2-26-2020

Use of auctions to assess consumer value for fresh and end-of-code milk

Molly Paterson
Johnsonville LLC

Stephanie Clark
Iowa State University, milkmade@iastate.edu

Use of auctions to assess consumer value for fresh and end-of-code milk

Abstract

The objective of this study was to survey consumers' milk purchasing behavior and investigate the effect of sensory experiences and an educational message on the perceived value of fluid milk at the beginning and near the end of code. Eleven auction sessions were carried out (n = 100 consumers), which included an explanation of the experiment, a survey about demographics and milk purchasing and consumption, sensory evaluation, an educational message, and 3 rounds of *n*th price auctions. Consumers were blindly served 2 pairs of milk samples from white-pigmented high-density polyethylene [2% and skim milk within 2 to 3 d of production (fresh) and 2% and skim milk with 2 to 3 d until the end of code (near-end)], and asked to indicate their preference and the level of acceptability for each sample using a 7-point hedonic scale. All samples were simultaneously evaluated by a panel of 8 judges who were trained to evaluate milk quality attributes on a 15 cm unstructured line scale. Results from the consumer panel acceptability rating session, trained panel descriptive analysis, and consumer auction bids were analyzed using multivariate factor analysis of variance. Subjecting pre- and post-survey responses to *k* means cluster analysis revealed 4 bidding populations in each round. Most participants (82%) indicated that they check the code date on milk every time they shop; 77% said they reached for the code date that was farthest out every time. However, on blind tasting, consumers did not prefer fresh over near-end milk. These findings were in agreement with their acceptability scores for fresh 2% (5.0/7.0), near-end 2% (5.2/7.0), fresh skim (4.5/7.0), and near-end skim (4.6/7.0) milks. Trained panelists did not detect a difference in "lacks freshness" flavor in fresh skim (1.9 cm/15.0 cm) or near-end skim milk (1.3 cm). Surprisingly, trained panelists did detect higher "lacks freshness" flavor in 1 lot of fresh 2% (2.3 cm) compared with near-end 2% milk (0.3 cm). When consumers bid on half gallons of milk with visible code dates, fresh skim was valued $0.27 higher than near-end skim, and fresh 2% was valued $0.29 higher than near-end 2%. After blind sensory evaluation, the margin between the fresh and near-end bids decreased to almost zero (fresh skim was valued only $0.03 more than near-end skim; near-end 2% was valued $0.01 more than fresh 2%). After the educational message about the meaning of code dates, consumer bids for near-end ($0.63) and fresh milk ($0.81) decreased compared with the first round of bidding ($0.74 and $1.01, respectively). Additionally, the margin in bids for fresh milk remained numerically higher than those for near-end milk ($0.15 for 2% and $0.21 for skim). The educational message about code date did not have the intended result of increasing consumer value for milk. Although consumers go out of their way to buy the freshest milk, they cannot necessarily distinguish fresh milk from milk at the end of code; consumers appear to value a code date that was farther out more than superior taste, even after a sensory experience and educational message.

Keywords

freshness, shelf life, sensory, waste

Disciplines

Dairy Science | Food Chemistry | Food Processing | Food Studies | Human and Clinical Nutrition

Comments

This accepted article is published as Paterson, M., Clark, S., Use of auctions to assess consumer value for fresh and end-of-code milk. *Journal of Dairy Science,* February 26, 2020. doi: 10.3168/jds.2019-17418

J. Dairy Sci. 103
https://doi.org/10.3168/jds.2019-17418

Use of auctions to assess consumer value for fresh and end-of-code milk

Molly Paterson[1] and Stephanie Clark[2]*
[1]Johnsonville LLC, PO Box 906, Sheboygan Falls, WI 53085
[2]Food Science and Human Nutrition Department, Iowa State University, Ames 50011

ABSTRACT

The objective of this study was to survey consumers' milk purchasing behavior and investigate the effect of sensory experiences and an educational message on the perceived value of fluid milk at the beginning and near the end of code. Eleven auction sessions were carried out (n = 100 consumers), which included an explanation of the experiment, a survey about demographics and milk purchasing and consumption, sensory evaluation, an educational message, and 3 rounds of *n*th price auctions. Consumers were blindly served 2 pairs of milk samples from white-pigmented high-density polyethylene [2% and skim milk within 2 to 3 d of production (fresh) and 2% and skim milk with 2 to 3 d until the end of code (near-end)], and asked to indicate their preference and the level of acceptability for each sample using a 7-point hedonic scale. All samples were simultaneously evaluated by a panel of 8 judges who were trained to evaluate milk quality attributes on a 15 cm unstructured line scale. Results from the consumer panel acceptability rating session, trained panel descriptive analysis, and consumer auction bids were analyzed using multivariate factor analysis of variance. Subjecting pre- and post-survey responses to k means cluster analysis revealed 4 bidding populations in each round. Most participants (82%) indicated that they check the code date on milk every time they shop; 77% said they reached for the code date that was farthest out every time. However, on blind tasting, consumers did not prefer fresh over near-end milk. These findings were in agreement with their acceptability scores for fresh 2% (5.0/7.0), near-end 2% (5.2/7.0), fresh skim (4.5/7.0), and near-end skim (4.6/7.0) milks. Trained panelists did not detect a difference in "lacks freshness" flavor in fresh skim (1.9 cm/15.0 cm) or near-end skim milk (1.3 cm). Surprisingly, trained panelists did detect higher "lacks freshness" flavor in 1 lot of fresh 2% (2.3 cm) compared with near-end 2% milk (0.3 cm). When consumers bid on half gallons of milk with visible code dates, fresh skim was valued $0.27 higher than near-end skim, and fresh 2% was valued $0.29 higher than near-end 2%. After blind sensory evaluation, the margin between the fresh and near-end bids decreased to almost zero (fresh skim was valued only $0.03 more than near-end skim; near-end 2% was valued $0.01 more than fresh 2%). After the educational message about the meaning of code dates, consumer bids for near-end ($0.63) and fresh milk ($0.81) decreased compared with the first round of bidding ($0.74 and $1.01, respectively). Additionally, the margin in bids for fresh milk remained numerically higher than those for near-end milk ($0.15 for 2% and $0.21 for skim). The educational message about code date did not have the intended result of increasing consumer value for milk. Although consumers go out of their way to buy the freshest milk, they cannot necessarily distinguish fresh milk from milk at the end of code; consumers appear to value a code date that was farther out more than superior taste, even after a sensory experience and educational message.

Key words: freshness, shelf life, sensory, waste

INTRODUCTION

The typical shelf life of high-temperature, short-time pasteurized milk in the United States ranges from 17 to 21 d (Martin et al., 2012). Milk shelf life is primarily limited by the growth and production of off-flavors by psychrotrophic bacteria that survive pasteurization (especially gram-positive rods, including *Paenibacillus*, *Bacillus*, and *Microbacterium*) or bacteria that enter milk post-pasteurization, such as gram-negative *Pseudomonas* (Fromm and Boor, 2004; Ranieri and Boor, 2009; Martin et al., 2012). Facilities with comprehensive cleaning and sanitation programs can effectively reduce post-pasteurization contamination, but spore-formers, which can enter milk at any stage between cow and packaging, tend to be the biggest limitation to milk shelf life (Martin et al., 2012).

