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## Assessment of consumer perceptions, preferences and behaviors:

- Part 1: fluid milk from different packaging
- Part 2: fresh and end of code milk

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## Part 1: Abstract

The objective of this study was to understand consumers' expectations and evaluate the impact of a sensory experience upon perceived value of fluid milk in translucent high-density polyethylene (translucent plastic), white-pigmented high-density polyethylene (lightblock), and paperboard. Eleven sessions were carried out (n=100). All sessions included an explanation of the consent form and the experiment process, a survey about demographics and milk purchasing and consumption behaviors, sensory evaluation, educational message, and auctions. Consumers were blindly served two pairs of milk samples 2% (from paperboard and translucent plastic); skim (paperboard and translucent plastic) and asked to indicate preference and the level of acceptability for each sample using a 7-point scale. Consumers were also asked to assess a value to each sample listed on a sheet of paper. Consumers also tasted 2 samples (2% and skim from lightblock) and were only asked to assess a value to those samples (not acceptability or preference). All samples tasted by consumers were simultaneously evaluated by a panel of 9 judges who were trained to evaluate milk quality attributes on a 15-cm line scale. All milk was from the same source, processed on the same timeline for each session; milk was stored in the warehouse until transport to the sessions. The results from the trained panel and consumer panel acceptability scores were analyzed using one-way ANOVA. Trained panelists detected higher levels of the oxidized attribute in skim (5.8 cm) and 2% (5.1 cm) milk from translucent plastic ( $p < 0.05$ ). Consumers did not have a significant preference for milk from translucent plastic or paperboard ( $p > 0.05$ ), though more regularly purchased plastic. There were no significant differences in consumers' acceptability scores between packaging of the same fat content ( $p > 0.05$ ) however, consumers did give higher acceptability scores to 2% in paperboard (5.2) than skim in paperboard (4.7). There were no differences in consumers' value (\$) for 2% or skim in paperboard or translucent plastic ( $p > 0.05$ ). After receiving an educational message and tasting "Certified Fresh" samples, 50% of consumers indicated positive comments regarding the packaging seal. Consumers were willing to pay significantly more for 2% in paperboard (\$0.39 more) or plastic (\$0.31 more) packaging with "Certified Fresh Taste" seal and for skim in "Certified Fresh Taste" paperboard (\$0.15 more) packaging ( $p < 0.05$ ) than when packaged without such labeling. Although consumers could not detect a difference in flavor between packaging types they valued the idea of a fresher tasting product and would pay more for a visual "Certified Fresh Taste" seal after hearing about the impact of light on milk in different packaging.

## **Materials and Methods**

### **Timeline and Milk Production**

The study was conducted from November 2012 to April 2013 in Ames, IA. Milk samples were produced at Agropur Inc. Division Natrel USA, under the Schroeder brand. Both 2% and Skim samples were produced in the same facility and followed the same timeline for each consumer panel. Samples were packaged by Agropur Inc. in half-gallon high-density polyethylene white pigmented containers (lightblock), half-gallon high-density polyethylene non-pigmented containers (translucent plastic), and half-gallon paperboard cartons. Samples were produced on normal production days at the facility and were held on-site for our use. All samples were held in Schroder's warehouse under black plastic bags to eliminate light exposure and were transported in closed coolers and held at 4°C in a commercial refrigerator until use.

### **Sensory Evaluation- Descriptive Analysis**

Nine people over the age of 18 were recruited from the university to participate in sensory evaluation. Panelist requirements were to have no aversion to milk, consume milk regularly, and have interest in sensory evaluation. Panelists were recruited from the department or dairy products evaluation team so that most had some understanding of evaluating dairy products prior to the study. Before the experiment, panelists were trained using Quantitative Descriptive Analysis during 8 initial one-hour sessions. Additional one-hour review sessions were conducted between experiments to remind consumers of the attribute characteristics and scale. Six milk attributes (cooked, feed, flat, foreign, lacks freshness, and oxidized) were chosen for evaluation. They were chosen from the milk-scoring guide for the National Collegiate Dairy Product Evaluation Contest because they are common milk attributes that could change in milk based upon processing or packaging and were expected to either develop or dissipate as milk was stored. For this study, panelists were instructed to use "foreign" for off-flavors they noticed that were not inherent to milk, such as sanitizer or flavoring. The attribute "lacks freshness" was defined for this study as characteristics that would indicate storage or bacterial growth in the milk. The attribute "oxidized" was to be specified by the panelist. They were instructed to indicate if it was metal oxidation (piercing, penny-like aroma with mouth drying) or light oxidation (wet cardboard aroma and mouth drying). Panelists were trained to taste milk in the same way throughout training and the subsequent tastings. Panelists received each milk sample in a 3-digit-labeled disposable plastic cup and were taught to immediately cover the cup in order to trap the aromas in the cup. They were instructed to swirl the cup gently to release any volatile compounds that were present. When tasting the milk, panelists were to take a mouthful of the sample while breathing in through the nose in order to catch any volatiles present. Scoring of the six attributes was agreed upon through discussion by the group and research investigator. The panelists were trained to recognize the attribute and to score the intensity of each of the six attributes on a 15cm line scale. Panelists were introduced to varying

degrees of each attribute that the research investigators prepared. The terms slight (3cm), definite (7.5cm) and pronounced (13cm) were defined on the line scale for all panelists (Table 1).

