.3
13	3.8	14.0	5.3	2.8	2.0	1.7	2.3	0.9	1.9	2.0
LSD	0.7	1.1	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.5
	Natural strawberry flavor	Other fruit flavor	Herbal/minty	Old ingredient	Vitamin	Aftertaste intensity	Sweet taste	Sour taste	Bitter	Astringent
1	1.8	1.5	ND ³	ND	ND	2.2	5.9	3.2	ND	1.9
2 ²	2.0	ND	ND	ND	ND	2.3	5.5	3.4	ND	2.3
3	1.7	1.5	2.2	ND	ND	2.2	5.3	3.4	ND	2.1
4 ²	1.0	2.5	ND	ND	ND	2.0	5.2	3.2	ND	2.2
5	2.5	ND	ND	ND	1.6	2.5	5.4	3.3	ND	2.2
6 ²	1.3	ND	ND	ND	ND	2.5	2.7	5.9	1.6	3.0
7	3.7	ND	ND	ND	ND	2.2	6.3	3.2	ND	1.9
8 ²	1.1	ND	2.5	ND	ND	3.0	5.7	3.6	ND	2.8
9	2.9	1.7	ND	ND	ND	2.4	5.7	3.4	ND	2.0
10	1.2	1.8	ND	ND	ND	2.1	5.9	3.1	ND	2.1
11 ²	4.5	ND	ND	ND	ND	2.1	6.2	3.4	ND	1.7
12	2.0	ND	ND	1.9	ND	2.4	5.3	3.8	ND	2.2
13	1.2	1.7	ND	ND	ND	2.2	5.8	3.0	ND	2.0
LSD	0.6	0.4	0.3	—	ND	0.3	0.4	0.3	—	0.3

¹Means in a column that differ by more than the least significant difference (LSD) value are different ($P < 0.05$). Attributes were evaluated by trained panelists using the 15 point universal Spectrum intensity scale where 1 = very low intensity and 15 = highest possible intensity (Meilgaard et al., 1999).

²Products selected for consumer testing.

³ND = not detected.

product considerably thicker than milk but still pourable and drinkable. Popular flavors mentioned by all groups were strawberry, peach, mixed berry, vanilla, and banana. When asked what flavors they would like to see, the group comments were different. Caucasians and African Americans tended to desire fruit combinations, more intense versions of current flavors, and were more daring in flavor concepts (chocolate chip, apple, key lime pie, etc). Hispanic consumers tended to desire tropical flavors such as passionfruit, guava, mango, papaya, pina colada, and coconut, which are more available in their countries of origin. Noted flavors that have been found to be popular with Hispanics in food products are often those from their countries of origin such as mango, pineapple, and hibiscus-orange, and industry observers predict these tropical flavors will become more popular (Brewster, 2002). It is important to emphasize that all of these observations were qualitative results from a small number of individuals. These re-

sults were used to compare with previously published literature and to guide in the development of the quantitative consumer ballot.

Quantitative Consumer Testing

Demographic characteristics of consumers were similar to focus group participant profiles (Table 4). Consumption frequency of yogurt and drinkable yogurt was higher for the Hispanic population with a large portion of this population consuming these products at least once per week. Regular yogurt consumption in African Americans consumers was higher than in Caucasians, but African Americans consumed drinkable yogurt the least frequently of the 3 ethnic groups. Not surprisingly, age, education, income level, citizenship (for Hispanics), yogurt consumption, and drinkable yogurt consumption were variable between the 3 ethnic groups ($P < 0.05$). Factors influencing purchase of yogurt and drinkable

Figure 2. Principal component biplot of descriptive sensory analysis of strawberry drinkable yogurts. Numbers represent drinkable yogurts (Table 2); underlined numbers are those chosen for consumer testing. PC = principal component.

yogurt were different between the 3 ethnic groups ($P < 0.05$; results not shown). Flavor and price were equally important to Caucasian consumers in purchase factors (87 and 85% of respondents, respectively), whereas flavor alone was selected as the most important purchase factor by African Americans and Hispanics (73 and 82% of respondents, respectively). Brand awareness was also different for the 3 ethnic groups ($P < 0.05$). All 3 groups were generally aware of and indicated purchase of Dannon and Yoplait brands. Caucasian consumers were more aware of organic brands (e.g., StonyField Farms) and store brands and indicated more frequent purchase of these products. A χ^2 test between yogurt and drinkable yogurt consumption was not significant ($P > 0.05$), suggesting that yogurt and drinkable yogurt are distinct products to consumers and confirming focus group results.