The 17 to 21 d shelf life of milk limits its competitiveness in the marketplace. Furthermore, because many

Received August 6, 2019.
Accepted January 6, 2020.
*Corresponding author: milkmade@iastate.edu

consumers do not know that the printed code date is a guide for inventory in the store—the last day milk can be sold at full price, and an indicator that the product inside should still taste great—much milk is unnecessarily discarded when it is close to the end of code. Food waste is an immense issue globally; approximately 1.3 billion tons, or one-third of all food produced for human consumption is lost or wasted each year (Gustavsson et al., 2011; Buzby et al., 2014). In the European Union, household food waste in particular accounts for the majority of food wasted (53%), followed by processing (19%), food service (12%), production (11%), and wholesale and retail (5%; Stenmarck et al., 2016). Buzby et al. (2014) reported that dairy products represent the third-highest share in total value lost per year (17%, or $27 billion) at the consumer level in the United States, just after meat, poultry, and fish (30%, $48 billion), and vegetables (19%, $30 billion). Further research is recommended to test new ideas and interventions to reduce household food waste (Hebrok and Boks 2017; Roe et al., 2018).

Although there are a many reasons for food waste, confusion about the meaning of code dates is one of them (Newsome et al., 2014; Fatka, 2019). We conducted the present research to understand consumers' perception about and value for printed code dates on milk, and to evaluate the potential to influence perception of value with an educational message about code dates using auctions. When a consumer chooses to purchase a product, they are revealing their willingness to pay for that product's specific attributes. Academic research on consumers' values for products, attributes, and services are commonly studied in hypothetical situations in which consumers simply state their preferences but exchange no money for goods. Revealed and stated preferences are traditional, hypothetical approaches to determining consumer value (Hanley et al., 2006). Lusk and Shogren (2009) laid out the use of auctions to elicit non-hypothetical values for products, in which consumers submit private bids for different products. In the end, one product is chosen to sell at "market price" (determined by group size), and the consumers who value that product above market price purchase it. Money is exchanged in auctions, so it is not hypothetical.

Our previous work using auctions revealed that consumers are strongly influenced by "bad" milk experiences (Paterson and Clark, 2020). Most participants in auction sessions (68%) believed that milk flavor was affected moderately to a great deal by code date; 84% checked the code date on milk "every time"; and 71% consciously looked for milk with the code date that was farthest out (Paterson and Clark, 2020). The objectives of the present study were to determine consumers' preferences and acceptability for milk with close (near-end) and further off (fresh) code dates, as well as to understand consumers' value for milk based on visual printed code dates, blind sensory evaluation, and an educational message about code dates. We hypothesized that milk samples with a fresh code date that was visible to consumers would attract higher auction bids, but not higher acceptability scores when blind-tasted.

MATERIALS AND METHODS

Timeline and Milk Production

The study, held in Ames, Iowa, began in November 2012 and concluded in April 2013. Milk samples were produced at Agropur Inc. Division Natrel USA, under the Schroeder brand name. Both 2% and skim milk 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 (light-blocking) containers. Samples were produced on normal production days at the facility and were held on-site for our use. Schroeder had a 21 d printed code date; milk was received approximately 16 d (near-end) and 3 d (fresh) after production, and held at 4°C in a commercial refrigerator until use.

Descriptive Analysis

The same 8 people recruited and trained for our companion study (Paterson and Clark, 2020) evaluated milk in the present study. The studies took place simultaneously, and panelists were not told that they were evaluating milk from different packaging or from different code dates. Panelist requirements, training sessions, and tasting sessions are described in the companion study. In brief, 7 panelists were trained for a minimum of 8 h to evaluate 6 attributes (cooked, feed, flat, foreign, lacks freshness, and oxidized) using references with varying degrees of defects, ranging from slight (3 cm) to definite (7.5 cm), to pronounced (13 cm) on a 15 cm unstructured line scale. Particularly relevant to the present study was training for the "lacks freshness" off-flavor. The definite level was created by opening a carton of milk and storing it in the refrigerator until the expiration date; a slight level of the off-flavor was noted after 3 d of storage. The present study, which began in the fall and continued into the spring, included 2 additional 1-h group sessions conducted after the winter break to review attribute characteristics and scoring before the spring sessions.

Consumer Session Organization

Consumer participants (n = 102) were recruited in the same fashion as in the companion study (Paterson and Clark, 2020), but were unique to the present study (i.e., consumers did not participate in both studies). Every auction session was conducted in the same fashion, facilitated by the use of a script, which was read by a single investigator. Consumers first signed consent forms and filled out a 27-question pre-survey about demographics and purchasing and consumption behaviors. The demographic, milk purchasing, and milk consumption questions asked in the companion study (Paterson and Clark, 2020) were also asked in the present study, except for those that were considered "priming" questions; those were moved to the post-survey. For example, questions asking about code date in the companion paper pre-survey were asked in the post-survey for the present study.

We conducted 3 rounds of *n*th price auctions based on the description in the next section. The name "*n*th price" auction refers to the median bid, which became the market price.

Finally, consumers filled out a 13-question post-survey with additional questions about purchasing and information gained from the session. The questions in the post-survey differed from those asked in the companion study (Paterson and Clark, 2020) because of different study objectives.

Auctions

Auctions were conducted in the same fashion as in the companion study (Paterson and Clark, 2020), including the balanced blocking of asset integration and the timing of $30 compensation. However, the milk options in this study differed from the previous work. In brief, consumers in all sessions were introduced to the concept of auctions and practiced 3 rounds of auctions using candy bars. Then, 3 rounds of auctions were conducted with milk: (1) bidding on products after viewing packaging; (2) bidding on products immediately after tasting 3-digit-coded samples; and (3) bidding on products after an educational message.

In the first round of auctions, consumers were shown 4 milk samples in their original half-gallon high-density polyethylene light-block Schroeder containers [2% milk with close (near-end) and further away (fresh) code dates, and skim milk with near-end and fresh code dates]. Consumers were allowed to take the milk containers out of the ice basins, look at them more closely, and ask questions. The market prices of similar local products (the same as those reported in Paterson and Clark, 2020) were shown to consumers to set the context, but none of those products were part of the auction itself. Participants used individual bidding sheets to write the price they were willing to pay for each of the milk samples (Figure 1).

Round 1: Panelist # _____

Product	My Bid
Reduced Fat Milk (2%), Apr 16, 2013 code date	
Skim Milk, Apr 30, 2013 code date	
Reduced Fat Milk (2%), Apr 16, 2013 code date	
Skim Milk, Apr 30, 2013 code date	

Figure 1. Bidding sheet provided to panelists in auction round 1, where panelists were asked to assess a value for each milk, considering fat level (2% or skim) and code date (near or far-out).

At the beginning of the second round of auctions, consumers were served 4 blind-coded milk samples in 2 sets: either 2 samples of 2% milk (1 with a close code date and 1 with far-out code date) or 2 samples of skim milk (1 with a close code date and 1 with a far-out code date). Participants were asked to indicate their preference in each pair and the acceptability of each sample on a 7-point hedonic scale (1 = dislike very much to 7 = like very much). Consumers were encouraged to take notes to help them remember what they liked or disliked about the samples. Samples were served randomly so that all possible sample orders were covered.