After completing training sessions, trained panelists evaluated milk samples using 15 cm line scales on paper. Each panelist had an individual private booth for evaluating samples and was given a unique 3-digit panelist code used to identify them. In the booth, panelists had a cup of tap water to cleanse the palate between samples, as well as a pencil and blank ballot for each sample to be tasted during that tasting session. Ballots were collected after each sample, and scales were measured by investigators and compiled in Microsoft Excel software. Trained panelists tasted samples simultaneously with consumers, but at a different location.

### **Sample Preparation**

Samples in all three types of packaging were exposed to light at 1300 lux for one hour on the same day as consumer sessions and trained panel tasting. 1300 lux was determined based on previous research and the average lux of local refrigerated lighted dairy cases (Chapman, 2001). After light exposure, samples were stored at 4°C in a commercial refrigerator. Within an hour of tasting, samples were poured into small plastic tasting cups with lids and stored in refrigerator on trays until tasting.

### **Consumer Surveys and Sensory Evaluation**

Consumers (n=100) were recruited through online postings, emails, flyers and word of mouth. The criteria were to be over the age of 18 and consume/purchase milk weekly. Every session was conducted in the same fashion by use of a “script”, which was read by the investigator. Panelists first signed consent forms and filled out a survey with questions about purchasing and consumption behavior as well as demographics. Panelists were given time to answer all questions unless one panelist was holding up the group, in which case that panelist would be allowed to return to the survey at the end of the session to complete it. Consumers were served 4 milk samples in two sets (either two 2% milk samples (one from paperboard and one from translucent plastic) or two skim milk samples (one from paperboard and one from translucent plastic)), and indicated preference in each pair and acceptability of each on a 7-point hedonic scale. Consumers were encouraged to take notes on paper to help them remember what they liked or disliked about samples. Samples were served to consumers randomly so that all sample orders were used. An educational message about the impact of light on flavor and nutrition of milk was presented. *Nth* Price Auctions were conducted based upon the description in the next section. Finally, consumers filled out a post survey with additional questions about purchasing and the information gained from the session.

### ***Nth Price Auctions***

To determine consumers' willingness to pay for and true value for certain attributes of fluid milk, *nth* price auctions were used (Lusk and Shogren, 2007). Consumers in all sessions were introduced to the concept of auctions and practiced three rounds of auctions using an unrelated set of items, in this case candy bars. Consumers were asked to submit a value for each milk in a total of three rounds. In the first round, consumers were visually shown four milk samples (2% and skim, paperboard and translucent plastic). In the second round, consumers assigned values to samples they had blindly tasted immediately prior to auction. On the bidding sheet, sample numbers were listed twice; once paired with paperboard and once paired with plastic (although investigators knew if the sample was from translucent or paperboard, true identity was not yet revealed). In other words, panelists still did not know if the sample tasted was from paperboard or plastic, but the intent was to obtain the perceived value of each sample based upon packaging and sensory experience. Thus 8 total options (skim and 2% milk, each from 2 packaging types) were available for "bidding" even though they had only tasted 4 samples. Consumers were allowed to use notes they had taken during sensory evaluation.

After completing the second round of auctions, consumers were given the following educational message: "As you probably have noticed, milk is packaged in several kinds of containers. Have you ever wondered if package style can influence the milk inside? When milk sits in the lighted refrigerated dairy case, if the milk is not protected from the light, the light can initiate chemical reactions. A study at Cornell University showed that consumers noticed a flavor defect after milk had been exposed to light for as little as 54 minutes. Not only is flavor affected, but vitamin A and the B vitamin riboflavin are reduced. The scientific term for that milk is "oxidized". When milk is packaged in paperboard, the packaging does not allow this process to occur. Technology has also been developed to inhibit this process from happening in plastic jugs. To help consumers make better choices, a new label "Certified Fresh Taste" is being considered. For milk to earn the right to carry this label, both chemical analysis and a trained panel of experts must affirm that milk in such packaging has no detectable oxidized flavor defects." While hearing the message, consumers were shown translucent plastic, paperboard and plastic lightblock packaging. Then consumers were given two additional milk samples to taste (skim and 2% in plastic lightblock) and told that they had "earned" the "Certified Fresh Taste" seal.

After the educational message and tasting, consumers assigned values to milks using the information they had gained during the entire session: visual of packaging types, blind tasting, educational message about impact of light on milks in different packaging and an option for "Certified Fresh Taste". During third round bidding, samples and their respective packaging type

were revealed. Specifically, their choices were: 2% milk from paperboard with or without “Certified Fresh Taste”, 2% milk from translucent plastic, 2% milk from light block packaging with “Certified Fresh Taste” seal, skim milk from paperboard with or without “Certified Fresh Taste”, skim milk from translucent plastic, and skim milk from light block packaging with “Certified Fresh Taste” seal (8 total options).