Consumer liking scores were distinct for the 5 products and they were affected by ethnicity ($P < 0.05$; Table 5), but the differences between ethnicity were generally small (Table 5, Figure 3) and occurred primarily for

products 6 and 8. Product 8 scored higher in overall liking and other attributes by Hispanic consumers compared with African American and Caucasian consumers. Product 8 was shown through descriptive analysis to have high color intensity, artificial strawberry flavor, and an herbal/minty note (Table 3) suggesting that these attributes are not negative to Hispanic consumers or that they do not negatively affect liking as much for Hispanics compared with African American or Caucasian consumers. Product 6 was scored lower in overall liking and other attributes by African Americans compared with Hispanic and Caucasian consumers (Table 4), and this product received very low overall acceptance ratings ($<4.5/9$) by all ethnic groups. Product 6 was profiled by trained panelists as very thick, low in strawberry aroma, and very sour tasting (Table 3). These characteristics were specifically noted as objectionable by African American focus group participants. These results suggested that thick viscosity is a “negative driver” for liking among all consumers for this product

Table 4. Demographic characteristics (%) of consumers

Characteristic	African American (n = 83)	Caucasian (n = 84)	Hispanic (n = 87)
Education*			
Did not finish high school	8	0	30
High school diploma/GED	25	16	38
Trade school/profession	10	5	5
College degree	45	40	10
Advanced degree	8	34	18
Gender (male/female, %)	40/60	33/68	44/56
Age*			
18–24 yr	14	26	29
25–35 yr	27	30	33
36–45 yr	34	17	27
>45 yr	25	27	11
Annual income*			
<\$10K	10	12	29
10–20K	6	45	34
20–40K	47	20	27
40–60K	31	9	6
>60K	6	14	5
US citizen (yes/no, %)	100/0	100/0	66/34
Shop for the household citizen (yes/no, %)	95/5	100	85/15
Yogurt consumption*			
Never	0	0	0
A few times per year	10	12	8
At least once per month	18	22	12
At least once per week	72	66	80
Drinkable yogurt consumption*			
Never	67	49	13
A few times per year	10	20	15
At least once per month	11	17	8
At least once per week	12	14	64

*Indicates difference in distribution among the 3 ethnic groups ($P < 0.05$).

category. Liking attributes of the other 3 products were consistent between the 3 ethnicities.

Cluster analysis was applied to explore consumer segmentation because there were not distinct differences associated with ethnicity and to explore the homogeneity among consumers. Three distinct consumer clusters were identified. Membership within the clusters was not exclusive to ethnic group, although there were differences in the distribution of ethnic groups among the 3 consumer clusters ($P < 0.05$). Caucasians were primarily in cluster 1 (49% of Caucasians, 42% of cluster 1), Hispanics were primarily in cluster 2 (58% of Hispanics, 47% of cluster 2), and African Americans were evenly distributed between clusters 1 and 2 (39 and 42% respectively) (Table 6). Cluster 3 was equally distributed among the 3 ethnic groups (Table 6). Age, education, income level, citizenship (for Hispanics), yogurt, and drinkable yogurt consumption were variable between the 3 ethnic groups (Table 4), but did not have any relationship with consumer cluster membership ($P > 0.05$).

