Assessment of consumers' perceptions, preferences, behaviors and values with fluid milk packaging, code date and new product concepts

Molly E. Paterson
Iowa State University

Follow this and additional works at: https://lib.dr.iastate.edu/etd

Part of the Food Science Commons

Recommended Citation
Paterson, Molly E., "Assessment of consumers' perceptions, preferences, behaviors and values with fluid milk packaging, code date and new product concepts" (2016). Graduate Theses and Dissertations. 15991.
https://lib.dr.iastate.edu/etd/15991

This Dissertation is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Assessment of consumers’ perceptions, preferences, behaviors and values with fluid milk packaging, code date and new product concepts

by

Molly Eileen Paterson

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Food Science and Human Nutrition

Program of Study Committee:
Stephanie Clark, Major Professor
Donald Beitz
Kenneth Prusa
Catherine Strohbehn
Keith Vorst

Iowa State University
Ames, Iowa
2016
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>v</td>
</tr>
<tr>
<td>NOMENCLATURE</td>
<td>vi</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>vii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>viii</td>
</tr>
<tr>
<td>CHAPTER 1 GENERAL INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER 2 LITERATURE REVIEW</td>
<td>4</td>
</tr>
<tr>
<td>Milk Consumption</td>
<td>4</td>
</tr>
<tr>
<td>Milk Flavor and Possible Off Flavors</td>
<td>7</td>
</tr>
<tr>
<td>Role of Milk Packaging</td>
<td>9</td>
</tr>
<tr>
<td>Food Product Dating</td>
<td>9</td>
</tr>
<tr>
<td>Sensory Evaluation</td>
<td>11</td>
</tr>
<tr>
<td>Assessing Consumer Value for Products</td>
<td>15</td>
</tr>
<tr>
<td>CHAPTER 3 ASSESSMENT OF CONSUMER PERCEPTIONS, PREFERENCES AND BEHAVIORS: FLUID MILK FROM DIFFERENT PACKAGING</td>
<td>26</td>
</tr>
<tr>
<td>Abstract</td>
<td>26</td>
</tr>
<tr>
<td>Introduction</td>
<td>27</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>30</td>
</tr>
<tr>
<td>Results and Discussion</td>
<td>39</td>
</tr>
<tr>
<td>Conclusions</td>
<td>45</td>
</tr>
<tr>
<td>CHAPTER 4 ASSESSMENT OF CONSUMER PERCEPTIONS, PREFERENCES AND BEHAVIORS: FRESH AND END OF CODE MILK</td>
<td>49</td>
</tr>
<tr>
<td>Abstract</td>
<td>49</td>
</tr>
<tr>
<td>Introduction</td>
<td>50</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>52</td>
</tr>
<tr>
<td>Results and Discussion</td>
<td>55</td>
</tr>
<tr>
<td>Conclusions</td>
<td>62</td>
</tr>
</tbody>
</table>
CHAPTER 5  USE OF SURVEYS AND CHOICE BASED CONJOINT ANALYSIS TO UNDERSTAND MILLENNIAL CONSUMERS’ VALUE FOR SPECIFIC ATTRIBUTES OF NEW DAIRY BASED BEVERAGES .................................. 64

Abstract ........................................................................................................ 64
Introduction ..................................................................................................... 65
Materials and Methods .................................................................................. 67
Results and Discussion ................................................................................... 70
Conclusions .................................................................................................... 77

CHAPTER 6  GENERAL CONCLUSIONS ......................................................... 81

APPENDIX A. TRAINED PANEL EVALUATION BALLOT ............................... 84
APPENDIX B. CONSUMER PURCHASING AND CONSUMPTION SURVEY ...... 85
APPENDIX C. CONSUMER SENSORY EVALUATION BALLOT EXAMPLE ........ 90
APPENDIX D. CONSUMER POST SURVEY .................................................. 91
APPENDIX E. CONSUMER NTH PRICE AUCTION BALLOT EXAMPLE .......... 93
APPENDIX F. LIGHT AND PACKAGING EDUCATIONAL MESSAGE ............... 95
APPENDIX G. CODE DATE EDUCATIONAL MESSAGE .................................. 96
APPENDIX H. INSTITUTIONAL REVIEW BOARD APPROVAL .......................... 97
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Importance of each attribute on consumers’ overall product profile choice</td>
<td>73</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Summary of utility score for flavor attribute</td>
<td>74</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Utility scores for base composition attribute</td>
<td>75</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Utility scores for package size attribute</td>
<td>76</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Utility score for package style attribute</td>
<td>76</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Utility scores for added benefits attribute</td>
<td>77</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1  Standard wetness scale as laid out by the Spectrum Method .......................... 13
Table 2  Possible off-flavors and training descriptors .................................................. 32
Table 3  Milk sample preparation for trained panel ...................................................... 34
Table 4  Trained panel score for skim milk exposed to light ....................................... 40
Table 5  Trained panel mean scores for 2% exposed to light ....................................... 40
Table 6  Consumer acceptability score for 2% milk from translucent HDPE and paperboard packaging ........................................................................................................ 42
Table 7  Consumer values for skim and 2% milk from different packaging ...... 44
Table 8  Consumer values for milk with and without certification ............................. 44
Table 9  Trained panel lacks freshness attribute score for milk from different code dates ............................................................................................................................ 56
Table 10 Consumer acceptability of milk from different printed code dates .... 58
Table 11 Consumer bids for milk from different code dates ..................................... 59
Table 12 Difference in consumers’ bid price for near and end sample bid............. 60
    subtracted from fresh sample bid by round
Table 12 Dairy based beverage possible attributes and levels ................................. 70
### NOMENCLATURE

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC</td>
<td>Choice-Based conjoint analysis</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
</tr>
<tr>
<td>HTST</td>
<td>High temperature short time</td>
</tr>
<tr>
<td>LB</td>
<td>Lightblock</td>
</tr>
</tbody>
</table>
ACKNOWLEDGMENTS

I would like to extend my greatest appreciation to my major professor, Dr. Stephanie Clark. Without her help, faith and overwhelming support this would not have been possible. She has taught me more about finding and understanding my passion than I ever thought I would gain during this process. I also want to thank my committee members, Drs. Ken Prusa, Keith Vorst, Catherine Strohbehn, and Don Beitz for their time, patience, and encouragement.

In addition, I would like to thank my trained panelists, survey participants, volunteers, and the Food Science and Human Nutrition Department for making this series of studies come together.

Lastly, without the encouragement, laughs, curiosity, and unconditional support of my parents, brothers and better half this would have not been possible.
ABSTRACT

Because of a decrease in consumption of fluid dairy milk, it is critical the dairy industry seeks to understand consumers’ perceptions, preferences and purchasing behaviors regarding dairy based beverages. Several factors could have led to the decline in consumption, such as the development of light induced oxidized off-flavor, a relatively short code date and the introduction of a multitude of alternative beverages to the market. Primary objectives of this research, were to understand consumers’ expectations and evaluate the impact of a sensory experience with milk from three different package dates, as well as milk from the beginning and end of code date, and finally to identify possible dairy-based beverage concepts that would provide consumers a reason to return to the dairy beverage category or increase their low consumption. Three studies were conducted to accomplish these objectives.

In the first study, trained panelists detected higher levels of the oxidized attribute in skim and 2% 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 differences in consumers’ value for 2% or skim in paperboard or translucent plastic. Consumers were willing to pay significantly more for 2% in paperboard or plastic packaging with “Certified Fresh Taste” seal and for skim in “Certified Fresh Taste” paperboard packaging than when packaged without such labeling. In the second study, trained panelists did not detect a difference in “lacks freshness” flavor in fresh skim or skim
milk toward the end of the code date. Consumers valued fresh milk over end of code milk but did not have a taste preference for 2% fresh milk over 2% near the end of code, or for skim fresh over skim end (p>0.05). These findings were in agreement with their acceptability scores (p>0.05). The margin of difference between consumers’ bids (between value for fresh and end of code milk) decreased (p<0.05) from round 1 (before tasting) to round 2 (after tasting). 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.