Finally, based upon the auctions process, one milk product was randomly selected as the product that would be purchased at “market price”. The market price of the product was determined using the *n*th highest price and *n*-1 highest bidders paid that price and could purchase the winning milk. The number of consumers in each session was numerically divided in half to determine *n*.

### **Statistical Analysis**

Statistical Analyses of trained panel and consumer sensory data was performed using SAS version 9.3 (Cary, NC). One-Way ANOVA with Tukey Kramer multiple pairwise comparison adjustment was used, with a significance level of  $P < 0.05$  selected. Analyses of consumer *N*th price auction data was performed using Wilcoxon Signed Rank Test in XLStat in Microsoft, Excel.

### **Results and Discussion**

#### **Consumer Surveys**

Consumers were asked several questions in both a pre-survey and post-survey. Questions included: typical purchasing habits, the number of people in their household, how much they spend on milk every month and what type of container they purchase. Also, in the post-survey they were asked how the information presented would affect their purchasing and if they would pay more for a milk that had been sealed with a “Certified Fresh Taste” sticker. 46% of consumers surveyed purchase skim milk, but sensory scores indicated that only about half of consumers gave skim milk higher acceptability scores. 83% of consumers surveyed buy plastic packaging, but only about half of those consumers gave plastic a higher acceptability score. Of consumers who purchase skim milk, 23% indicated purchasing it for nutritional aspects. This confirms that although consumers buy one type of packaging regularly, they are not necessarily purchasing because of a perceived superior flavor. Also, more consumers who purchase skim milk stated they purchase it for nutritional aspects than for flavor, which would explain the trend that higher acceptability scores were given to 2% milk samples.

#### **Sensory Evaluation**

The trained panelists evaluated six attributes, however for this study, the off-flavor oxidized was used to monitor main differences in samples because it would indicate any off-flavors due to exposure to light. Trained panelists recognized the oxidized attribute at higher levels in skim

and 2% from translucent plastic than in skim and 2% from lightblock packaging ( $p < 0.05$ ). Oxidized scores for milk in paperboard and lightblock packaging were not significantly different ( $p > 0.05$ ; Tables 2 and 3).

Although trained panelists detected oxidized off-flavor in milk from translucent packaging, consumers did not have a significant preference for milk from one type of packaging over the other when served samples blindly ( $p > 0.05$ ; data not shown). There were no differences in consumers' acceptability scores between milks of the same fat content in different packaging ( $p > 0.05$ ), however they did significantly prefer 2% in paperboard to skim in paperboard (Table 4). Consumer surveys indicated that although 46% of those surveyed purchase skim milk regularly, only 13% of those indicated purchasing it for flavor. This could explain the higher scores for 2% milk; consumers prefer the taste but have the perception they should buy skim for other reasons.

Milk in lightblock plastic packaging had significantly lower oxidized attribute scores than in translucent plastic, but was not significantly different than paperboard. Light block packaging does not block 100% of the light, but is more effective than non-pigmented packaging in decreasing degradation of vitamins due to light, as well as preventing oxidized off-flavors (van Aardt, et al., 2001).

### **Nth Price Auctions**

Consumers' values were not significantly different for ½ gallons of milk when based only on packaging type (before tasting) or after blindly tasting samples ( $p > 0.05$ ). However, consumers were willing to pay more for 2% in lightblock plastic (\$0.99) and in paperboard (\$1.10) and for skim in paperboard (\$0.96) with a "Certified Fresh Taste" seal that guaranteed milk would taste fresh ( $p < 0.05$ ). Consumers were also willing to pay more for skim in lightblock plastic with a "Certified" seal, but not significantly ( $p > 0.05$ ). This does not align with consumers' sensory responses. Consumers' values based upon blind sensory were not significantly different; acceptability scores for translucent plastic (milk exposed to light) and paperboard (milk not exposed to light) were not different, however, when samples were revealed and "Certified Fresh Taste" seal was offered consumers' bid higher values. These results confirm that consumers value the idea (marketing) of a fresher tasting product, even though they don't necessarily notice a difference in taste.

### **Conclusion**

Milk in translucent plastic (exposure to light in dairy case) had higher trained panelist scores for the oxidized off-flavor attribute than paperboard packaging, but consumers did not notice a difference between milk from translucent plastic and paperboard upon tasting. Milk with a

higher oxidized score did not receive significantly lower values (\$) from consumers. Although consumers indicated no difference in value for packaging in early auction rounds, after learning about the impact of light on milk in translucent packaging and being offered a “Certified Fresh Taste” seal on milk protected from light, consumers’ values for lightblock and paperboard packaging with the seal significantly increased. Behaviors and perceptions of milk in different packaging appear to be dictated by marketing of fresh taste rather than actual sensory experience.

#### **Literature Cited**

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**Table 1.** Descriptions of the six chosen attributes.