Next, consumers were asked to assign values to the samples they had just blindly tasted, keeping in mind that the products represented the half-gallon packages of the Schroeder milk they had seen previously, but without the identities revealed. Instead, on the bidding sheet (Figure 2) only the numbers associated with the samples tasted were listed. Consumers were encouraged

Round 2: Panelist # _____

Product	My Bid
Reduced Fat Milk (2%), #742	
Skim Milk, #537	
Reduced Fat Milk (2%), #407	
Skim Milk, #708	

Figure 2. Bidding sheet provided to panelists in auction round 2, where panelists were asked to assess a value for each milk, considering fat level (2% or skim) and sensory experience (what they wrote down about each coded sample they tasted).

to use the notes they had taken during the sensory evaluation.

In the third round of auctions, consumers were read 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 7 to 10 d beyond the "best by" date because companies want to sell only high-quality products to you.

After the investigator read the message, the 4 samples and their respective code dates were revealed, and participants were asked to assess a value for each sample. Participants used individual bidding sheets to write the price they were willing to pay for each of the milk samples (Figure 3).

Finally, 1 milk product was randomly selected as the product that would be purchased at "market price." The number of consumers in each session was numerically divided in half to determine n. The market price of the product was determined using the nth highest price assessed by participants. The highest bidders ($n - 1$ and those who bid higher than the $n - 1$ bidder) paid the nth price and were expected to purchase the randomly selected milk.

Statistical Analysis

We performed statistical analyses of trained panel data, consumer survey and sensory data, and consumer nth price auction data using JMP Pro 14.0 (SAS Institute Inc., Cary, NC). We conducted predictor screening to narrow down the most viable predictors for variability in auction bids. We conducted multivariate factor ANOVA with the greatest predictors of auction bids, using Tukey-Kramer multiple pairwise comparison adjustment and considering a significance level of $P < 0.05$. The demographic, knowledge, purchasing, and consumption variables best at explaining the variability in bids were subjected to k means cluster analysis. Differences in cluster means were considered significant when 1-way ANOVA with Tukey-Kramer adjustment resulted in $P < 0.05$.

RESULTS AND DISCUSSION

Descriptive Analysis

Although the trained panelists evaluated 6 attributes, the off-flavor "lacks freshness" was the main differentia-

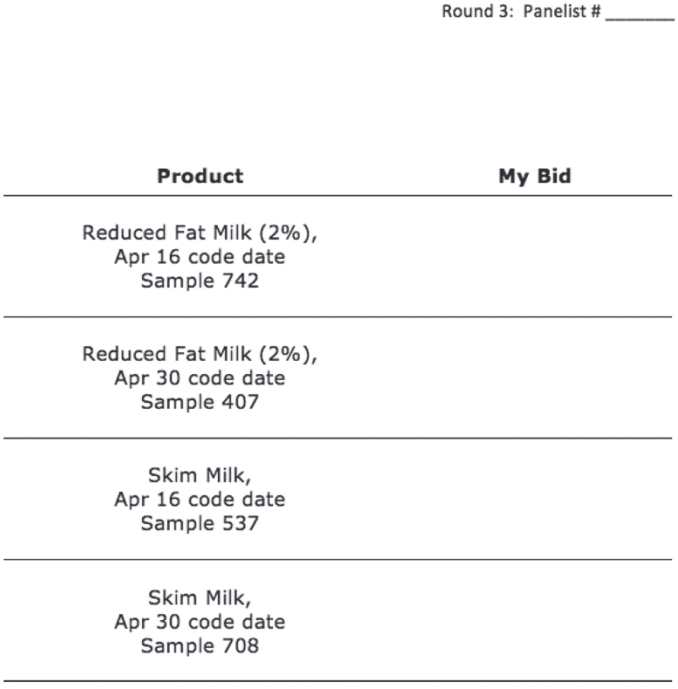

Figure 3. Bidding sheet provided to panelists in auction round 3, where panelists were asked to assess a value for each milk after an educational message, coupled with information about fat level (2% or skim), code date (near or far-out), and sensory experience.

Table 1. Mean consumer acceptability scores (n = 100 panelists) and trained panel lacks-freshness scores (n = 8 panelists) for 2% and skim milk from different code dates

Sessions	Sample	Consumer acceptability[1]	Trained panel (lacks freshness)[2]
1–4	2% Nov 20 code date (near-end)	4.8[a]	0.01[b]
	2% Dec 4 code date (fresh)	4.6[a]	4.11[a]
	Skim Nov 20 code date (near-end)	4.4[a]	0.57[ab]
	Skim Dec 4 code date (fresh)	4.7[a]	3.67[ab]
5–8	2% Apr 16 code date (near-end)	5.3[A]	0.48[ab]
	2% Apr 30 code date (fresh)	5.5[A]	0.41[ab]
	Skim Apr 16 code date (near-end)	4.7[A]	2.39[ab]
	Skim Apr 30 code date (fresh)	4.7[A]	0.83[ab]
9–11	2% Apr 30 code date (near-end)	5.4[z]	0.32[ab]
	2% May 14 code date (fresh)	5.0[z]	2.04[ab]
	Skim Apr 30 code date (near-end)	4.8[z]	1.06[ab]
	Skim May 14 code date (fresh)	4.0[z]	0.68[ab]

[a,b]For the trained panel, scores with different superscript letters differed ($P < 0.05$).

[a,A,z]Within a column, different symbol styles indicate different consumer tasting populations; within a style, scores with different superscript letters differed ($P < 0.05$).

[1]Scored on a hedonic scale of 1 (dislike very much) to 7 (like very much).

[2]Scored on a 15-cm line scale for intensity.

tion in samples, because it was defined as anything that would indicate storage or bacterial off-flavors. A 3-way ANOVA of trained panel data confirmed no panelist, fat content, product age, or interaction effects ($P > 0.05$). Surprisingly, the "lacks freshness" mean score was higher ($P < 0.05$) for fresh 2% milk (December 4 date) than near-end 2% milk (November 20 date) in the first 4 sessions (Table 1). Although the skim milk dated December 4 (fresh) received a numerically higher mean "lacks freshness" score than the milk dated November 20 (near-end), no other "lacks freshness" scores differed during the study period ($P > 0.05$).

Consumer Demographics, Pre-survey, Preference, and Acceptability

Outlier analysis of participant data revealed 2 outliers in the data set. One participant, who bid $11.18 to $11.30 on half-gallon milk options in round 3 of the auctions, was highly unusual, so their data were removed from all analyses. Another participant who bid high ($2.50 and $5.00) on all samples in every round also selected 7.0 for all hedonic scores. Although the panelist could have been sincere and truly liked and wanted every milk option, in each case they composed a single cluster in the k means cluster analysis. Thus, data for this participant were also excluded from all analyses.