In contrast to ethnicity-specific differences, which were small, the differences in liking profiles between

the clusters were more distinct (Figure 4, Table 7). Based on PLS analysis, natural fruit flavor and sweet taste were general drivers of liking for all 3 clusters. Figure 5 shows the PLS2 from group or cluster 2 consumers as an example. The descriptive attributes natural strawberry flavor, strawberry aroma, and sweet taste were associated with PC1, which is also where the majority of consumers were located. Discriminant analysis was applied as a method to validate results observed from cluster analysis. Discriminant analysis is a classification technique for grouping observations or variables into predetermined classes. In the current study, we applied this technique to confirm that consumers could be classified or grouped according to the attribute ratings that clustered the consumers. The results can be displayed as a biplot with the linear combinations of liking attributes that correctly allocated the consumers (Figure 6). Discriminant analysis was able to place consumers into the 3 identified clusters with 92% correct allocation, confirming the 3 consumer clusters (Figure 6). Figure 6 also visually confirms that the largest number of Hispanic consumers is located in cluster 2.

Table 5. Consumer attribute means within ethnic groups¹

Group/attribute	Product ²				
	6	11	2	4	8
African American (n = 83)					
Overall liking	2.4 ^f	6.9 ^{ab}	7.2 ^{ab}	3.7 ^e	4.8 ^d
Appearance liking	3.7 ^d	6.9 ^a	6.7 ^a	4.8 ^c	5.6 ^b
Color liking	3.8 ^d	6.9 ^{ab}	6.7 ^{ab}	5.1 ^c	5.8 ^b
Thickness liking	3.7 ^d	6.7 ^a	6.7 ^a	4.2 ^{cd}	4.9 ^{bc}
Sweet taste liking	2.2 ^f	7.0 ^{ab}	7.0 ^{ab}	3.8 ^e	4.9 ^d
Strawberry flavor liking	2.6 ^g	7.0 ^{ab}	7.2 ^{ab}	4.1 ^e	5.2 ^{cd}
Caucasian (n = 84)					
Overall liking	3.6 ^e	6.6 ^b	6.9 ^{ab}	3.4 ^e	4.7 ^c
Appearance liking	5.8 ^b	7.0 ^a	7.3 ^a	4.6 ^c	4.6 ^c
Color liking	5.8 ^b	6.8 ^{ab}	7.2 ^a	4.8 ^{cd}	4.5 ^{cd}
Thickness liking	4.9 ^{bc}	6.5 ^a	6.8 ^a	4.0 ^{cd}	4.5 ^c
Sweet taste liking	3.4 ^e	6.6 ^b	6.9 ^{ab}	3.7 ^e	4.6 ^d
Strawberry flavor liking	3.3 ^f	6.6 ^b	6.8 ^b	3.2 ^f	4.8 ^d
Hispanic (n = 87)					
Overall liking	3.8 ^e	7.3 ^a	7.5 ^a	3.8 ^e	5.6 ^c
Appearance liking	4.5 ^c	7.0 ^a	7.3 ^a	4.5 ^c	5.8 ^b
Color liking	4.1 ^d	6.4 ^b	7.1 ^{ab}	5.1 ^c	6.2 ^b
Thickness liking	4.7 ^{bc}	7.2 ^a	7.2 ^a	3.5 ^d	5.3 ^b
Sweet taste liking	3.7 ^e	7.1 ^{ab}	7.5 ^a	3.7 ^e	5.8 ^c
Strawberry flavor liking	3.4 ^f	6.7 ^b	7.5 ^a	3.4 ^f	5.8 ^c

^{a-g}Means in a row for a particular attribute across all ethnic groups and products followed by different letters are different ($P < 0.05$).

¹Products were scored using a 9-point scale where 1 = low intensity/dislike extremely and 9 = high intensity/like extremely.

²Product number refers to drinkable yogurt selected for consumer testing (Table 1).

From the DA functions (the linear combinations of liking attributes that were able to correctly group the consumers) and examination of Table 7, the 3 clusters

were separated based on liking attributes of product 2, overall and aroma liking of product 8, and overall liking of product 11 (discriminant function 1; Figure 6) and

Figure 3. Overall liking profiles of each ethnic group. Bars represent standard deviations of the means.