Attribute	Descriptors
Cooked	Eggy, sulfur, custardy
Feed	Grassy, stalky, hay
Flat	Watered down, thinner mouth feel, less dairy fattiness
Foreign*	Bleach, sanitizer, flavoring (such as vanilla)
Lacks Freshness**	Fruity, fermented
Oxidized***	Light: Cardboard, mouth-drying sensation, smells like wet brown paper towel Metal: Some similar characteristics as light oxidized, metallic tastes, penny coin taste, tingling sensation at the back of the tongue

\*Foreign attribute is designated for flavors that are not supposed to be in milk but are not included in the other six off-flavors; examples include: sanitizer or artificial flavoring (such as vanilla)

\*\*Lacks freshness attribute is designated for flavors that would indicate storage or bacterial growth in milk; examples include: fruity or fermented

\*\*\* Oxidized attribute could be metal or light; panelists were to indicate type of oxidation occurring followed by rating intensity

**Table 2.** Trained Panel Mean Scores for 2% Milk Samples.

Treatment	Feed	Foreign	Lacks	Cooked	Flat	Oxidized
2% Paperboard	0.0a	0.0a	0.7a	1.05a	0.06a	0.32b
2% Plastic	0.0a	0.9a	0.5a	1.3a	0.0a	5.05a
2% LB	0.0a	0.0a	0.5a	1.5a	0.0a	2.08b

<sup>a-b</sup> means in same column that have different superscripts are significantly different ( $p < 0.05$ ); scores based on 7-point hedonic scale.

**Table 3.** Trained Panel Mean Scores for Skim Milk Samples.

Treatment	Cooked	Feed	Flat	Foreign	Lacks	Oxidized
Skim Paperboard	0.06a	0.0a	12.8a	0.5a	0.5a	3.0ab
Skim Plastic	0.4a	0.2a	13.5a	0.0a	0.8a	5.8a
Skim LB	0.9a	0.1a	13.5a	0.5a	1.1a	2.4b

<sup>a-b</sup> means in same column that have different superscripts are significantly different ( $p < 0.05$ ); scores based on 7-point hedonic scale.

**Table 4.** Mean Consumer Acceptability Scores for Milk.

Sample	Acceptability Score
Skim Paperboard	4.67a
Skim Plastic	4.83ab
2% Paperboard	5.21b
2% Plastic	4.89ab

<sup>a-b</sup> means in same column that have different superscripts are significantly different ( $p < 0.05$ ); scores based on 7-point hedonic scale.

## Part 2: Abstract

The objective of this study was to understand consumers' expectations and evaluate the impact of a sensory experience upon perceived value of fluid milk at the beginning and end of code. Eleven sessions were carried out (n=103). All sessions included an explanation of the consent form and the experiment process, a survey about demographics and milk purchasing and consumption behaviors, sensory evaluation, educational message, and auctions. Consumers were blindly served two pairs of milk samples (2% within 2-3 days of production (fresh) and 2% with 2-3 days to end of code (end); skim (fresh and end)) and asked to indicate preference and the level of acceptability for each sample using a 7-point scale. Consumers were also asked to assess a value to each sample listed on a sheet of paper. All samples tasted by consumers were simultaneously evaluated by a panel of 8 judges who were trained to evaluate milk quality attributes on a 15-cm line scale. All milk was from the same source, processed on the same timeline for each session; milk was stored in the warehouse until transport to the sessions. Eighty-five participants (82%) indicated they check for the farthest out code date more than half the time they shop. However, upon tasting, consumers did not have a preference for 2% fresh milk over 2% end, or for skim fresh over skim end ( $p>0.05$ ). These findings were in agreement with their acceptability scores, which were 4.7 for skim fresh, 4.6 for skim end, 5.1 for both 2% fresh 2% end ( $p>0.05$ ). Trained panelists did not detect a difference in lacks freshness flavor in skim fresh (1.9 cm) or skim end (1.3 cm). Trained panelists also did not detect a difference in cooked, feed, flat, foreign or oxidized flavors for 2% or skim milk samples. Surprisingly, trained panelists detected a significant difference in lacks freshness flavor of 2% fresh (2.3 cm) and 2% end (0.3 cm) ( $p<0.05$ ). When the one off-flavored batch of 2% fresh milk was removed from analysis, trained panelists could not distinguish a difference in lacks freshness between 2% fresh (1.0 cm) and 2% end (0.4 cm) ( $p>0.05$ ). Sensory evaluation significantly impacted consumers' value for these milks, as the margin of difference between consumers' bids decreased ( $p<0.05$ ) from round 1 (before tasting; skim fresh-skim end=\$0.27, 2% fresh-end = \$0.31) to round 2 (after tasting; skim fresh-end=\$0.03, 2% fresh-end=\$0.11). These results confirm that although many consumers go out of their way to buy the freshest milk, they cannot necessarily distinguish fresh milk from milk at the end of code; many consumers' value for milk hinges on the idea of a farther out code date rather than actual perception of superior taste. After tasting and receiving an educational message about the meaning of code dates, 83% of consumers stated the information would impact their future purchases.