Participants (n = 100) were 68% female and 31% male. Age groups were as follows: 24% were 18 to 24; 35% were 25 to 34; 15% were 35 to 44; 11% were 45 to 54; and 15% were 55 and older. Living situation was as follows: 20% lived alone; 27% represented 2-person households; 27% lived with 2 others; and 25% lived with 3 or more people. Educational status was as follows: 16% had some college; 28% had 4-year college degrees; 36% had a master's degree; 8% had a doctoral degree; and the remainder had other levels of education. For milk consumption, 94% indicated that they consumed dairy milk (as a beverage, in coffee, cereal, recipes, or other) once a week or more frequently; 91% indicated that they drank milk (as a beverage) at least once a week. Besides consuming milk regularly, we hoped that participants were familiar with the milk market or had some experience purchasing milk: 78% of those surveyed were the primary purchasers in their households. Regarding fat content typically purchased, 48% purchased skim milk, 9% purchased low fat (1%) milk, 27% purchased reduced fat (2%) milk, 13% purchased whole milk, and only 3% purchased something else (e.g., chocolate milk). Of those who purchased skim milk, 27% said that they purchased it for nutritional reasons, and only 7% purchased it for flavor; a family member's preference and price were the other primary reasons for purchasing skim milk (5% of participants for each). Milk packaged in plastic was purchased regularly by 76% of participants, followed by 15% in paperboard, 4% in glass, 4% in white containers (light-block high-density polyethylene), and 1% in another type of packaging. For package size, 61% of participants purchased milk in gallons, 27% in half gallons, 5% in quarts, and 7% in single-serve containers. Responses to other select pre- and post-survey questions are included in Table 2. Although a completely different group of consumers participated in the companion study (Paterson and Clark, 2020), the demographic, purchasing,

Table 2. Summary of select pre- and post-survey questions and frequency of responses (n = 100 consumers)

Questions (question number)	Response (% responding)			
Pre-survey				
(24) How much do you think processing of milk affects milk quality (flavor) attributes?	Has no effect (0)	Has a small effect (21)	Affects moderately (45)	Affects a lot (33)
(25) How much do you think processing of milk affects nutritional attributes?	Has no effect (4)	Has a small effect (19)	Affects moderately (42)	Affects a lot (34)
(26) How much do you think light exposure affects milk flavor and nutritional attributes?	Has no effect (9)	Has a small effect (31)	Affects moderately (32)	Affects a lot (28)
(27) Have you ever tasted "bad" milk? (If yes, please describe what was bad about it)	No (13)	Yes (87)	—	—
Post-survey				
(5) Before today, how much did you think milk quality (flavor) is affected by the code date?	Has no effect (5)	Has a small effect (23)	Has a moderate effect (41)	Affects a lot (31)
(6) Before today, how often did you check the code date (often marked "best by," printed on the package) when you purchased milk?	Never (3)	Less than half of the time (12)	About half of the time (4)	Every time (81)
(7) Before today, how often did you consciously look for milk with the farthest out code date?	Never (6)	Less than half of the time (12)	About half of the time (6)	Every time (77)
(8) How much will what you have heard today about code date affect what milk product you purchase and consume?	Not at all (16)	A little (29)	Moderately (39)	Very much (16)
(10) After today, would you be willing to pay more for milk with a code date farther away?	No (72)	Yes (28)	—	—
(11) After today, would you be willing to pay less for milk with a code date that is close?	No (20)	Yes (80)	—	—
(12) After today, will you be more likely to look for milk with the farthest out code date?	Not likely (15)	Somewhat likely (27)	Very likely (19)	Every time (39)
(13) How willing would you be to pay more for milk that was processed differently than traditional pasteurization if you knew it would taste fresh longer?	Not at all likely (18)	Slightly likely (42)	Moderately likely (27)	Very likely (12)

Table 3. Consumers' mean and geometric mean bid price ($) for half gallons of skim and 2% milk with fresh and near-end printed code dates, along with mean margin consumers were willing to pay for fresh milk (near-end sample bid subtracted from fresh sample bid), by round (n = 100)

Auction round[1]	Mean fresh milk bids	Geometric mean fresh milk bids	Mean near-end milk bids	Geometric mean near-end milk bids	Mean margin (fresh − near-end)
Round 1, 2% milk	$1.02^{A}	$1.19	$0.74^{AB}	$1.04	$0.29^{a}
Round 1, skim milk	$0.99^{A}	$1.12	$0.73^{AB}	$1.03	$0.27^{ab}
Round 2, 2% milk	$0.83^{AB}	$0.79	$0.82^{AB}	$0.99	−$0.01^{c}
Round 2, skim milk	$0.66^{AB}	$0.95	$0.64^{AB}	$0.79	$0.03^{bc}
Round 3, 2% milk	$0.87^{AB}	$0.90	$0.73^{AB}	$0.78	$0.15^{abc}
Round 3, skim milk	$0.76^{AB}	$0.79	$0.54^{B}	$0.78	$0.21^{abc}

[A,B]Bids with different superscript letters differed ($P < 0.05$).

[a–b]Margins with different superscript letters differed ($P < 0.05$).

[1]Round 1 bids were submitted after package viewing. Round 2 bids were submitted after sensory evaluation; sample identity was not revealed. Round 3 bids were submitted after code date educational message; sample identity was revealed.

and consumption trends were similar, including the fact that 87% of participants in the present study had experienced "bad" milk before (Table 2).

Similar to the companion study (Paterson and Clark, 2020), consumers' mean acceptability scores for 2% and skim milk exhibited central tendencies (Table 1). Mean acceptability scores were 4.5/7.0 for fresh skim milk, 4.6/7.0 for near-end skim milk, 5.0/7.0 for fresh 2% milk, and 5.2/7.0 for near-end 2% milk ($P > 0.05$); we found no significant differences in acceptability within or across lots (Table 1).

Consumers did not have a significant preference for fresh milk over near-end milk when samples were paired ($P > 0.05$; data not shown). However, in the first 4 auction sessions, we found a significant preference for near-end 2% milk over fresh 2% ($P < 0.05$; data not shown). This aligned with the higher mean scores for "lacks freshness" by trained panelists for the fresh 2% milk served in the first 4 sessions. An extraneous factor that was not related to the length of storage (because the milk was fresh), but that the consumers were sensitive enough to notice, was to blame for this unexpected result.

Auctions

We used auctions to elicit non-hypothetical willingness-to-pay values for milk with different code dates. Similar to the companion study (Paterson and Clark, 2020), in which different consumers were involved, consumers were not told to bring money or that products would be available to purchase. This ensured that the circumstances reflected real value for the milk. Individual bids (not shown) for milk ranged from $0.00 to $3.19 per half gallon, with means ranging from $0.54 to $1.02 (Table 3). Geometric means, which may better reflect participants' value for the available options, ranged from $0.78 to $1.19 per half gallon. These values were slightly lower than those reported in the companion paper, which may be explained by natural variability in value for milk, because the population demographics were similar. Multivariate analysis revealed no meaningful main effect of timing of the $30 compensation payment, asset integration, milk fat typically purchased, or 2-way interactions on bids. For instance, it was not informative that in rounds 1 and 3 only, those told to record the ways they planned to use the $30 bid more for near-end 2% milk ($P < 0.05$) than those who did not undergo asset integration. Additionally, it was not very meaningful that in round 3 only, those who typically bought 1% milk bid higher ($P < 0.05$) for near-end skim milk than those who typically bought whole milk.

Looking only at the arithmetic and geometric means of bids is incomplete. A better way to understand consumer behavior is to analyze the differences (margins) between fresh and near-end milk of the same fat content, within rounds (Table 3) and between rounds (Table 4). Such comparisons enable an interpretation of how much the code dates, sensory experiences, and educational message influenced consumers' value for milk. To determine the margin that individual consumers were willing to pay for fresh milk over near-end milk, we subtracted the individual bids for near-end milk from the individual bids for fresh milk within the same rounds (Table 3; far right column). We calculated between-round margins by subtracting individual bids in round 2 from bids in round 1 (to evaluate value of code date over taste); subtracting bids in round 3 from bids in round 2 (to evaluate the value of taste over the educational message); and subtracting bids in round 3 from bids in round 1 (to evaluate the value of code date over educational message; Table 4). Then we conducted ANOVA.