In the third study, Millennial consumers indicated flavor and base composition (e.g., milk, yogurt, mixture, etc.) were the most important attributes to low-milk consumption subjects surveyed. However, consumers’ decisions are complex and all attributes offered had some importance. Within flavor and base composition, consumers desired common flavors such as chocolate or strawberry over an unflavored product and preferred a mix of dairy milk and milk alternative as the base over dairy milk alone or drinkable yogurt. Millennial consumers also valued the convenience of a single serve or package of multiple single serve size packages.

In order to stay competitive and give consumers an incentive to drink more milk, the dairy industry should consider flavored dairy-based choices packaged in smaller convenient packages that are shelf stable.
CHAPTER 1
GENERAL INTRODUCTION

The decrease in fluid milk consumption has become an issue for the dairy industry with negative potential impacts on human health. Dairy products contain nine essential nutrients including: protein, calcium, potassium, phosphorus, vitamins A, D and \( B_{12} \), riboflavin and magnesium (Heaney et al. 2011, Kliem and Givens 2011). Per capita fluid milk consumption was approximately 27.5 gallons in 1980, but decreased to only 17 gallons in 2015 (USDA 2016). Some possible reasons contributing to the choice not to drink milk include intolerance, lifestyle, bad taste (Black et al. 2002), and increased competition in the beverage market. Any actions intended to understand and help reverse the decline in fluid milk consumption will have important positive impacts on society. This dissertation summarizes studies designed 1) to understand the impact of packaging, light oxidation and code dates upon milk value and purchasing intent, and 2) to investigate how a set of varying attributes of a dairy-based product may draw low and non-milk Millennial consumers back to the dairy category.

Light oxidation is the cause of a common flavor defect in milk that can make it objectionable to consumers. Oxidized flavor has been described as cardboard, painty or metallic (Alvarez 2009). Chapman et al. (2002) found that untrained panelists were able to detect samples exposed to light in a dairy case after as little as 54 minutes of exposure at 2000 lux. Understanding this off-flavor is critical because milk spends an average of 8 hours in a lighted dairy case. Because the majority of milk on grocery stores is packaged in translucent high-density polyethylene
containers, most milk in grocery stores is light oxidized. Do consumers notice and do they value milk from different packaging differently? This dissertation aims to answer this question.

Most fluid milk in the United States has a 10-21 day shelf-life (Chapman et al. 2001). Consumers may use the printed date on the package to help guide their purchases. A study that looked at how consumers shopped in relation to code dates found that consumers were likely to reject a repeat purchase based on the printed shelf-life date (Gimenez et al. 2008). This could be a problem for the dairy industry because of the relative short shelf life in comparison to other beverages available.

To stay competitive in the beverage market, the industry may need to increase shelf-life (Chapman et al. 2001). When pushed to make a decision on the spot, will consumers pay less for milk that is close to the end of code, or will they pay more for milk that will not reach the end of code for another two weeks? This dissertation will answer these questions.

Stewart et al. (2012) recognized that there is a generational change tied to individual consumption. This means those born in 1960-1970 drink more milk than those born between the years 1990-2000. Many reasons for this trend have been considered. Fisher (2001) found that soft drink consumption has dramatically increased and therefore potentially displaces milk consumption in infants, toddlers, and adolescents. In addition to competition in the beverage market, there also is a demand for milk alternatives. Plant-based alternatives are a rising trend and can be both economical and functional (provide a lactose free alternative) in comparison to cows’ milk (Sethi 2016). Will consumers indicate willingness to purchase a dairy
beverage with new attributes? Are consumers interested in dairy based beverages in a different format than unflavored fluid dairy milk? This dissertation will answer these questions.

Because of a combination of possible factors, consumers have reduced consumption or have chosen to leave the dairy milk category completely. Researchers are unsure of the reasons they have left the category or the potential for them to return to the category. It is not known what combination of factors have the most impact on a consumers’ value for fluid milk and desire to purchase and consume a dairy-based beverage.

Understanding consumers’ desire for and value of specific attributes will help the industry develop new dairy based beverages in an effort to increase and encourage regular dairy milk consumption, which in turn will improve nutritional value of consumers’ diets.
CHAPTER 2
LITERATURE REVIEW

The US Food and Drug Administration (FDA) defines milk as the lacteal secretion, obtained from the complete milking of one or more healthy cows (CFR 2016). Milk and dairy products provide nine essential nutrients to the human body, including protein, calcium, phosphorus, iodine, riboflavin, niacin, potassium and vitamin A and B12 (Kliem et al. 2011). According to the United States Department of Agriculture (USDA) nutrient database (2016) whole dairy milk contains approximately 88% water, 3.2% protein, 3.3% fat, 4.8% carbohydrate and minor amounts of other constituents including vitamins and minerals. According to the Dietary Guidelines for Americans, 2-3 cups per day of dairy is recommended for children and adults (2010).

Milk Consumption

Cow’s milk plays a critical role in the human body and is an important source of essential nutrients (Haug 2007). Humans have consumed cows milk for centuries (Varnam 2001). However, consumption of fluid milk as a beverage has steadily declined over the last several years and has fallen to about 0.6 cups per capita per day (ERS 2016). Per capita fluid milk consumption was approximately 27.5 gallons in 1980, but only 17 gallons in 2015 (USDA, ERS 2016). There are several possibilities for this trend in consumption.

Allergy and Intolerance

Demand for cow’s milk has changed over the last several years because of milk protein allergy and lactose intolerance (Donker 2007). Cow’s milk allergy
(CMA), or food allergy in general, is caused by a specific immune response that is affected by interactions among the gut, bacterial colonization and antigen exposure factors and occurs reproducibly after exposure to certain foods (Sicherer 2011, Katz 2013, Boyce 2010). CMA is the most common allergy among children (Katz et al. 2013). In children with an allergy to cow’s milk, the typical treatment is total dairy avoidance (Kivisto et al. 2015). CMA in children can be outgrown, but it is likely that children may keep the habits formed while avoiding dairy milk.

Lactose intolerance, or lactose maldigestion, is completely different from milk allergy. Lactose is a disaccharide made up of glucose and galactose and found primarily in dairy products (Rosensweig 1969). Lactase is the enzyme required to break down lactose into glucose and galactose. When there is an insufficient amount of lactase present in the intestine, the transit of the lactose that is not digested can lead to symptoms such as abdominal pain and flatulence (Matthews 2005, He et al., 2006). In a study by Black et al., (2002) 40% of consumers chose not to drink milk because of intolerance.

Lactose intolerance is often what consumers self-describe after a problematic dairy encounter, which can limit their dairy consumption (Klesges et al. 1999). In some people, these symptoms are more likely to be lactose maldigestion, which is a more slight sensitivity to dairy, or even irritable bowel syndrome, which does not have an obvious cause but is typically a group of symptoms including: diarrhea, abdominal pain and changes in bowel movements, or celiac disease which shares similar symptoms but is a result of a reaction to gluten (Vernia 1995, Jankowiak 2008). Misdiagnosis of lactose intolerance becomes an issue for the dairy
industry because demand increases for milk alternatives (Valencia-Flores et al. 2013).

**Milk Alternatives**

Mainly because of the absence of lactose, consumption of plant-based milk alternatives has increased (Sethi 2016). There are several plant-based/ non-dairy milk alternatives, including, but not limited to: oat, rice, soy, almond, coconut, cashew, sesame, hemp, sunflower and quinoa “milks”.