## **Materials and Methods**

### **Timeline and Milk Production**

The study was conducted from November 2012 to April 2013 in Ames, IA. Milk samples were produced at Agropur Inc. Division Natrel USA, under the Schroeder brand name. Both 2% and Skim samples were produced in the same facility and followed the same timeline for each consumer panel. Samples were packaged by Agropur Inc. in half-gallon high density polyethylene white pigmented containers. Samples were produced on normal production days at the facility and were held on-site for our use. Schroeder has a 21 day printed code date, and milk was received approximately 16 days (near end code date) and 3 days (fresh code date) after production, and held at 4°C in a commercial refrigerator until use.

### **Sensory Evaluation- Descriptive Analysis**

Nine people over the age of 18 were recruited from the university to participate in sensory evaluation. Panelist requirements were to have no aversion to milk, consume milk regularly, and have interest in sensory evaluation. Panelists were recruited from the department or dairy products evaluation team so that most had some understanding of evaluating dairy products prior to the study. Before the experiment, panelists were trained using Quantitative Descriptive Analysis during 8 initial one-hour sessions. Additional one-hour review sessions were conducted between experiments to remind consumers of the attribute characteristics. Six milk attributes (cooked, feed, flat, foreign, lacks freshness, and oxidized) were chosen for evaluation. They were chosen from the milk-scoring guide for the National Collegiate Dairy Product Evaluation Contest because they are common milk attributes that may change in milk based on processing or packaging and were expected to either develop or dissipate as milk was stored. For this study, panelists were instructed to use “foreign” for off-flavors they noticed that were not inherent to milk, such as sanitizer or flavoring. The attribute “lacks freshness” was defined for this study as characteristics that would indicate storage or bacterial growth in the milk. The attribute “oxidized” was left to be specified by the panelist. They were instructed to indicate if it was metal oxidation (piercing, penny-like aroma with mouth drying) or light oxidation (wet cardboard aroma and mouth drying). Panelists were trained to taste milk in the same way throughout training and the subsequent tastings. Panelists received each milk sample in a 3-digit-labeled disposable plastic cup and were taught to immediately cover the cup in order to trap the aromas in the cup. They were instructed to swirl the cup gently to release any volatile compounds that were present. When tasting the milk, panelists were to take a mouthful of the sample while breathing in through the nose in order to catch any volatiles present. Scoring of the six attributes was agreed upon through discussion by the group and research investigator. The panelists were trained to recognize the attribute and to score the intensity of each of the six attributes on a 15cm line scale. Panelists were introduced to varying degrees of each attribute that the research investigators prepared. The terms slight (3cm),

definite (7.5cm) and pronounced (13cm) were defined on the line scale for all panelists (Table 1).

After completing training sessions, trained panelists evaluated milk samples using 15 cm line scales on paper. Each panelist had an individual private booth for evaluating samples and was given a unique 3-digit panelist code used to identify them. In the booth panelists had a cup of tap water to cleanse the palate between samples, as well as a pencil and blank ballot for each sample to be tasted during that tasting session. Ballots were collected after each sample, and scales were measured by investigators and compiled in Microsoft Excel software. Trained panelists tasted samples simultaneously with consumers, but at a different location.

### **Consumer Surveys and Sensory Evaluation**

Consumers (n=103) were recruited through online postings, emails, flyers and word of mouth. The criteria were to be >18 and consume/purchase milk weekly. Every session was conducted in the same fashion by use of a “script,” which was read by the investigator. Panelists first signed consent forms and filled out a survey about purchasing and consumption behavior as well as demographics. Panelists were given time to answer all questions unless one panelist was holding up the group, in which case the panelist would be allowed to return to the survey at the end of the session to complete it. Consumers were served 4 milk samples in two sets (with two 2% milk samples (one with near code date and one with far code date) or two skim samples (one with near code date and one with far code date)), and indicated preference in each pair and acceptability of each on a 7-point hedonic scale. Consumers were encouraged to take notes on paper to help them remember what they liked or disliked about samples. Samples were served to consumers randomly so that all sample orders were covered. An educational message about the meaning of code date was presented. *Nth* price auctions were conducted based upon description in the next section. Finally consumers filled out a post survey with additional questions about purchasing and the information gained from the session.

### ***Nth* Price Auctions**

To determine consumers’ willingness to pay for certain attributes of fluid milk, *nth* price auctions were used (Lusk and Shogren, 2009). Consumers in all sessions were introduced to the concept of auctions and practiced three rounds of auctions using an unrelated set of items, in this case candy bars. Consumers were asked to submit a value for each milk in a total of three rounds. In the first round, consumers were visually shown four milk samples (2% and skim, near end code and far out code). In the second round, consumers assigned values to samples they had blindly tasted immediately prior to the auction. On the bidding sheet, only sample

numbers were revealed. Consumers were allowed to use notes they had taken during sensory evaluation.

After completing the second round of auctions, consumers were given the following educational message: "Have you ever wondered how to interpret the date on the top of a package of milk? We are here to tell you a little more about it...As you may know, pasteurization is a process of heating milk to a specific temperature for a definite length of time in order to kill microorganisms that can cause illness. The time-temperature combination of pasteurization is legally regulated throughout the country. Commercially sold milk in Iowa must be pasteurized.