Table 6. Ethnicity distribution within each identified consumer cluster¹

Group	African	Caucasian	Hispanic
Group 1 (n = 95)	n = 32	n = 40	n = 23
Group 2 (n = 109)	n = 35	n = 23	n = 51
Group 3 (n = 49)	n = 16	n = 19	n = 14

¹Ethnicity distribution among the 3 consumer clusters is different ($P < 0.05$).

attribute likings of product 8, sweet taste liking of products 4 and 6, and strawberry liking of product 4 (discriminant function 2; Figure 6). Descriptive analysis (Figure 1) characterized high intensities of natural strawberry flavor in products 2 and 11. Product 4 was characterized by high intensities of other fruit and artificial strawberry flavors and a low natural strawberry flavor. Product 8 was differentiated by a distinct herbal/minty flavor and high color intensity, and it was sweetened with an artificial sweetener, which may account for its high aftertaste intensity and astringency relative to other products evaluated. Product 6 had high intensities of dairy sour flavor and sour taste, and low sweet taste intensity. Based on these products and attribute differences, the 3 consumer clusters were characterized. Cluster 1 consumers were drinkable yogurt likers. These consumers liked drinkable yogurts that displayed moderate to high intensities of fresh fruit flavor

and sweet taste. Other flavors (e.g., herbal/minty) and excessively high sweet taste were not liked. Cluster 2 consumers were drinkable yogurt lovers. These consumers loved drinkable yogurts in general. Drinkable yogurts with moderate to high intensities of fresh fruit flavor and sweet taste were liked but so were products with intense color, other fruit flavors, and products with artificial sweeteners. Consumers in cluster 3 were designated “drinkable yogurt hard-sells.” Although consumers in cluster 3 consumed yogurt and drinkable yogurt, sensory properties did not appear to largely influence liking. It is possible that these consumers purchase or consume these products for reasons other than flavor, such as health or convenience.

Barnes and others (1991b) studied the consumer acceptability of yogurt as related to sweetness and sourness ratings through descriptive analysis. They reported that consumer liking was significantly correlated with sweetness intensity and sweetness:sourness ratio for strawberry stirred yogurts. In general, as sweetness increased in the yogurts, consumer acceptance increased. These results are consistent with focus group and hedonic testing results of the current study. A large number of consumers (clusters 1 and 2) preferred products with high sweetness. Both focus group results and hedonic results indicated that products that were “too sour” were disliked. Future research might investigate if these liking clusters are similar for other

Figure 4. Overall liking profiles of the separate consumer clusters identified by 2-step cluster analysis (TCA). Bars represent standard deviations of the means.

Table 7. Consumer attribute means¹ within each consumer cluster

Consumer cluster	Product ²				
	6	11	2	4	8
Cluster 1					
Aroma liking	4.7 ^{B,a}	7.2 ^{A,a}	7.4 ^{A,a}	3.8 ^{C,b}	4.0 ^{C,b}
Color liking	4.7 ^{B,a}	7.0 ^{A,a}	7.3 ^{A,a}	4.2 ^{C,b}	4.1 ^{C,b}
Overall liking	2.6 ^{D,b}	7.2 ^{B,a}	7.7 ^{A,a}	2.3 ^{D,c}	3.6 ^{C,b}
Strawberry flavor liking	2.2 ^{D,b}	6.8 ^{B,ab}	7.4 ^{A,b}	2.1 ^{D,c}	3.6 ^{C,c}
Sweetness liking	2.3 ^{C,c}	7.0 ^{A,a}	7.3 ^{A,b}	2.3 ^{C,c}	3.4 ^{B,c}
Texture liking	4.4 ^{B,a}	7.0 ^{A,a}	7.2 ^{A,a}	2.9 ^{C,b}	3.3 ^{C,c}
Cluster 2					
Aroma liking	4.6 ^{D,a}	7.2 ^{AB,a}	7.5 ^{A,a}	5.4 ^{C,a}	6.9 ^{B,a}
Color liking	4.5 ^{D,a}	6.8 ^{B,a}	7.3 ^{A,a}	5.7 ^{C,a}	7.0 ^{AB,a}
Overall liking	3.6 ^{E,a}	7.5 ^{B,a}	8.0 ^{A,a}	4.8 ^{D,a}	6.6 ^{C,a}
Strawberry flavor liking	3.5 ^{D,a}	7.1 ^{B,a}	8.1 ^{A,a}	4.7 ^{C,a}	6.8 ^{B,a}
Sweetness liking	3.4 ^{D,b}	7.2 ^{B,a}	8.0 ^{A,a}	4.9 ^{C,a}	6.8 ^{B,a}
Texture liking	4.4 ^{D,a}	7.1 ^{B,a}	7.6 ^{A,a}	4.7 ^{D,a}	6.4 ^{C,a}
Cluster 3					
Aroma liking	4.6 ^{B,a}	5.9 ^{A,b}	5.4 ^{A,b}	4.3 ^{B,b}	4.4 ^{B,a}
Color liking	4.4 ^{B,a}	6.0 ^{A,b}	5.7 ^{A,b}	4.6 ^{B,b}	4.6 ^{B,b}
Overall liking	3.8 ^{BC,a}	5.1 ^{A,b}	4.7 ^{A,b}	3.4 ^{C,b}	4.1 ^{B,b}
Strawberry flavor liking	3.8 ^{C,a}	5.7 ^{A,b}	4.8 ^{B,c}	4.0 ^{C,b}	5.2 ^{AB,b}
Sweetness liking	4.1 ^{BC,a}	5.8 ^{A,b}	5.2 ^{A,c}	3.8 ^{C,b}	4.5 ^{B,b}
Texture liking	4.4 ^{BC,a}	5.6 ^{A,b}	5.0 ^{AB,b}	4.2 ^{C,a}	4.6 ^{BC,b}