Consumers bid numerically more for half gallons of fresh milk than for near-end milk when they could see

Table 4. Differences in consumers' bids between rounds for a given milk (later bid subtracted from earlier bid for same milk); n = 100

Auction round[1]	Margin from fresh counterpart in round 2	Margin from near-end counterpart in round 2	Margin from fresh counterpart in round 3	Margin from near-end counterpart in round 3
Round 1, fresh 2% milk	$0.20^{ab}		$0.13^{A}	
Round 1, near-end 2% milk		−$0.07^{b}		$0.01^{A}
Round 1, fresh skim milk	$0.32^{a}		$0.23^{A}	
Round 1, near-end skim milk		$0.09^{ab}		$0.18^{A}
Round 2 fresh 2% milk			−$0.07^{yz}	
Round 2 near-end 2% milk				$0.10^{x}
Round 2 fresh skim milk			−$0.11^{z}	
Round 2 near-end skim milk				$0.08^{xy}

$^{a,b; A; x–z}$Margins with the same lettering system but different superscript letters differed ($P < 0.05$).

[1]Round 1 bids were submitted after package viewing. Round 2 bids were submitted after sensory evaluation; sample identity was not revealed. Round 3 bids were submitted after code date after educational message; sample identity revealed.

the code date (Table 3, far right column). In round 1, participants bid an average of $0.29 more for fresh 2% milk and $0.27 more for fresh skim milk than for their near-end counterparts; in round 3, participants bid $0.15 more for fresh 2% and $0.21 more for fresh skim than for their near-end counterparts (Table 3). These margins for fresh milk revealed consumers' high value for fresh code dates on milk at the beginning of the session, when only code date and fat content information was available.

In round 2 (in contrast to rounds 1 and 3), when participants bid on 3-digit-coded samples they tasted (no visible code date information), the margin for fresh milk dropped to almost zero (Table 3; round 2). Consumers bid numerically less on all 4 milk options when they did not know the code date. Although the mean margin for skim milk in round 2 ($0.03) did not differ significantly from the margin in round 1 (because of high variability in bids), it was numerically lower than the margin in round 1 (by $0.24). This mirrored the lack of difference in acceptability or preference for fresh over near-end skim milk when participants could not see a code date. For 2% milk, the margin for fresh milk dropped significantly, such that near-end 2% was valued only 1 cent more than fresh ($P < 0.05$). The fact that the margins in bids were lowest in round 2 shows that consumers value and rely heavily on printed code dates in their decision-making. This finding supports the work of Wansink and Wright (2006), who demonstrated that a yogurt labeled as fresh was not rated as significantly more acceptable than one that was unlabeled, but that a product that was even 1 d past the code date was significantly denigrated in its acceptability. This is particularly disturbing in light of the fact that most foods taste good and are safe well beyond their code dates, but consumers do not know this. A bill introduced to the United States House, by Representatives Pingree and Newhouse, is designed to cut food waste and end consumer confusion about food dating labels (Fatka, 2019). The bipartisan *Food Date Labeling Act* includes 2 labeling options—"Best If Used By" (to communicate that the quality of the food may begin to deteriorate after the date) and "Use By" (to communicate the time after which the product should not be consumed)—to be uniformly applied throughout the country.

Although we did not conducted statistical analysis on geometric means, it is interesting that the near-end 2% milk geometric mean in round 2 was numerically higher than the other bids in round 2, likely reflecting the distaste some participants had for the fresh 2% milk in the first 4 auction sessions (where a significant preference for near-end 2% milk was found, although the acceptability scores did not differ significantly).

The findings in Table 4 (upper left) also demonstrate that consumers valued milk in round 1 (when they could see the label and date) more than in round 2 (when they could not), with one exception. Fresh 2% milk was valued by $0.20 more in round 1 than in round 2; fresh skim was valued $0.32 more in round 1 than round 2, and near-end skim was valued $0.09 more in round 1 than in round 2. The exception was for the near-end 2%, which was valued $0.07 more in round 2 (after tasting) than in round 1 ($P < 0.05$), which is attributed to the participants from the first 4 focus groups who experienced a distaste in the fresh 2% milk.

By round 3, when participants were informed that near-end milk should taste fresh, and they had personally discovered in the previous round that the near-end milk did not taste different from the fresh milk, they still bid numerically more for fresh milk ($0.15 more for fresh 2% and $0.21 more for fresh skim) than for near-end milk (Table 3; $P > 0.05$). The fact that all bids dropped numerically in round 3 suggests a devaluation of the milk by participants compared to when they first arrived at the session. Furthermore, the slight drop in margins in round 3 (indicating less differentiation between fresh and near-end milk than in round 1; Table 3

far right column) reflects that as participants received more information, they did not want to pay as much more for fresh milk over near-end milk as they did at the beginning of the session. Initially this may seem like a good thing (because the educational message and tasting experience taught them that fresh and near-end milk had little difference); however, the fact that overall bids dropped in round 3 demonstrates that participants perceived a lower overall value for the milk. This finding supports those of Theotokis et al. (2012), who reported that reduced prices near the expiration date signaled inferior quality and prompted some consumers to have negative perceptions about brand quality. This may be why some grocery store managers elect to discard milk and other dairy products within a few days of the end of code, rather than reducing prices. Unfortunately, this practice contributes to food waste and propagates the perception that milk near the end of code is bad.

When comparing the margins in bids between rounds 2 and 3 (Table 4, lower right), and between rounds 1 and 3 (Table 4, upper right), we noted that providing more information in round 3 did not positively affect bidding (value for milk). Fresh 2% milk was valued by $0.13 more in round 1 than round 3; skim milk was valued $0.23 more in round 1 than round 3; near-end skim milk was valued $0.18 more in round 1 than in round 3. In contrast, near-end 2% milk was valued by $0.01 more in round 3 than in round 1. This suggests that participants liked the flavor of the near-end 2% milk better before they knew it was near the end of its code than after (such as the difference between "Would you like a brownie?" and "These brownies were made 2 weeks ago, would you like one?"). We believe that these findings are related to the amount of time consumers expect milk to last in their refrigerator after purchasing. Although the study designs were different, it is worthwhile to consider the present findings in light of the work of Roe et al. (2018), who demonstrated that discard intentions were lower for milk in containers without date labels. Consumers were presented with whole milk stored for 15, 20, 30, and 40 d; asked to open and smell (not taste) the milk samples; and then asked to indicate whether they would keep or discard the milk half-gallon container. Samples were presented in 2 flights of 4 that were identical, except that 1 flight featured a sell-by label with a date set to 18 d after bottling, and the other flight lacked such information. Participants were 28% more likely to discard the fresh milk with date labels than the same milk without; 40% were more likely to discard near-end milk with date labels than the same milk without. The authors acknowledged that simply removing code dates may not achieve large reductions in milk discards and suggested that consumer education about date labels is needed, as well as further innovations in milk labeling to support improved sustainability and reduce discard rates of milk attributable to sell-by date labels. However, the present work shows that providing more information about the meaning of the code date did not increase consumers' value for near-end milk; thus, more information is not always better.