Even though all of the dangerous bacteria are killed by pasteurization, milk still contains harmless bacteria that can cause spoilage. This is why milk must be refrigerated. Pasteurized milk has a refrigerated shelf life of approximately 21 days when unopened. Once opened, milk typically tastes good for about 7 days. When milk is opened and removed from the refrigerator several times during the week, spoilage bacteria numbers increase, so milk will spoil with time. Even though spoiled milk tastes bad, it is not dangerous. Consumers want to know that what they are purchasing is fresh and is going to taste good. That is why there is a date printed on most food packages. The code date or "best by" date printed on packages of milk is the last day that milk can be sold at full price. Companies determine that code date by experimentation to determine how long milk will maintain low levels of spoilage bacteria, and taste its best. A code date is used to ensure that on that date your milk will only have low numbers of spoilage bacteria and will taste fresh. Theoretically, unopened milk should taste fresh seven to ten days beyond the "best by" date because companies want to sell only high quality products to you."

After the educational message and tasting, consumers assigned values to milks using the information they had gained during the entire session: visual of packaging types, blind tasting and educational message about the printed code date on milk packaging. During third round bidding, samples and their respective code dates were revealed (4 total choices).

Finally, based upon the auctions process, one milk product was randomly selected as the product that would be purchased at "market price." The market price of the product was determined using the  $n$ th highest price and  $n-1$  highest bidders paid that price and could purchase the winning milk. The number of consumers in each session was numerically divided in half to determine  $n$ .

## **Statistical Analysis**

Statistical Analyses of trained panel and consumer sensory data was performed using SAS version 9.3 (Cary, NC). One-Way anova with Tukey Kramer multiple pairwise comparison adjustment was used. Significance level of  $P < 0.05$ . Analyses of consumer *Nth* price auction data was performed using Wilcoxon Signed Rank Test in XLStat in Microsoft, Excel.

## **Results and Discussion**

### **Consumer Surveys**

Consumers were asked several questions in both a pre-survey and post-survey. Included were questions about their typical purchasing habits, the number of people in their household, how much they spend on milk every month, what type of container they purchase and if they check the code date (Figure 1). Also, in the post-survey they were asked how the information presented would affect their purchasing and if they would pay more for a farther out code date or less for a closer code date (Figures 2-4).

### **Sensory Evaluation**

The trained panelists evaluated six attributes, however for this study, the off-flavor “lacks freshness” was used to monitor main differences in samples because it had been defined as anything that would indicate storage or bacterial growth. Trained panelists’ lacks freshness scores were higher ( $p < 0.05$ ) for 2% milk with a fresh (Dec. 4) than near end (Nov. 20) code date in the first sessions (Table 2). Lacks freshness scores of all other samples did not significantly differ ( $p > 0.05$ ).

Consumers were asked to indicate acceptability of each sample on a 7-point hedonic scale. Acceptability scores did not differ significantly in any of the consumer sessions (Table 2).

Consumers also did not have a significant preference for near or far code date when samples were paired, except in the first session, where they preferred 2% skim milk with a near end code date over fresh date ( $p < 0.05$ ; data not shown).

### ***Nth* Price Auctions**

Based on the consumer sessions, when shown containers of milk, consumers were willing to pay more for ½ gallons of “fresh” milk than “near-end” code milk when they could see the code date (Table 3; rounds 1 and 3). Consumers were not willing to pay more for “fresh” milk based on taste alone (when they could not see the code date; Table 3; round 2). We were interested in how much bids increased or decreased between bidding rounds (after package visualization, after sensory, and after educational message and package revelation (to connect sensory experience to code date). Analyzing the differences between rounds acts as an indicator for

how much a sensory experience or an educational message may influence a consumer's buying behavior.

The margin (difference in value) consumers were willing to pay for the milk was calculated by subtracting bids for the "near-end code" milk from the "fresh" milk bid price within the same rounds (round 1, 2 and 3). The Wilcoxon sign rank test was used to detect significant differences. Comparisons were as follows for both skim and 2%: round 1 vs. round 2, round 2 vs. round 3, and round 1 vs. round 3. There were significant differences in the margin of consumers' values between fresh and near end code bids except in round 1 vs. 3 for skim ( $p > 0.05$ ) (Table 4).

All differences were positive (higher bid price for "fresh" than "near-end code" bid). However, it important to note that bids for "fresh" decreased from the 1<sup>st</sup> to the 2<sup>nd</sup> round and from the 1<sup>st</sup> to the 3<sup>rd</sup> round. Though not significant, the fact that the bids for "fresh milk" were lowest in round 2 (after they tasted milk but could not see code dates) suggests that consumers rely on code date in their decision-making.