However, there is great debate about the relationship between saturated fats and health, and the importance of dairy fats in the human diet has been promoted (Elmwood 2010, Soedamah 2011).

**Other Beverage Consumption**

In addition to the demand for functional beverages like milk alternatives in recent decades, there also have been shifts in general beverage consumption. Popkin (2010) indicated that the biggest shifts include nearly a doubled increase in sugar sweetened beverage consumption, a small increase in juice consumption, and an overall decrease in milk consumption among children and adults. In another study, consumption of regular carbonated soft drinks increased from childhood to adulthood, but then began to decline in adulthood as consumption of diet carbonated soft drinks increased (Storey 2006).

**Nutrition and Health Trends**

Dairy consumption has continued to be encouraged through the Dietary Guidelines for Americans, 2010, however special emphasis is placed on low-fat and fat-free dairy products (Stewart 2013). Because of consumers’ negative perceptions
of fat and cholesterol content in milk, some may shy away from it. Bus and Worsley (2002) found that consumers surveyed perceived whole fat milk inferior to soy milk and reduced fat milk. While total fluid milk consumption continues to decline, low fat and non-fat fluid milk consumption has actually increased (USDA 2013).

**Milk Flavor and possible off flavors**

Milk should have a delicate flavor profile that is slightly sweet with no unpleasant aftertaste (O'Connor and O'Brien 2006). Some variation in milk quality is likely because of several factors, including: type of feed, season, breed, milk handling, storage condition, processing and packaging (Alvarez 2009). Additionally, flavors in milk can be considered a defect if they manifest an odor or aftertaste (Bodyfelt et al. 1988). The possible off-flavors in milk can be categorized into 4 groups: absorbed, bacterial, chemical, and delinquency. The off-flavors most relevant to the present work are associated with processing and storage, including: cooked, flat, foreign, lacks freshness and oxidized.

Cooked is a term used to describe a flavor milk may take on because of the heating process during production. A product that seems to be watered down or lacks mouth feel is termed flat. Foreign is not nearly as common as these other off-flavors but indicates a defect because of something that is not native to the product, like sanitizer. Although lacks freshness may sound unappealing, it is usually not a strong off-flavor. Lacks freshness suggests milk that is stale or has lost the typical characteristics of high quality milk.
**Light induced oxidized off-flavor**

Light induced oxidized off-flavor has been described as burnt, burnt protein, burnt feathers or wet cardboard (Alvarez 2009). This off-flavor poses a threat to the dairy industry because it is common in milk stored under light and many studies have shown it is easily detected by trained and untrained consumers (Chapman et al. 2002, Alvarez 2009, Webster 2009, Walsh 2015). However, on the other hand, it is so common in the industry, that some consumers simply consider it normal “milk flavor” (Clark, personal communication). In addition to the off-flavor, light oxidized milk has lower nutritional value because of reduced riboflavin content.

*Photo-oxidation in Milk*

Photo-oxidation reactions require light, a photosensitizer, such as riboflavin, vitamin K, and triplet state oxygen (Webster 2007). Riboflavin is known to be very sensitive to light. While milk is on display in a lighted dairy case, riboflavin absorbs the light energy, which leads to a shift of one of its electrons. This shift changes the energy state from ground to excited triplet state. The exited triplet riboflavin then produces riboflavin radicals, which lead to oxidation of the milk and nutrient degradation (Choe 2005). This is a problem for the dairy industry because most milk is stored in the presence of light and the majority of milk is packaged in semi-translucent high-density polyethylene (HDPE) containers (Keoleian and Spitzley 1999).

*Typical Light Exposure*

In a retail store, milk typically spends around 8 hours in the lighted dairy case (Chapman et al. 2002). Some stores are making the switch to lighting
alternatives such as LED light or motion activated light, to alleviate lights do not remain on all day (Martin 2016). These are improvements, however oxidation is a chain reaction, so once the photosensitizer is exposed to light, the reaction will continue (Choe 2005). Because of the problematic nature of light in the retail dairy case, the type of package the milk is in plays a critical role in its flavor quality.

**Role of Milk Packaging**

Packaging materials play a critical role in the purchase decision, safety, and sensory experience of food products. All packaging materials interact with the food that they protect (Duncan and Webster 2009). A major factor affecting the development of light-oxidized off-flavor in milk is the packaging material of the product (Webster 2009). Milk is typically packaged in glass, HDPE, or polyethylene terephthalate (PET), which are clear or translucent, and paperboard packaging, which blocks light. Occasionally milk is packaged in HDPE or PET that uses white or yellow pigmented resin, which inhibit, but do not completely block light from interacting with the milk. Milk packaged in non-tinted HDPE containers have shown to contain significantly higher levers of oxidized off-flavors than other packaging (van Aardt et al. 2001, Potts 2016).

**Food Product Dating**

The Institute of Food Science and Technology Guidelines (1993) defined shelf life as the time the food product will remain safe, retain desired sensory characteristics and comply with label declarations made. Shelf life can be confusing for consumers, because there is not consistency among producers regarding how the date is printed on food packaging. According to the USDA Food Safety and
Inspection Service, there are a few different dates that consumers may encounter (2013). A “sell-by” indicates to the retailer how long they should display the product. A “best if used by” date is recommended for best flavor or quality. Lastly, a “use by” date is the final date that would want to use a product while at peak quality. None of the dates indicate lack of safety. The code date is chosen by the manufacturer to help them ensure a fresh and tasty product to consumers. There are not federal regulations on labeling, except for infant formula, but if a calendar date is used it must have day, month and year included.

**Milk Processing and Spoilage**

Most fluid milk sold in the US has a 10-21 day code date printed on the package (Chapman et al. 2001). The producer determines this date, which depends on the quality of raw milk, processing conditions, microbial growth, packaging materials, temperature and storage, and exposure to light (Simon and Hansen 2001). Traditionally high temperature short time (HTST) pasteurization is utilized in milk processing. HTST pasteurization requires milk to be heated to a minimum of 72°C or 161°F for 15 seconds (PMO 2009). Currently, bacterial spoilage is the limiting factor in extending the shelf life of fluid milk (Boor 2001). The bacteria that grow while pasteurized milk is stored cause undesirable changes in the aroma and flavor of the milk.

**Code Date and Purchase Behavior**

Consumers are known to use the printed date on the package to help them make purchasing decisions. In a study by Gimenez (2008), consumers were found likely to reject a product at point of purchase based on that printed date. Because
many competitive beverages (including but not limited to bottled water, sports beverages, sodas, etc.) have longer printed shelf-life dates, to stay competitive, the dairy industry may want to look into ways to increase printed shelf life or code dates of milk (Chapman et al. 2001).

**Sensory Evaluation**

Flavor is arguably one of the most important factors that impacts consumers’ purchasing. In addition to the visual properties that play a role at the buying stage of a product, consumers also indicated a high rating for taste importance at the buying stage (Schifferstein 2013). This suggests that even if they have not tasted the product yet, they have high sensory expectations at the point of purchase.

Sensory evaluation is critical to the food industry. The main uses of sensory evaluation are in quality control, product development and research, and provide reliable tests in order to make decisions in the food industry (Meilgaard et al. 2007).

**Descriptive Analysis**

Descriptive analysis is a technique that utilizes a panel of trained judges to evaluate a product and its characteristics. This method is usually done with scaling techniques. Panelists are trained to detect, describe and quantify the levels of certain sensory attributes. These attributes can include appearance, aroma, texture, flavor, and even sound (Meilgaard et al. 2007). Descriptive analysis is important if the researcher wants a detailed description of certain product attributes.