We believe that at the beginning of the session (round 1), when participants expected a large, obvious quality difference, they were willing to pay a higher margin for fresh milk than for near-end milk. Then, after the sensory experience revealed little difference in quality (round 2), bids moved closer together and we saw a decrease in the total value for fresh milk (rather than an increase in the value for near-end milk). This is not a desired result: we would like all milk to be purchased at the highest possible price. By round 3, when consumers were given an educational message about the code date and the sample identities were revealed to them, the bids for fresh milk increased from round 2 (because consumers were aware of the printed date), but participants did not increase their total bids to the level of their initial round 1 value because they did not value the milk as much as they did at first. Once consumers had more information and the code date was revealed, in amount less they were willing to pay for near-end milk, or the amount more they were willing to pay for fresh milk diminished. Participants' overall value for milk decreased (although not significantly) from round 1 to round 3 as they gained more information. This was a surprising and disappointing finding, because our hope was that more education would lead to higher bids. However, it is important to note that these participants received only one educational message about code dates. Theotokis et al. (2012) demonstrated that, under specific conditions, or when consumers become more familiar with the practice, pricing based on expiration date can provide a successful waste reduction and revenue management practice with no negative effects for brand image.

Several factors are involved when participants bid in auctions. In the present study, influential factors that likely came into play included whether participants generally bought skim or 2% milk, the amount of milk already at home, the amount of money participants had on hand, and participants' unfamiliarity with the available brand. Although the sessions did not exceed 80 min, fatigue may have also come into play. It is possible that participants bid less in the final round because they simply lost interest in the process or in taking home milk ("winning" the auction). Another factor could be willingness to waste. Wilson et al. (2017) took auctions to another level when they asserted that at the point of purchase, consumers have a willingness

to purchase and a level of perceived waste (how much of that item they expect to discard), and that the perception about the date label may influence product value. Combining these concepts with auctions, Wilson et al. (2017) demonstrated that when consumers were presented various code date labels, labels that were more suggestive of food safety ("Use By," "Fresh By") led to the greatest willingness to waste, and labels that were more suggestive of food quality ("Sell By," "Best By") led to the lowest willingness to waste. These factors may have been at play in the present study as well.

To further understand factors affecting participants' bids, we conducted predictor screening using hedonic scores, 7 demographic factors, 7 knowledge factors, 22 purchasing factors, and 3 consumption factors (pre-survey and post-survey responses). Although hedonic scores and the purchasing and consumption variables "fat content typically purchased," "age of participant," and "willingness to pay more for a code date farther away" were the greatest predictors of variability in the data set, none of these was highly correlated with auction bids or hedonic scores ($r < 0.46$). Similar to the companion study (Paterson and Clark, 2020), milk fat content typically purchased had the greatest effect on bids. Bids for 2% milk were correlated within and between rounds ($r = 0.56$ to 0.93); bids for skim milk were highly correlated within and between rounds ($r = 0.58$ to 0.90); and bids for skim and 2% milk were not strongly correlated ($r < 0.55$).

We then used k means cluster analysis to better characterize distinct bidding populations (Table 5). For round 1, cluster 1 was composed of 15 participants who primarily purchased 2% and whole milk. These "2% selecting" consumers bid higher (average $1.51) for 2% than for skim milk (average $0.52). Cluster 2 was composed of 30 participants who primarily purchased skim and 1% milk. These "high bidding" consumers tended to bid high for all milk options (average $1.71), and their bids for fresh products (average $1.84) tended to be higher than their bids for near-end products (average $1.60). Cluster 3 was composed of 17 participants who primarily purchased skim milk. These "fresh skim selecting" consumers bid higher for skim milk (average $1.33) than for 2% milk ($0.50), with a higher cluster mean for fresh skim ($1.78) than for near-end skim ($0.88). Cluster 4 was composed of 20 participants who, similar to those in cluster 1, primarily purchased 2% and whole milk. But in contrast to the consumers in cluster 1, these "low bidding fresh 2% selecting" consumers bid low (average $0.12) for all milk options; their bids for fresh 2% milk ($0.57) were the highest in the cluster. Cluster 5 was composed of 17 participants who primarily purchased skim and 1% milk. These "low bidding skim selecting" consumers tended to bid low (average $0.12) for all milk options; their bids for skim products (average $0.21) tended to be higher than their bids for 2% products (average $0.03).

For round 2, cluster 1 was composed of 28 participants who primarily purchased 2% milk. These "2% liking, 2% higher bidding" consumers gave higher hedonic scores to 2% milk and also bid higher for it (average 5.53/7.0; $0.94) than they did for skim milk (average 3.84/7.0; $0.21). Cluster 2 was composed of 17 participants who primarily purchased 1% milk. These "milk liking, high bidding" consumers gave high mean hedonic scores (average 5.53/7.0) and bid high (average $1.67) for all milk options. Cluster 3 was composed of 7 participants who primarily purchased skim and 1% milk. These "flavor conscious" consumers gave higher scores to and bid higher for fresh skim and near-end 2% milk (average 6.00/7.0; $1.80) than for fresh 2% and near-end skim milk (average 3.57/7.0; $1.08). This difference in hedonic scores and bids revealed that the "lacks freshness defect" in the single lot of fresh 2% milk, identified by trained panelists, offended this portion of the consumer population enough to create an independent cluster. Cluster 4 was composed of 26 participants who primarily purchased skim and 1% milk. These "skim milk liking, low bidding" consumers tended to give high hedonic scores to milk (average 5.37/7.0), with slightly higher scores for skim (average 5.87/7.0) than for 2% (average 5.15/7.0). Still, they bid low (average $0.46) for all milk options, with higher bids for skim (average $0.64) than for 2% (average $0.28). Cluster 5 was composed of 15 participants who primarily purchased 1% and 2% milk. These "milk non-liking, low bidding" consumers gave low hedonic scores (average 3.28/7.0) and bid low (average $0.22) for all milk options. It is unknown if they did not like the particular milk tasted that day, if they were not interested in taking milk home that day, or if something else influenced these lower scores and bids.

For round 3, cluster 1 was composed of 16 participants who primarily purchased 1% and 2% milk. These "2% liking, 2% higher bidding" consumers gave higher hedonic scores and bids to 2% milk (average 5.85/7.0; $1.39) than to skim (average 3.57/7.0; $0.11). Cluster 2 was composed of 11 participants who primarily purchased skim milk. These "skim liking, higher bidding" consumers gave higher hedonic scores and bids to skim (5.28/7.0; $1.27) than to 2% (4.37/7.0; $0.44). Cluster 3 was composed of 21 participants who primarily purchased skim and 1% milk. These "milk liking, high bidding" consumers gave high hedonic scores (average 5.39/7.0) and bid high (average $1.65) for all milk options. Cluster 4 was composed of 23 participants who primarily purchased skim and 1% milk. Similar to cluster 4 in round 2, these "milk liking, low bidding"

consumers gave high hedonic scores (average 5.68/7.0) but bid low (average $0.28) for all milk options; their bids for fresh products (average $0.48) tended to be higher than bids for near-end products (average $0.09). Cluster 5 was composed of 24 participants who primarily purchased 1% and 2% milk. Similar to cluster 5 in round 2, these "milk non-liking, low bidding" consumers gave low hedonic scores (average 3.66/7.0) and bid low (average $0.24) for all milk options; their bids for fresh products (average $0.36) tended to be higher than bids for near-end products (average $0.12).

Consumer Post-Survey

To prevent priming, we asked no questions about code date in the pre-survey. In the post-survey, participants were asked to reflect on their typical behavior; responses to select questions are included in Table 2. Most of the participants (72%) expressed a prior belief that code date affects milk flavor moderately to a great deal. A higher quantity (82%) reported that they checked the code date on milk every time, and 77% indicated that they consciously looked for milk with the code date that was farthest out every time. These findings are similar to the responses to the same questions in the pre-survey from the companion study (Paterson and Clark, 2020), which suggests that participants' responses were not affected by whether the question was asked before or after the educational message. However, unique to this study's post-survey, participants were asked if, after the session, they would be more likely to look for milk with the code date that was farthest out. Suggesting perhaps a slight drop in the demand for the code date that was farthest out after the educational message, 19% of participants indicated that they would be very likely, and 39% said they would look for the code date that was farthest out every time (Table 2). Participants were also asked how much what they heard during the session about code dates would affect the milk products they purchased and consumed; 55% said it would affect them moderately to very much (Table 2).