As panelists received more information (round 3; educational message about code date), they were not willing to pay as high of a margin for a "fresh" milk over an "end" milk as they were at the beginning of the session, but bidding increased over the 2<sup>nd</sup> round. This could be partially because at the beginning of the session (round 1), when they expected a large, obvious quality difference, they were willing to pay more for "fresh" milk than for "near-end code" milk. After the sensory experience revealed little difference in quality ("near-end code" milk tasted good, which may have surprised panelists), bids moved closer together and the total value for "fresh" milk decreased (rather than value for "near-end code" milk increasing; Table 3). In the 3<sup>rd</sup> round of the session, consumers were given an educational message about code date and the sample identities were revealed to them. The sensory experience, combined with the educational message, influenced their bids. The bids for "fresh" milk increased from the 2<sup>nd</sup> round because they were aware of the printed date, however panelists did not increase their bids to the level of the consumers' initial 1<sup>st</sup> round value (probably because "fresh" and "near-end code" samples tasted so similar). Once consumers had more information (message about the meaning of code date, combined with their sensory experience), as well as the code date revealed, the difference in amount less they wanted to pay for "near-end code" date or amount more they wanted to pay for "fresh" was not as large. Understanding consumers' behaviors could indicate the need to extend milk shelf life, which would make it a stronger competitor in the beverage market (Chapman, 2001).

## **Conclusion**

Near end code date milk *did not* have lower trained panelist, consumer acceptability or consumer preference scores than fresh code date milk. Behaviors and perceptions of milk with a fresh and near end printed code date appear to be dictated by a convenience factor rather than a sensory experience. Our code date research showed that consumers' value code dates, even if they do not fully understand them. Although many consumers indicated that they go out of their way to buy the freshest milk, they could not actually distinguish fresh milk from milk at the end of code. Consumers bid higher for milk that had a code date farther away than a close code date. The margin of difference between prices they would pay for fresh and end code milk decreased after an educational message about code date. Consumers bid higher for far away code milk, even after tasting revealed they could not tell the difference, and the educational message about its meaning. The higher bid was not because they preferred the taste, but rather because they valued the printed date and length of time they perceived that their milk could stay "fresh" in their refrigerator.

## **Literature Cited**

1. Chapman, K. W., L. J. Whited and K. J. Boor. 2002. Sensory threshold of light-oxidized flavor defects in milk. *J. Food Sci.* 67:2770-2773.
2. Lusk, J. L., J. F. Shogren. 2007. *Experimental Auctions*. 1st ed. Cambridge University Press.

**Table 1.** Descriptions of the six chosen attributes.

Attribute	Descriptors
Cooked	Eggy, sulfur, custardy
Feed	Grassy, stalky, hay
Flat	Watered down, thinner mouth feel, less dairy fattiness
Foreign*	Bleach, sanitizer, flavoring (such as vanilla)
Lacks Freshness**	Fruity, fermented
Oxidized***	Light: Cardboard, mouth-drying sensation, smells like wet brown paper towel Metal: Some similar characteristics as light oxidized, metallic tastes, penny coin taste, tingling sensation at the back of the tongue

\*Foreign attribute is designated for flavors that are not supposed to be in milk but are not included in the other six off-flavors; examples include: sanitizer or artificial flavoring (such as vanilla)

\*\*Lacks freshness attribute is designated for flavors that would indicate storage or bacterial growth in milk; examples include: fruity or fermented

\*\*\* Oxidized attribute could be metal or light; panelists were to indicate type of oxidation occurring followed by rating intensity

**Table 2.** Consumer acceptability and trained panel lacks freshness scores for 2% and skim milk samples.

Treatment	Consumer Acceptability <sup>†</sup>	Trained Panel <sup>††</sup>
2% November 20 <sup>th</sup> code date	4.79 <sup>a</sup>	0.01 <sup>a</sup>
2% December 4 <sup>th</sup> code date	4.61 <sup>a</sup>	4.11 <sup>b</sup>
Skim November 20 <sup>th</sup> code date	4.44 <sup>a</sup>	0.57 <sup>ab</sup>
Skim December 4 <sup>th</sup> code date	4.74 <sup>a</sup>	3.67 <sup>ab</sup>
2% April 16 <sup>th</sup> code date	5.32 <sup>A</sup>	0.48 <sup>ab</sup>
2% April 30 <sup>th</sup> code date	5.48 <sup>A</sup>	0.41 <sup>ab</sup>
Skim April 16 <sup>th</sup> code date	4.71 <sup>A</sup>	2.39 <sup>ab</sup>
Skim April 30 <sup>th</sup> code date	4.74 <sup>A</sup>	0.83 <sup>ab</sup>
2% April 30 <sup>th</sup> code date	5.38 <sup>α</sup>	0.32 <sup>ab</sup>
2% May 14 <sup>th</sup> code date	5.0 <sup>α</sup>	2.04 <sup>ab</sup>
Skim April 30 <sup>th</sup> code date	4.75 <sup>α</sup>	1.06 <sup>ab</sup>
Skim May 14 <sup>th</sup> code date	4.0 <sup>α</sup>	0.68 <sup>ab</sup>

<sup>a,b</sup> within a column, significant differences exist when scores do not share the same letter (p<0.05)

<sup>a, A, α</sup> within a column, different symbol style indicates different consumer tasting population, significant differences exist when scores do not share same letter, but share same symbol style (p>0.05)

<sup>†</sup> Scored on a 7-point hedonic scale; 1=dislike very much, 7=like very much

<sup>††</sup> Scored on a 15-cm line scale for intensity

**Table 3.** Consumers' bid price for skim and 2% milk ½-gallons with fresh and near-end printed code dates across all 3 bidding rounds (n=103).