Descriptive analysis with a trained panel also can be used to correlate with instrumental analysis or consumer (untrained) sensory evaluation.
Descriptive Analysis of Milk

Descriptive analysis of milk has been studied numerous times (Lawless and Claassen 1993, Chapman et al. 2002, Martin 2016). This method is particularly important in fluid milk because of the common issue of oxidized off-flavor. Descriptive analysis has been used to determine how soon after light exposure the oxidized off flavor can be detected (Chapman et al. 2002). Typically a 15 cm line scale is utilized for evaluation and this can be done on paper or a computer (Meilgaard 2007). A zero on the line scale indicates none of that particular attribute is noted, whereas a 15 indicates an intense level of that attribute. There are several methods for descriptive analysis, including, but not limited to the Flavor Profile Method, Texture Profile Method, Quantitative Descriptive Analysis (QDA), and The Spectrum™ Method.

Quantitative Descriptive Analysis (QDA)

Quantitative Descriptive Analysis is designed so that the group moderator, who is a sensory professional, acts as a leader but not a panel member. The trained panelists, typically 8-12 individuals who have had some previous training background or have been prescreened, then generate and agree on a set of descriptors to use for evaluation (Drake 2002). The set of descriptors is refereed to as a lexicon. The lexicon can be fine tuned through the use of anchors. Anchors provide differing levels of attributes for panelists to taste and understand. Lexicons are said to be an indispensable tool for description of food (Drake 2002). Panelists use the developed lexicon and a 15cm scale to score blind-coded samples, independently, in private booths.
The Spectrum™ Method Descriptive Analysis

Another common descriptive analysis method is the Spectrum™ Method, which was designed by Gail Civille (1992). It has similarities to QDA in that panelists typically have some training background, they learn and agree on terms together and a 15cm line scale is utilized. However, in an effort to provide a more technical profile of products, several product characteristics and standardized anchors for training are laid out within the method as seen in Table 1 (Meilgaard 2007). This method allows panel facilitators to have a standardized, widely understood set of terms that will translate among other projects and to other panel facilitators. The Spectrum Method has been utilized to evaluate an array of products including meats and dairy (Maughan et al. 2012, Newman 2014).

Table 1. Standard Wetness Scale as laid out by the Spectrum™ Method

<table>
<thead>
<tr>
<th>Value</th>
<th>Reference</th>
<th>Brand/Type</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Unsalted Cracker</td>
<td>Nabisco</td>
<td>1 cracker</td>
</tr>
<tr>
<td>3.0</td>
<td>Carrots</td>
<td>Uncooked, fresh</td>
<td>½” slice</td>
</tr>
<tr>
<td>7.5</td>
<td>Apples</td>
<td>Red Delicious, fresh</td>
<td>½” slice</td>
</tr>
<tr>
<td>10.0</td>
<td>Ham</td>
<td>Oscar Mayer</td>
<td>½” piece</td>
</tr>
<tr>
<td>15.0</td>
<td>Water</td>
<td>filtered, room temp.</td>
<td>½ tbsp.</td>
</tr>
</tbody>
</table>

Technique: Hold the sample in mouth; feel surface with lips and tongue.

Definition: The amount of moisture, because of an aqueous system, on the surface.
Consumer Affective Tests

In addition to the necessity of trained descriptive panels, consumer panels play a key role in enabling investigators to understand consumers’ preference and liking for goods. The purpose of affective consumer tests is to assess preference for or acceptability of products, product ideas or product attributes (Meilgaard 2007). Affective consumer tests are not limited to the food industry, and are widely used in all consumer goods industries. A paired preference test is a common consumer test that pairs two samples together and requires the panelists to make a decision of which sample they prefer. An acceptance test is used when a researcher wants to know to what extent the sample is disliked or liked by consumers. The product is evaluated on its own merit, but may also be compared to other formulations or a competitor’s product. A hedonic scale is used, which may focus on consumer liking, intensity of an attribute or the appropriateness of the intensity of an attribute; also know as a just about right scale (JAR) (Meilgaard 2007).

Preference and Acceptability of Milk

The flavor attributes of milk have been widely studied, but more often than not the focus is on light oxidized off-flavor. A large untrained consumer panel was able to detect light oxidized off-flavor within a range between 54 minutes and 2 hours (Chapman et al. 2002). Approximately 304 participants completed a consumer test in which they completed a computer questionnaire that used a five point JAR scale to evaluate and a 9 point hedonic scale to rate several flavor and texture attributes of milk in relation to code date and light exposure (Martin 2016). The use of a hedonic scale in this study suggested that consumers were more
influenced by the effect of light exposure than code date. Higher scores were given to the samples not exposed to LED lighting vs. the samples that were exposed to light.

**Assessing Consumer Value for Products**

Consumers’ purchasing decisions are complex and hinge on more than just a sensory experience. Values for products and services as a whole as well as the individual attributes that make up a product go into the consumers’ final decision to purchase a product. Economists and marketing experts commonly use several different methods to understand these values.

**Auctions**

Every time a consumer makes a choice between two or more options, they reveal their values for that choice. Economists call this consumers’ willingness to pay or willingness to accept a good or service. Traditional approaches used to elicit value are called revealed preference and stated preference (Hanley et al. 2006). Revealed preferences are implicit values and work well for a good or service that already exists, while stated preferences ask consumers to state a value for a good or service that does not necessarily exist. In both cases, real money is not exchanged, so in essence, the stakes are not high and reliability may be questionable. Auctions, on the other hand, provide a method that places consumers in a non-hypothetical situation to state their values; money is typically exchanged (Lusk and Shogren 2009).
Types of Auctions

Although all auctions are used to understand consumers’ value for goods, there are several different mechanisms to choose from. English auctions have participants sequentially offer ascending bids and the single highest bidder pays market price. Participants in a 2nd price auction will simultaneously submit their private bids and the highest bidder will pay the 2nd highest price. The Becker-DeGroot-Marschak method (BDM) and Random nth price also have panelists simultaneously submit private bids, however the market price is randomly drawn. Potentially more than one panelist will pay the market price. In a collective auction, private bids are submitted together and the market price is the mean bid. In this auction mechanism, each individual pays the market value (Lusk and Shogren 2009). Typically a moderator will carry out auctions, they will give consumers some or no information depending on the purpose of the research. The information can be pictures, visual representations, product prototypes, or written information. The participants will be told how the auction will be carried out, and sometimes a practice round is carried out to alleviate any confusion.

Nth price auction mechanism

In an Nth price auction, the market price and number of high bidders depends on the panel size. The half point of the group size and bids, when listed numerically typically determines N. For instance, with 20 people involve, there will be 20 bids submitted. The midpoint, 10, is N. The participants who bid above N are the high bidders and pay the market price, N. The participant who bid the middle or median bid is not a winner, because his/her value is not above market price. Using Nth price
auctions enables participants to feel like they have a real chance at being one of the
high bidders, and in turn is more likely to elicit true values for the products.

Uses of Auctions

Auctions have been used to elicit true values for many types of good and
services. Just a glimpse of this list includes: beef steaks, kiwi fruit, cigarettes, used
cars, and even coffee mugs (Hoffman 1993, Bohm 1994, Knetch et al. 2001, Jaeger
and Harker 2005, Rousu et al. 2005). Even though they have been widely used
within several industries, there is little research about milk that utilizes auctions.
Some of the only research was done by Fox et al. (1994), who used experimental
auctions to understand acceptability of milk from cows treated with bovine
somatotropin.