When participants were asked if they would be willing to pay more for milk with a code date that was farther out, 72% said yes; 80% said they would be willing to pay less for milk with a code date that was close (Table 2). However, we did not see this behavior play out in the auction round conducted immediately before the post-survey (round 3). When it came down to spending

Table 5. Cluster means resulting from k means cluster analysis of each auction round

Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Round 1	n = 15	n = 30	n = 17	n = 20	n = 17
Typical fat purchased[1]	3.20^{a}	1.90^{b}	1.06^{c}	3.45^{a}	1.12^{c}
2% milk, fresh	$1.65^{a}	$1.89^{a}	$0.43^{bc}	$0.57^{b}	$0.04^{c}
2% milk, near-end	$1.37^{a}	$1.63^{a}	$0.07^{b}	$0.15^{b}	$0.01^{b}
Skim milk, fresh	$0.57^{b}	$1.78^{a}	$1.78^{a}	$0.17^{b}	$0.23^{b}
Skim milk, near-end	$0.47^{bc}	$1.57^{a}	$0.88^{b}	$0.05^{c}	$0.19^{c}
Round 2	n = 28	n = 17	n = 7	n = 26	n = 15
Typical fat purchased[1]	3.04^{a}	2.00^{bc}	1.71^{bc}	1.19^{c}	2.47^{ab}
2% milk, fresh	$0.94^{b}	$1.97^{a}	$1.02^{b}	$0.31^{c}	$0.23^{c}
2% milk, near-end	$0.93^{b}	$1.69^{a}	$1.70^{a}	$0.25^{c}	$0.25^{c}
Skim milk, fresh	$0.25^{b}	$1.36^{a}	$1.89^{a}	$0.56^{b}	$0.24^{b}
Skim milk, near-end	$0.16^{c}	$1.65^{a}	$1.13^{ab}	$0.71^{b}	$0.16^{c}
Hedonic score[2] 2%, fresh	5.14^{a}	6.29^{a}	3.00^{b}	5.38^{a}	3.80^{b}
Hedonic score 2%, near-end	5.93^{a}	5.41^{ab}	6.00^{ab}	4.92^{b}	3.27^{c}
Hedonic score skim, fresh	4.14^{b}	4.76^{ab}	6.00^{a}	5.81^{a}	2.93^{c}
Hedonic score skim, near-end	3.54^{b}	5.65^{a}	4.14^{b}	5.92^{a}	3.13^{b}
Round 3	n = 16	n = 11	n = 21	n = 23	n = 24
Typical fat purchased[1]	2.75^{a}	1.00^{b}	1.90^{ab}	1.65^{b}	2.75^{a}
2% milk, fresh	$1.33^{a}	$0.45^{b}	$1.77^{a}	$0.42^{b}	$0.42^{b}
2% milk, near-end	$1.44^{a}	$0.43^{b}	$1.68^{a}	$0.11^{b}	$0.12^{b}
Skim milk, fresh	$0.21^{b}	$1.27^{a}	$1.71^{a}	$0.53^{b}	$0.29^{b}
Skim milk, near-end	$0.23^{b}	$1.27^{a}	$1.45^{a}	$0.07^{b}	$0.11^{b}
Hedonic score 2%, fresh	5.50^{a}	4.91^{ab}	5.29^{ab}	5.57^{a}	4.04^{b}
Hedonic score 2%, near-end	6.19^{a}	3.82^{b}	5.76^{a}	5.52^{a}	3.92^{b}
Hedonic score skim, fresh	3.69^{bc}	4.91^{ab}	5.19^{a}	5.96^{a}	3.50^{c}
Hedonic score skim, near-end	3.44^{b}	5.64^{a}	5.33^{a}	5.65^{a}	3.17^{b}

$^{a–c}$Variables with different superscripts in the same row differed for typical fat purchased, bid mean, or hedonic score ($P < 0.05$).

[1]Where 1 = skim milk; 2 = 1% milk; 3 = 2% milk; 4 = whole milk; 5 = other (e.g., chocolate).

[2]Hedonic scores ranged from 1 (dislike very much) to 7 (like very much).

their own money, lower bids on near-end milk than on fresh milk (Table 3) suggested a continued reluctance to buy near-end milk even after tasting and education. More intentional work to educate consumers about the meaning of code dates is necessary to improve the value of milk with near-end code dates. Still, Hebrok and Heidenstrøm (2019) reported that education on the meaning of date labeling was insufficient to achieve food waste reduction on a satisfactory scale. Thompson et al. (2018), who conducted a survey of 548 Scottish consumers, concluded that consumer communication must go beyond improving expiration date knowledge to address the complex nature of risk perceptions and conceptions of code date trust. Schmidt and Matthies (2018) suggested that promotion of behavioral changes by intervention programs hold the potential to reduce food waste. Hebrok and Heidenstrøm (2019) recommended targeting several decisive moments at which food waste prevention measures should be implemented: acquiring, storing, assessing food quality and safety, valuing, and eating. Aschemann-Witzel et al. (2018) suggested that consumer acceptance of pricing based on expiration dates can be increased through increasing consumer familiarity with the practice, improving perceived quality, and providing tips to increase consumer confidence that they can use an entire food at home. This is based on the belief that consumer acceptance of "suboptimal food" can be changed in at least 2 ways: price reduction or increased value perception. Aschemann-Witzel et al. (2018) demonstrated that consumers were more motivated to buy food near the end of code when waste-preventing messages were used rather than promotions focusing on reduced price. In the present study, we demonstrated the lack of difference between fresh and near-end milk with a taste test, but only communicated the meaning of code dates. Perhaps if we had gone further, explaining that food waste is reduced by choosing near-end code date products, consumers would have felt a greater sense of altruism and may have been more likely to purchase near-end options.

Milk processors must continue to carefully set and monitor code dates printed on fluid milk to maximize shelf life and quality and ensure positive dairy experiences. Extending milk shelf life beyond 21 d should be a goal (Chapman et al., 2001), but dairy industry representatives should also consider other innovations to reduce waste and invigorate the fluid milk category. Use of novel packaging strategies—for instance, "smart" or "intelligent" packaging—to monitor the condition of the internal product and inform consumers when milk quality is no longer good (Chen et al., 2017; Newsome et al., 2014; Ščetar et al., 2019) could help revitalize the fluid milk category.