	Skim "Fresh" Code bid (\$)	Skim Near-end Code bid (\$)	2% "Fresh" Code bid (\$)	2% Near-end Code bid (\$)
Round 1	1.05 <sup>a</sup>	0.78 <sup>a</sup>	1.09 <sup>a</sup>	0.78 <sup>a</sup>
Round 2	0.72 <sup>a</sup>	0.69 <sup>a</sup>	1.00 <sup>a</sup>	0.89 <sup>a</sup>
Round 3	0.90 <sup>a</sup>	0.69 <sup>a</sup>	1.02 <sup>a</sup>	0.86 <sup>a</sup>

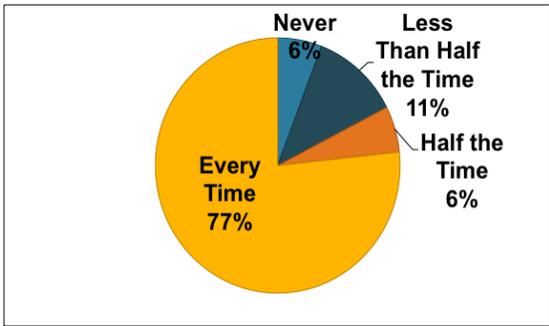
<sup>a</sup> shared superscripts in the same column indicate no significant difference between samples.

**Table 4.** Difference in consumers' bid price for near end sample bid subtracted from fresh sample bid by round\* (n=103).

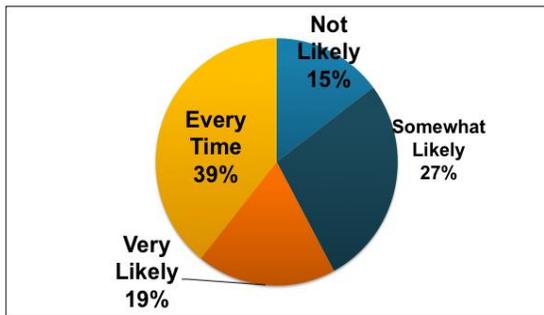
	Treatment	Margin (fresh bid minus near end bid, \$)
Rd. 1 vs. 3	2% Round 1	0.30 <sup>a</sup>
	2% Round 3	0.15 <sup>b</sup>
Rd. 1 vs. 2	Skim Round 1	0.26 <sup>a</sup>
	Skim Round 3	0.20 <sup>a</sup>
Rd. 2 vs. 3	2% Round 1	0.30 <sup>a</sup>
	2% Round 2	0.10 <sup>b</sup>
	Skim Round 1	0.27 <sup>a</sup>
	Skim Round 2	0.03 <sup>b</sup>
	2% Round 2	0.10 <sup>a</sup>
	2% Round 3	0.16 <sup>b</sup>
	Skim Round 2	0.03 <sup>a</sup>
	Skim Round 3	0.21 <sup>b</sup>

\* round 1: only package seen; round 2: after sensory evaluation, but sample tasted not directly connected to specific package; round 3: all information revealed.

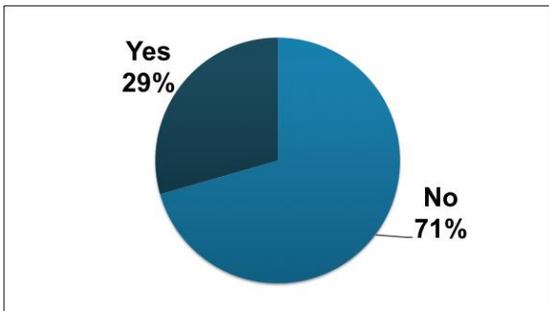
<sup>a,b</sup> superscripts with same fat content and within same round comparison are significantly different.



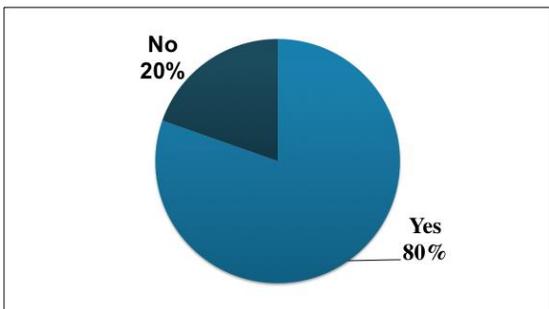
**Figure 1.** Responses to pre-survey question regarding how often consumers check for the farthest out printed code date.



**Figure 2.** Responses to post-survey question regarding how often consumers will continue to check for farthest out printed code date.



**Figure 3.** Responses to post-survey question regarding willingness to pay MORE for a printed date that is farther away from current date.



**Figure 4.** Responses to post-survey question regarding willingness to pay LESS for a printed date that is closer to current date.