Conjoint Analysis

Many factors make up a consumer’s choice to purchase or consume
something. Often in research most approaches to understand consumers’ values
focus on a single product in a single format (Cardello 2007). This is useful to
understand preference for the product as a whole, but not as useful when it comes
to understanding what attributes of that product are most important to the
consumer. Cardello (2007) found that consumers’ perception of processing risk had
more weight on their decision than actual risk.

When considering conjoint analysis, there are many concepts that need
preview. An “attribute” is a product characteristic, such as fat content. “Levels” are
different degrees of an attribute, like non-fat, low-fat and reduced-fat. A product
“profile” combines several single levels of the attributes being studied. A “set” of
profiles makes up a single “task”. In order to understand what perceptions make up consumer decision-making, conjoint analysis is recommended for new food products.

Conjoint measurement looks at the joint effects of different levels of two or more attributes on the value judgments of a consumer within a set product profile (Rao 2014). Although based on some older fundamental properties, individual attributes and their differing levels were examined by Luce and Tukey (1964) and have been considered the basis of conjoint analysis that is used today.

*Types of Conjoint Analysis*

Conjoint analysis methods have evolved since first studied and there are now several methods commonly employed depending on the study.

*Full Profile*

The full profile method is considered one of the first methods for conjoint analysis. It requires the participant to provide a value judgment for every profile combination based on the attributes and levels being studied (Rao 2014). Typically this is burdensome to panelists, as the complete set of product profiles can be quite large.

*Partial Profile*

The partial profile conjoint method is similar to the full profile. However, rather than requiring a value judgment for every profile possibility, the profiles are randomly selected and spread across participants. This not often the most desired method for conjoint, however can be useful for some market simulations if there is a large enough sample of participants.
Self-Explicated

Self-explicated may be the most complicated for panelists of all the conjoint methods. This method requires participants to assign a numerical value to each of the attributes and levels within in a product profile and total each one up.

Choice Based

The method of choice based conjoint (CBC) has become more popular since the 1990s and has become the most widely used conjoint technique (Orme 2009). The reason for its popularity is because it closely mimics a consumers’ purchasing behavior. Rather than having participants assign a direct value judgment to a product profile or attribute, participants are asked to choose the product profile they would purchase from a set of similar profiles. Participants see several product profiles that are grouped together into tasks. Their utility scores or part-worths for each attribute can then be determined based on the product profile they chose from each task. Choice based conjoint analysis can be easily carried out through software programs that are readily available to researchers.

Adaptive

Depending on the program, adaptive based conjoint analysis asks participants to identify products closest to what they would prefer. Essentially, the program uses this preliminary information to build the set of product profiles that the participant will see on subsequent computer screens. It is very similar to choice based conjoint analysis, except the set of profiles seen is tailored based on the participants’ previous responses. This method is valuable, but also may require some expertise in software use or even a special program.
This thesis focuses on the impact of product visual, sensory experience, educational message and new product concepts in an effort to understand consumers’ perceptions and values for fluid milk. In addition to perception of fluid milk, the researchers would like to gain an understanding of the types of new or existing dairy based beverages that would draw low and non-milk consumers back to the category and in general increase fluid milk consumption.

The objective of this research was two-fold. The first objective was to determine if consumers’ perception or value for milk from different packaging or different code dates varied depending on visual cues, sensory experience or educational impact. Perceptions, preferences and values were evaluated using auctions. The second objective was to determine if Millennial consumers who currently consume little to no fluid cow’s milk would consider returning to the dairy category if offered new dairy based beverage options. Perceptions, preferences and values were evaluated using choice based conjoint analysis. The Iowa State University Institutional Review Board approved research.
References


CHAPTER 3

ASSESSMENT OF CONSUMER PERCEPTIONS, PREFERENCES AND BEHAVIORS:

FLUID MILK FROM DIFFERENT PACKAGING.

Abstract

Oxidized off-flavor and riboflavin degradation are problems the dairy industry faces and can partially be alleviated by packaging type. The objective of the research was to understand consumers’ expectations and evaluate the impact of packaging, sensory experience and educational message upon consumer value for fluid milk in translucent high-density polyethylene, white-pigmented high-density polyethylene, and paperboard. Eleven in-person sessions (N=100) included a demographics and consumption survey, preference and acceptability sensory evaluation, educational message, and nth price auctions. A panel of 9 judges who were trained to evaluate milk quality attributes simultaneously evaluated all samples tasted by consumers. Milk samples were from the same source (Agropur, St. Paul, MN) and processed on the same timeline for each session; milk was stored in the warehouse in half-gallon containers until transport to the sessions. On the day of sensory evaluation, milk samples were exposed to fluorescent light (1300 lx) for one hour. Trained panelists detected higher levels of the oxidized attribute in skim and 2% 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 differences in consumers’ value ($) for 2% or skim in paperboard or translucent plastic based solely on visual package.
After receiving an educational message about the effect of light on milk flavor and riboflavin, and tasting “Certified Fresh Taste” samples, 50% of consumers indicated positive comments regarding the packaging seal. Consumers were willing to pay significantly more for 2% in paperboard or plastic packaging with “Certified Fresh Taste” seal and for skim in “Certified Fresh Taste” paperboard packaging than when milk was 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.

**Introduction**

Dairy products contain nine essential nutrients important to the human body, including protein, calcium, potassium, phosphorus, vitamin A, vitamin D, vitamin B₁₂, riboflavin and magnesium (Heaney et al. 2011; Kliem and Givens 2011). However, fluid milk consumption as a beverage has been declining for decades. Per capita consumption was approximately 27.5 gallons in the US in 1980, but has fallen to only 17 gallons in 2015 (USDA 2016). According to Black et al. (2002), there are several factors that may influence this decline, including intolerance (40%), lifestyle choice (18%), and bad taste (42%).

Lactose intolerance and maldigestion as well as cow’s milk allergy play a role in driving consumers away from dairy milk (Donker 2007). Cow's milk allergy is prevalent in children, and often consumers will choose a treatment of total dairy avoidance in their diets (Scurlock 2005, Katz et al. 2013). Lactose maldigestion is more prevalent in older adults and in certain ethnic populations (Rao et al. 1994).
Lactose maldigestion and cow’s milk allergy are two separate reactions to dairy, even though consumers may confuse them.

Because of these types of issues, the desire for plant-based alternatives has increased (Sethi 2016). The most recognizable plant-based alternatives include soy, almond and coconut milk, but there are many others, including: oat, sunflower, hemp and quinoa milk. In addition to allergy or intolerance, some consumers view whole fat dairy milk inferior to the nutrition of soymilk and reduced fat milk (Bus and Worsley 2002). Not only are consumers drinking milk alternatives, but consumption of other beverages also has increased. In a study by Popkin (2010), they found that one of the biggest consumption shifts was a doubled increase for sugar-sweetened beverages as well as a small increase in juice consumption.

One problem limiting fluid milk consumption is its tendency to develop off-flavors. Milk should have a delicate flavor that is clean and slightly sweet because of the lactose content. There also should be no unpleasant aftertaste (O’Connor and O’Brien 2006, Alvarez 2009). The combination of riboflavin in milk and exposure to light via a retail dairy case can induce light oxidation. Light induced oxidation imparts an off-flavor that has been described as burnt, burnt feathers, wet cardboard and oxidized milk can have a mouth drying effect (Alvarez 2009). This off-flavor is easily detected by trained and untrained panelists (Chapman et al. 2002, Webster 2009, Walsh 2015, Potts 2016). Light induced oxidation has been detected by untrained consumers in as little as 54 to 120 minutes, which is well within the timeframe that milk will sit in a retail dairy case under lighting (Chapman et al. 2002).
Packaging materials interact with the food that they protect, and milk is no exception (Duncan and Webster 2009). Milk is packaged in a few different package materials, however translucent high-density polyethylene (HDPE) is the most common packaging type. Translucent HDPE allows the light of the store and retail case to pass through the packaging to the milk, which will in turn allow for light-induced oxidation. Milk packaging with pigmentation provides additional protection by blocking wavelengths that are detrimental to milk flavor quality. Webster et al (2009) found that blocking the 400-600nm range of wavelengths helped reduce off-flavor.