CONCLUSIONS

The present study showed that when consumers purchase milk based on the printed code date, the perception of freshness, which may not be based in reality, weighs on their purchasing decision; consumers respond to code dates even if they do not fully understand them. Although most participants indicated that they went out of their way to buy the freshest milk, they could not distinguish fresh milk from milk at the end of its code in a blind tasting. Milk near the end of its code did not receive higher "lacks freshness" scores from trained panelists or lower consumer acceptability scores, but consumers bid more money for fresh milk than for near-end milk in auctions when they could see the code date on the packaging, even after tasting revealed they could not tell the difference, and after an educational message taught about the meaning of the code date. Additionally, mean bids for milk dropped numerically after consumers learned the meaning of code dates. Thus, consumer education (in the form of a targeted message about code dates) and tasting fresh and near-end milk side by side can be informative but may not positively change purchasing behavior. The margin of difference between prices consumers would pay for fresh and near-end milk decreased after an educational message about code date, but higher bids were not because consumers preferred the taste; they were more likely because they valued the length of time they perceived that their milk could stay "fresh" in their refrigerator. Milk purchasing behaviors related to code date appear to be driven by a convenience factor or perception about freshness rather than an actual sensory experience. This finding indicates that the dairy industry should continue to work to increase milk shelf life and consider innovations to ensure milk freshness and positive dairy experiences as a way of ensuring repeat purchases.

ACKNOWLEDGMENTS

This work would not have been possible without funding from the dairy farmers of Iowa through the Midwest Dairy Association (now Midwest Dairy, Ankeny, IA) and the Agricultural Utilization Research Institute (AURI, Crookston, MN), and milk donated by Agropur Inc. Division Natrel USA (St. Paul, MN). We are also grateful to the staff of the Iowa State University Nutrition Wellness Research Center, and to all of our focus group participants and trained panelists. We also acknowledge the program of study committee members Donald Beitz, Kenneth Prusa, Catherine Strohbehn, and Keith Vorst (Iowa State University) and the cooperation of Marin Bozic (University of Minnesota). This article is a product of the Iowa Agriculture and Home

Economics Experiment Station, Ames, Iowa. Project No. IOW04002 is sponsored by Hatch Act and State of Iowa funds. The authors have not stated any conflicts of interest.

REFERENCES

Aschemann-Witzel, J., A. Giménez, and G. Ares. 2018. Consumer in-store choice of suboptimal food to avoid food waste: the role of food category, communication and perception of quality dimensions. Food Qual. Prefer. 68:29–39. https://doi.org/10.1016/j.foodqual.2018.01.020.

Buzby, J. C., H. F. Wells, and J. Hyman. 2014. The estimated amount, value, and calories of postharvest food losses at the retail and consumer levels in the United States. USDA-ERS Economic Information Bulletin 121. Accessed Jun. 4, 2019. www.ers.usda.gov/publications/eibeconomic-informationbulletin/EIB-121.aspx.

Chapman, K. W., H. T. Lawless, and K. J. Boor. 2001. Quantitative descriptive analysis and principal component analysis for sensory characterization of ultrapasteurized milk. J. Dairy Sci. 84:12–20. https://doi.org/10.3168/jds.S0022-0302(01)74446-3.

Chen, Y., G. Fu, Y. Zilberman, W. Ruan, S. K. Ameri, Y. S. Zhang, E. Miller, and S. R. Sonkusale. 2017. Low cost smart phone diagnostics for food using paper-based colorimetric sensory arrays. Food Control 82:227–232. https://doi.org/10.1016/j.foodcont.2017.07.003.

Fatka, J. 2019. House bill standardizes food date labels. Feedstuffs. Accessed Aug. 5, 2019. www.feedstuffs.com/news/house-bill-standardizes-food-date-labels.

Fromm, H. I., and K. J. Boor. 2004. Characterization of pasteurized fluid milk shelf-life attributes. J. Food Sci. 69:M207–M214.

Gustavsson, J., C. Cederberg, U. Sonesson, R. Van Otterdijk, and A. Meybeck. 2011. Global food losses and food waste—Extent, causes and prevention. Accessed May 30, 2019. www.fao.org/3/mb060e/mb060e.pdf.

Hanley, N., J. F. Shogren, and B. White. 2006. Introduction to Environmental Economics. Oxford University Press, Oxford, UK.

Hebrok, M., and C. Boks. 2017. Household food waste: Drivers and potential intervention points for design—an extensive review. J. Clean. Prod. 151:380–392. https://doi.org/10.1016/j.jclepro.2017.03.069.

Hebrok, M., and N. Heidenstrøm. 2019. Contextualising food waste prevention—Decisive moments within everyday practices. J. Clean. Prod. 210:1435–1448. https://doi.org/10.1016/j.jclepro.2018.11.141.

Lusk, J., and J. F. Shogren. 2009. Experimental Auctions: Methods and Applications in Economic and Marketing Research. Cambridge University Press, New York, NY.

Martin, N. H., N. R. Carey, S. C. Murphy, M. Wiedmann, and K. J. Boor. 2012. A decade of improvement: New York State fluid milk quality. J. Dairy Sci. 95:7384–7390. https://doi.org/10.3168/jds.2012-5767.

Newsome, R., C. G. Balestrini, M. D. Baum, J. Corby, W. Fisher, K. Goodburn, T. P. Labuza, G. Prince, H. S. Thesmar, and F. Yiannas. 2014. Applications and perceptions of date labeling of food. Compr. Rev. Food Sci. Food Saf. 13:745–769. https://doi.org/10.1111/1541-4337.12086.

Paterson, M., and S. Clark. 2020. Use of auctions to assess consumer value for milk from different packaging. J. Dairy Sci. 103:XXXX–XXXX. https://doi.org/10.3168/jds.2019-16984.

Ranieri, M. L., and K. J. Boor. 2009. Short communication: Bacterial ecology of high-temperature, short-time pasteurized milk processed in the United States. J. Dairy Sci. 92:4833–4840. https://doi.org/10.3168/jds.2009-2181.

Roe, B. E., D. M. Phinney, C. T. Simons, A. S. Badiger, K. E. Bender, and D. R. Heldman. 2018. Discard intentions are lower for milk presented in containers without date labels. Food Qual. Prefer. 66:13–18. https://doi.org/10.1016/j.foodqual.2017.12.016.

Ščetar, M., I. Barukčić, M. Kurek, K. Lisak Jakopović, R. Božanić, and K. Galić. 2019. Packaging perspective of milk and dairy products. Mljekarstvo 69:3–20. https://doi.org/10.15567/mljekarstvo.2019.0101.

Schmidt, K., and E. Matthies. 2018. Where to start fighting the food waste problem? Identifying most promising entry points for intervention programs to reduce household food waste and overconsumption of food. Resour. Conserv. Recy. 139:1–14. https://doi.org/10.1016/j.resconrec.2018.07.023.

Stenmarck, A., C. Jensen, T. E. Quested, and G. Moates. 2016. Estimates of European food waste levels. Accessed May 30, 2019. www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf.

Theotokis, A., K. Pramatari, and M. Tsiros. 2012. Effects of expiration date-based pricing on brand image perceptions. J. Retailing 88:72–87. https://doi.org/10.1016/j.jretai.2011.06.003.

Thompson, B., L. Toma, A. P. Barnes, and C. Revoredo-Giha. 2018. The effect of date labels on willingness to consume dairy products: Implications for food waste reduction. Waste Manag. 78:124–134. https://doi.org/10.1016/j.wasman.2018.05.021.

Wansink, B., and A. O. Wright. 2006. "Best if used by…" how freshness dating influences food acceptance. J. Food Sci. 71:S354–S357. https://doi.org/10.1111/j.1750-3841.2006.00011.x.

Wilson, N. L. W., B. J. Rickard, R. Saputo, and S.-T. Ho. 2017. Food waste: The role of date labels, package size, and product category. Food Qual. Prefer. 55:35–44. https://doi.org/10.1016/j.foodqual.2016.08.004.

ORCIDS

Stephanie Clark https://orcid.org/0000-0002-3253-3042