^{A-D}Means for attributes in a row within each cluster followed by different uppercase letters are different ($P < 0.05$).

^{a-c}Means for specific attributes in a column followed by different lowercase letters are different ($P < 0.05$).

¹Products were scored using a 9-point scale where 1 = low intensity/dislike extremely and 9 = high intensity/like extremely.

²Product number refers to drinkable yogurt selected for consumer testing (Table 1).

Figure 5. Correlation biplot of descriptive attributes for consumers in cluster (group) 2 using the partial least squares model. Principal component (PC) 1 explains 44%; PC2 explains 35%. Attributes are descriptive attributes (Table 1). Circles indicate each consumer in group 2. Attributes underlined are those significantly associated with consumer liking.

Figure 6. Discriminant plot demonstrating 92% correct allocation of consumers into 3 distinct clusters.

yogurt/drinkable yogurt flavors and determine the influence of degree of Hispanic acculturation or country of origin on liking profiles.

CONCLUSIONS

Descriptive sensory analysis of strawberry drinkable yogurt revealed differences in sensory properties. Qualitative focus groups and quantitative consumer testing results with each ethnic group were complementary and consistent. Our results suggest that ethnicity does not solely define liking profiles of commercially available strawberry drinkable yogurts. Three distinct consumer clusters were identified, each with different ethnic constitutions: drinkable yogurt likers, drinkable yogurt lovers, and drinkable yogurt hard sells. The results of this research could be used by product developers to meet the needs of specific consumers based on ethnicity and consumer segment.