Beyond sensory perceptions of dairy milk, an understanding of consumers’ value for milk is needed. Every time a consumer makes a choice, their value for a product or its attributes are revealed. Revealed or stated preferences are some traditional approaches to elicit value (Hanley et al. 2006). Both of these methods work well with existing products, however auctions introduce a method that is non-hypothetical and money is typically exchanged (Lusk and Shogren 2009). Several different styles of auctions are currently utilized by economists to understand consumers’ value or willingness to pay for a good or service. Typically, consumers are given several product options, and in private, they submit their value for each. Depending on group size, a number of participants who bid higher than the “market value” purchase one of the product options; money is exchanged. Auctions have been used to determine willingness to pay for goods like beef steaks, kiwi, cigarettes, cars and coffee mugs (Hoffman 1993, Bohm 1994, Knetch et al. 2001, Jaeger and Harker 2005, Rousu et al. 2005).
Additional research is needed to understand consumers’ value for milk based on packaging type, flavor and marketing/product education as well as how their value compares to their stated preferences and behaviors. The objectives of this study are to determine consumers’ preferences and acceptability for 2% and skim milk from translucent and pigmented (LB) HDPE and paperboard packaging as well as to understand consumers’ value for the same milk samples based on visual, taste and education marketing message using nth price auctions.

We hypothesize that milk samples exposed to light and in translucent HDPE will have an oxidized off-flavor that will warrant lower acceptability scores as well as lower stated values compared to milk from alternative packaging that blocks light or contains a “Certified Fresh Taste” seal.

**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, St. Paul, MN under the Schroeder brand. This producer was chosen because it is not readily available in the geographical location of the study and therefore consumers would not be biased because of brand alone. Both 2% and skim milk samples were produced on the same day in the same facility, in three different half-gallon sized packages: HDPE white pigmented containers (LB), half-gallon HDPE non-pigmented containers and half-gallon paperboard cartons. Samples were processed within five days of each consumer panel. Samples were produced on normal production days at the facility and were held on-site for our use. All samples were held in Agropur’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.

**Sample Preparation**

Samples in all three types of packaging were exposed to fluorescent lights at 1300 lux for one hour on the same day as consumer sessions and trained panel tasting. Light intensity was measured with a light meter (General Electric Cleveland, OH). The intensity of light and duration 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 2-ounce (59 mL) plastic tasting cups with 3-digit random numbers and lids, and stored in a refrigerator.

**Sensory Evaluation-Descriptive Analysis**

The Iowa State University Institutional Review Board approved the protocol for suitability of recruitment of human subjects. 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 dairy, consume milk regularly, and have interest in sensory evaluation. Panelists were recruited from the program 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 eight initial one-hour sessions. Additional one-hour review sessions were conducted between experiments to remind panelists of the attribute characteristics
and scale. Six milk attributes (cooked, feed, flat, foreign, lacks freshness, and oxidized) were chosen for evaluation (Appendix A). They were chosen from the milk-scoring guide for the National Collegiate Dairy Product Evaluation Contest because they are common attributes that change in milk based upon processing or packaging and were expected to either develop or dissipate as milk was stored (Table 2).

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).

Table 2. Possible Off-flavors and Training Descriptors

<table>
<thead>
<tr>
<th>Off-flavor</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitter</td>
<td>Typically an aftertaste; piercing, noticeable on the back of the tongue</td>
</tr>
<tr>
<td>Cooked</td>
<td>Eggy, sulfur, custard; could be slightly sweeter</td>
</tr>
<tr>
<td>Feed</td>
<td>Grassy, alfalfa, hay</td>
</tr>
<tr>
<td>Flat</td>
<td>Watered down, thin mouth feel</td>
</tr>
<tr>
<td>Foreign*</td>
<td>Sanitizer, bleach, swimming pool</td>
</tr>
<tr>
<td>Lacks Freshness**</td>
<td>Storage, stale, old, taking on other flavors from fridge, fruity, fermented</td>
</tr>
<tr>
<td>Light Oxidized</td>
<td>Cardboard, wet paper towel, mouth drying</td>
</tr>
<tr>
<td>Metal Oxidized</td>
<td>Similar to light, but more tingling mouthfeel, copper penny aroma</td>
</tr>
</tbody>
</table>

*Foreign was used in this study to denote any flavor which was not encompassed by the other terms and should not be present in milk.
**Lacks Freshness was used in this study to denote any flavor which would indicate spoilage or an old product.
Panelists were trained to taste milk in the same way throughout training and subsequent tasting sessions. Panelists received each milk sample in a 3-digit-labeled disposable plastic cup and were taught to swirl the cup for approximately 15 seconds (leaving the cup covered to trap volatile compounds in the headspace), lift the lid, and sniff the headspace. 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 attributes and to score the intensity of each of the six attributes on a 15 cm line scale. Panelists were introduced to varying degrees of each attribute that the research investigators prepared. The terms slight (3 cm), definite (7.5 cm) and pronounced (13 cm) were defined on the line scale for all panelists (Table 3).

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 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.
Table 3. Milk sample preparation for trained panel

<table>
<thead>
<tr>
<th>Off-flavor</th>
<th>Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitter</td>
<td>D- 0.5% quinine solution in water; add ½ teaspoon to approximately 20 oz. milk from a paperboard or lightblock container</td>
</tr>
<tr>
<td>Cooked</td>
<td>D- Organic, ultrapasteurized milk from paperboard container</td>
</tr>
<tr>
<td>Feed</td>
<td>P- Steep alfalfa hay in water; filter tea and add 3 teaspoons to 20oz milk from paperboard or lightblock container</td>
</tr>
<tr>
<td>Flat</td>
<td>P- skim milk</td>
</tr>
<tr>
<td></td>
<td>D- 1% milk</td>
</tr>
<tr>
<td>Foreign</td>
<td>D- Dilute 2 tablespoons of bleach in a gallon of water; add 2 teaspoons of solution to 20oz milk from paperboard or lightblock container</td>
</tr>
<tr>
<td>Lacks Freshness</td>
<td>S- Milk opened and left in fridge for a couple days prior to tasting</td>
</tr>
<tr>
<td></td>
<td>D- Milk open and close to expiration date; left in the fridge for several days</td>
</tr>
<tr>
<td>Light Oxidized</td>
<td>S- Milk in translucent plastic purchased straight from the store</td>
</tr>
<tr>
<td></td>
<td>D-Milk in translucent plastic with 5-10 minutes of direct sunlight exposure</td>
</tr>
<tr>
<td></td>
<td>P-Milk in translucent plastic with 20 or more minutes of direct sunlight exposure</td>
</tr>
<tr>
<td>Metal Oxidized</td>
<td>P- 0.25% cupric sulfate solution in water; ½ teaspoon added 1-2 hours prior to training</td>
</tr>
<tr>
<td></td>
<td>D- 1:2 dilution of pronounced defect</td>
</tr>
<tr>
<td></td>
<td>S- 1:4 dilution of pronounced defect</td>
</tr>
</tbody>
</table>

S,D,P indicate intensity on the scale as follows: S-slight, D-definite, P-pronounced

**Consumer Surveys and Sensory Evaluation**

Focus groups of 7 to 13 milk-consuming volunteers (N = 100) gathered in ten individual sessions. Volunteers were recruited through online postings, emails, flyers and word of mouth. The criteria were to be over the age of 18, have no aversions to dairy, and consume/purchase milk weekly. Every session was conducted in the same fashion by use of a “script”, which was read by the investigator for consistency. Panelists first signed consent forms and filled out a survey with questions about purchasing and consumption behavior as well as
demographics (Appendix B).

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 first shown a visual of the products available and participated in an auction after viewing. After the bids were collected, consumers moved onto sensory analysis followed by another auction.

Consumers were served four 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 (Appendix C). Samples were identified with a unique 3-digit code. 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 after tasting. Finally, consumers filled out a post survey with additional questions about purchasing and the information gained from the session.

In a post-survey, participants 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 (Appendix D).
Certified Fresh Taste Seal

In the final round of Nth price auctions, consumers were given an educational message about packaging type and light oxidation. They also were given information regarding a seal of certification we had developed called, “Certified Fresh Taste.” The following description was read to consumers, “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.”

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, 2009). Consumers were introduced to the concept of auctions and practiced three rounds of auctions using an unrelated set of items, in this case candy bars. One candy bar was randomly selected as the product that would be purchased at “market price”. The auction was not hypothetical; panelists actually purchased candy bars.

The milk auction consisted of three rounds, but the intent of each round differed. Prior to the first round of milk auctions, the context was set so that all consumers knew the cost of some milk products available in the local markets. Visual and price representations of whole milk in a HDPE gallon, skim milk in a HDPE half-gallon, organic milk in a paperboard half-gallon and 1% milk in a paperboard quart were provided. This was helpful information for consumers to help assess their bids. Although many consumers indicated being primary grocery
purchasers, they may not remember on the spot what they are used to paying in the store.

In the first round of milk auctions, four half-gallon containers of Schroeder milk were shown to the panelists: 2% in paperboard and translucent HDPE, and skim milk in paperboard and translucent HDPE. Consumers were asked to submit a value ($) for each milk. The intent of this round was to determine the value of each milk based solely on packaging and fat content.

In the second round, consumers were instructed to assign values to samples they had blindly tasted immediately prior to the 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 revealed to consumers). In other words, panelists still did not know if the sample tasted was from paperboard or plastic, but were asked to indicate how much they valued the milk if it was available in paperboard and the value if it was available in translucent plastic. Thus, eight total options (skim and 2% milk, each from 2 packaging types) were available for “bidding” (Appendix E). The intent of this exercise was to obtain the value of each sample based upon combined information: packaging and sensory experience. Consumers were allowed to use notes they had taken during sensory evaluation to inform their stated value.

After completing the second round of auctions, consumers were given an educational message about the likely correlation between packaging type and light-oxidized off-flavor and reduced riboflavin content. They also were introduced to a
novel “Certified Fresh Taste” milk seal (Appendix F). While hearing the message, consumers were shown translucent HDPE, paperboard and LB packaging. Then consumers were given two additional milk samples to taste (skim and 2% in LB) and told that the milks they were tasting had “earned” the “Certified Fresh Taste” seal. Again, they were allowed to take notes on the samples they had tasted.

In this third round of auctions, panelists were asked to assign values to milks using the information they had received during the entire session, including: visual of packaging types, blind tasting, educational message about impact of light on milk in different packaging and an option for “Certified Fresh Taste”. To assist with the third round bidding, samples and their respective packaging type were revealed. Specifically, the options 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 (eight total options). The intent of the third round of auctions was to learn the impact of educational message about packaging, combined with a sensory experience, on milk value.

Finally, as a key component of the auctions process, one milk product was randomly selected as the product that would be purchased at “market price”. The selected product was chosen blindly by the researcher prior to the in-person sessions and held in a sealed envelope. The market price of the product was determined using the $nth$ highest price, and $n-1$ highest bidders actually paid that price for the milk. The number of consumers in each session was numerically
divided in half to determine n. For example, a group of 13 people would have an n equal to 7. The 7th highest bid, when listed in order, would be the market price and the 6 participants who bid above that would exchange money for the milk randomly by the researcher before the session started. Enough of that sample was received to account for ties in bidding and extra participants. In the event of a tie at the 6th price, meaning that numerically the 7th price was the same as the 6th, the market price would shift down until there was no tie. If the 7th price was $0.00, those who bid above $0.00 would buy the milk for no cost to them, however anyone who bid $0.00, even if they were ranked before or up to the 7th price, would not get the chance to purchase the milk. The reason they were not given the opportunity to purchase is because a $0.00 bid indicates no value for that product.

**Statistical Analysis**

Statistical analyses of trained panel and consumer data were performed using SAS version 9.3 (Cary, NC). One-Way ANOVA with Tukey Kramer multiple pairwise comparison adjustment and a significance level of P<0.05 were selected.

**Results and Discussion**

**Trained Sensory Evaluation**

The objective of trained sensory analysis in this study was to confirm the extent to which exposure to light and packaging type affected the level of oxidized off-flavor in the milk products provided to the consumer panelists. The light exposure and packaging type did not significantly affect the cooked, feed, flat, foreign, or lack freshness scores. In contrast, significantly higher oxidized off-flavor was detected in skim and 2% milk from translucent HDPE than skim and 2% milk
from LB packaging (p<0.05; Tables 4 and 5). Milk in LB packaging had significantly lower oxidized attribute scores than in translucent plastic, but as expected, 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 because of light, as well as preventing oxidized off-flavors (Van Aardt, et al. 2001). Based on the intensity of light exposure and duration of exposure, these results were expected and are in line with other studies (Chapman et al. 2002, Potts et al. 2016).

Table 4. Trained panel score for skim milk exposed to light.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cooked</th>
<th>Feed</th>
<th>Flat</th>
<th>Foreign</th>
<th>Lacks</th>
<th>Oxidized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paperboard</td>
<td>0.06a</td>
<td>0.00a</td>
<td>12.8a</td>
<td>0.50a</td>
<td>0.50a</td>
<td>3.00ab</td>
</tr>
<tr>
<td>Translucent HDPE</td>
<td>0.40a</td>
<td>0.20a</td>
<td>13.5a</td>
<td>0.00a</td>
<td>0.80a</td>
<td>5.80a</td>
</tr>
<tr>
<td>Lightblock HDPE</td>
<td>0.90a</td>
<td>0.10a</td>
<td>13.5a</td>
<td>0.50a</td>
<td>1.10a</td>
<td>2.40b</td>
</tr>
</tbody>
</table>

*a-b means in same column that have different superscripts are significantly different (p<0.05); scores based on 15 cm line scale.

Table 5. Trained panel mean scores for 2% milk exposed to light.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cooked</th>
<th>Feed</th>
<th>Flat</th>
<th>Foreign</th>
<th>Lacks</th>
<th>Oxidized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paperboard</td>
<td>1.05a</td>
<td>0.00a</td>
<td>0.06a</td>
<td>0.00a</td>
<td>0.70a</td>
<td>0.32b</td>
</tr>
<tr>
<td>Translucent HDPE</td>
<td>1.30a</td>
<td>0.00a</td>
<td>0.00a</td>
<td>0.90a</td>
<td>0.50a</td>
<td>5.05a</td>
</tr>
<tr>
<td>Lightblock HDPE</td>
<td>1.50a</td>
<td>0.00a</td>
<td>0.00a</td>
<td>0.00a</td>
<td>0.50a</td>
<td>2.08b</td>
</tr>
</tbody>
</table>

*a-b means in same column that have different superscripts are significantly different (p<0.05); scores based on a 15cm line scale.
Consumer Acceptability and Preference

Consumers (N = 100) recruited for the in-person sessions were 57% female and 43% male and ranged in age from 18 to above 55. The majority of consumers (78%) indicated they are the primary milk purchaser in their household. Of respondents, 88% indicated that they drink milk at least once a week and 46% purchased skim milk. In addition to skim milk, 16% purchased 2% milk and 38% purchased something else, such as 1%, whole, chocolate or other. Of those who purchased skim milk, 23% indicated purchasing it for nutritional aspects, and only 13% indicated purchasing it for flavor. A family member’s preference was indicated as another reason for purchasing skim milk. Milk packaged in plastic was purchased regularly by 83% of consumers surveyed, followed by 11% in paperboard and 6% in another type of packaging.