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REFERENCES

- Anonymous. 2006. Subject: Yogurt Drinks in the United States. <http://www.researchandmarkets.com/reports/339088> Accessed Jan. 30, 2007.
- Anonymous. 2007a. Drinkable yogurt is fastest-growing food and beverage category, ACNielsen finds. *Cheese Marketing News*, Feb. 9, 2007.
- Anonymous. 2007b. Subject: Yogurt drinks fastest growing in the world—Study. <http://www.reuters.com/article/companynewsandPR/idUSN2440974620070124> Accessed Jan. 31, 2007.
- Arnott, N. 1994. La Yogurt goes Latino. *Sales and Marketing Management* 146:16.
- Banfield, J. D., and A. E. Raftery. 1993. Model-based Gaussian and non-Gaussian clustering. *Biometrics* 49:803–821.
- Barnes, D. L., S. J. Harper, F. W. Bodyfelt, and M. R. McDaniel. 1991a. Correlation of descriptive and consumer panel flavor ratings for commercial prestirred strawberry and lemon yogurts. *J. Dairy Sci.* 74:2089–2099.
- Barnes, D. L., S. J. Harper, F. W. Bodyfelt, and M. R. McDaniel. 1991b. Prediction of consumer acceptability of yogurt by sensory and analytical measures of sweetness and sourness. *J. Dairy Sci.* 74:3746–3754.
- Berry, D. 2003. Growth Continues. *Dairy Foods Magazine* 104:24–29.
- Biasioli, F., F. Gasperi, E. Aprea, I. Endrizzi, V. Framondino, F. Marini, T. Chiu, D. Fang, J. Cheng, Y. Wang, and C. Jeris. 2001. A robust and scalable clustering algorithm for mixed type attributes in large database environment. 7th Assoc. Comput. Machin. (ACM) Special Interest Group on Knowledge Discovery and Data Mining, San Francisco, CA. ACM, New York, NY.
- Bogue, J., and C. Ritson. 2005. Integrating consumer information with new product development process: the development of lighter dairy products. *Int. J. Consum. Stud.* 30:44–54.
- Brewster, E. 2002. Hispanic flavors heat up. *Beverage Industry* 93:41–42.

- Chiu, T., D. Fang, J. Cheng, Y. Wang, and C. Jeris. 2001. A robust and scalable clustering algorithm for mixed type attributes in large database environment. 7th Assoc. Comput. Machin. (ACM) Special Interest Group on Knowledge Discovery and Data Mining, San Francisco, CA. ACM, New York, NY.
- Decker, K. J. 2004. Crossing Borders: Designing for the Hispanic Demographic. Food Product Design. Available <http://www.foodproductdesign.com/articles/0904CS.html>. Accessed Mar. 30, 2007.
- Eder, R. 2003. Drinkable yogurt beats the bagel. Drug Store News 25:42.
- Johanningsmeier, S., R. McFeeters, and M. A. Drake. 2005. A hypothesis for the chemical basis for perception of sourness. J. Food Sci. 70:R44–R48.
- Kalvianinen, N., K. Roininen, and H. Tuilora. 2003. The relative importance of texture, taste and aroma on a yogurt-type snack food preference in the young and elderly. Food Qual. Pref. 14:177–186.
- Martens, H., and M. Martens. 2001. Multivariate Analysis of Quality: An Introduction. John Wiley & Sons, West Sussex, UK.
- Meilgaard, M. M., G. V. Civille, and T. Carr. 1999. Sensory Evaluation Techniques. 3rd ed. CRC Press, New York, NY.
- Pollen, N. R., C. R. Daubert, P. Prabhasankar, M. A. Drake, and M. L. Gumpertz. 2004. Quantifying fluid food texture. J. Texture Stud. 35:642–657.
- Raymond, J. 2001. The multicultural report. Am. Demogr. 23:3–6.
- SPSS. 2001. Subject: The SPSS Twostep Cluster Component: A scalable component enabling more efficient customer segmentation. SPSS Inc., Chicago, IL. http://www.spss.ch/upload/1122644952_The%20SPSS%20TwoStep%20Cluster%20Component.pdf Accessed June 22, 2006.
- Tsuchiya, A., E. Almiron-Roig, A. Lluch, D. Guyonnet, and A. Drewnowski. 2006. Higher satiety ratings following yogurt consumption relative to fruit drink or dairy fruit drink. J. Am. Diet. Assoc. 106:550–557.
- Ward, C. D., C. S. Koeferli, P. P. Schwegler, D. Schaeppi, and L. E. Plemmon. 1999. European strawberry yogurt market analysis with a case study on acceptance drivers for children in Spain using principal component analysis and partial least squares regression. Food Qual. Pref. 10:387–400.
- Zhang, T., R. Ramakrishnon, and M. Livny. 1996. BIRCH: An efficient data clustering method for very large databases. Paper presented at The Assoc. Comput. Machin. (ACM), Special Interest Group on Management of Data Conference on Management of Data, Montreal, Canada. ACM, New York, NY.