Although trained panelists detected oxidized off-flavor in milk from translucent HDPE packaging, consumers did not have a significant preference for milk in paperboard over milk in translucent HDPE when served samples blindly (p>0.05). Previous work has shown that consumers can detect differences between untreated milk and milk exposed to light after approximately 54 minutes (Chapman et al. 2002), and our trained panelists detected oxidized off-flavor in the same samples provided to the consumer panelists. Thus, these findings suggest that these consumers either did not notice or did not find the oxidized flavor to be objectionable. Because translucent HDPE is so common in the marketplace, it is likely that consumers are accustomed to oxidized milk flavor and accept it as
standard. In summary, oxidized flavor may not be a major dictator of milk package
type selection.

Acceptability panels allow investigators to dig a little deeper into consumer
impressions than preference allows. In all cases, central tendencies were seen for
milk acceptability scores; milk samples were only slightly liked by panelists (Table
6). However, while there were no differences in consumers’ acceptability scores
between milks of the same fat content in different packaging (p>0.05), consumers’
mean acceptability scores for 2% in paperboard were higher (p < 0.05) than skim in
paperboard (Table 6). Because panelists did not see the package from which the
milk came, the higher acceptability of 2% in paperboard does not indicate a
preference for packaging, but rather an increased liking for the higher fat product
based upon taste/flavor or mouth feel. This is confirmed in the finding that the
consumers’ mean scores were also higher (p < 0.05) for the 2% in paperboard than
the skim in HDPE. The samples packaged in paperboard should have had little to no
light-induced oxidation because of the protective effect of the packaging, whereas
the translucent HDPE had very little protection from light, and contained the
oxidized off-flavor, as noted by the trained panel.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Acceptability Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim Paperboard</td>
<td>4.67&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim HDPE</td>
<td>4.83&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Paperboard</td>
<td>5.21&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% HDPE</td>
<td>4.89&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>ab</sup> means in same column that have different superscripts are significantly different (p< 0.05); scores based on 7-point hedonic scale.
Consumer surveys indicated that although 46% of those surveyed purchase skim milk regularly, only 13% purchased it for flavor. This could explain the higher scores for 2% milk; consumers may prefer the taste, but purchase skim because of other perceptions. Consumption of lower fat dairy milk also is encouraged by The Dietary Guidelines for Americans (2010), which could explain the higher amount of skim purchased yet the higher acceptability score for the higher fat product.

**Nth Price Auctions**

Consumers’ values may change depending on product or attribute. We use auctions to elicit willingness-to-pay bids (Lusk and Shogren 2009). In this study, consumers were asked to bid three different times based on 1) product packaging, 2) blind sensory evaluation and 3) educational message and revealed product identities. All products available for bid were ½ gallon containers.

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) (Table 7). This indicates that package type was not the primary driver for their purchasing choices in store. This also shows that even though the trained panel confirmed oxidized off-flavor in the translucent HDPE, consumers did not consequently discount their bids. While milk values appear quite low ($0.77 to $1.03), it is important to note that the panelists were not told in advance that milk would be available for sale at the focus group, nor were they told to bring extra money. Consumers may not have brought money with them, may have had milk at home or may have needed milk. Many factors influence the value consumers were willing to pay at the time of these sessions.
Table 7. Consumer values for skim and 2% milk from different packaging.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Value ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim Plastic</td>
<td>1.03a</td>
</tr>
<tr>
<td>Skim Paperboard</td>
<td>1.00a</td>
</tr>
<tr>
<td>2% Plastic</td>
<td>0.77a</td>
</tr>
<tr>
<td>2% Paperboard</td>
<td>0.77a</td>
</tr>
</tbody>
</table>

*𝑎𝑏 means in same column that have different superscripts are significantly different (p< 0.05); values are in USD

It is notable that consumers were willing to pay more (p<0.05) for 2% in LB and in paperboard and for skim in paperboard with a “Certified Fresh Taste” seal than milk that had not been certified (Table 8). Consumers were also willing to pay a little more for skim in LB with a “Certified Fresh Taste” seal, but not significantly more than milk that had not been certified (p>0.05).

Table 8. Consumer values for skim and 2% milk with and without “Certified Fresh Taste” label.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Skim Plastic</th>
<th>Skim Paper</th>
<th>2% Plastic</th>
<th>2% Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Certification</td>
<td>0.87a</td>
<td>0.82a</td>
<td>0.61a</td>
<td>0.79a</td>
</tr>
<tr>
<td>Certified Label</td>
<td>0.96a</td>
<td>0.97b</td>
<td>0.99b</td>
<td>1.10b</td>
</tr>
</tbody>
</table>

*𝑎𝑏 means in same column that have different superscripts are significantly different (p< 0.05); values are in USD

These findings do not align with consumers’ stated values after acceptability testing. Consumers’ values based upon blind sensory were not significantly different; acceptability scores for translucent HDPE (non light protective) and paperboard (light protective) were not different; however, when sample identities were revealed and consumers were offered the option of a “Certified Fresh Taste” seal, they bid higher values for the “Certified Fresh Taste” products. These results confirm that consumers value the idea (marketing) of a fresher tasting product, even though they do not necessarily notice a difference in taste.
In the brief post-survey, 64% of consumers indicated they are at least moderately interested in consuming non-oxidized milk. This is particularly interesting because their acceptability scores did not indicate a higher liking for the non-oxidized sample; however based on their bids, the certified label is valued by consumers. Fifty-nine (59)% also indicated their purchasing and consumption would be at least moderately impacted by the information presented during the session.

**Conclusions**

Milk in translucent HDPE with exposure to light, similar to a retail 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 HDPE and paperboard upon tasting. Milk with a higher oxidized score did not receive significantly lower acceptability scores or auction values from consumers, indicating consumers were not offended by the oxidized off-flavor enough to alter their value for the product. 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 LB and paperboard packaging with the seal were significantly higher than milk in translucent HDPE. Behaviors and perceptions of milk in different packaging appear to be influenced more by marketing of fat content and fresh taste rather than actual sensory experience.
References


CHAPTER 4
ASSESSMENT OF CONSUMER PERCEPTIONS, PREFERENCES AND BEHAVIORS:
FRESH AND END OF CODE MILK.

Abstract

Fluid dairy milk that is processed by high temperature short time (HTST) pasteurization typically has a 21-day code date in the U.S., as determined by the manufacturer. Sometimes code dates can be confusing to consumers because they do not understand the printed date and what it indicates about the product inside. The objective of this study was to understand consumers’ expectations and evaluate the impact of a sensory experience upon value of fluid milk at the beginning and end of code. Focus group sessions with milk consumers were carried out (n=103). All sessions included a survey, sensory evaluation, educational message, and nth price auctions. A panel of trained judges (n=9) was trained using Quantitative Descriptive Analysis to simultaneously evaluate the milk quality of the samples served to consumers. All milk was from the same source (Agropur, St. Paul, MN), processed on the same timeline for each session; milk was stored in the warehouse until transport to the sessions. Both the trained panelists and untrained consumers were served milk that was within 3 days of production (fresh) and within 3 days of the end of its printed code date (end). Consumers indicated higher values for fresh milk over end milk, but did not have a taste 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 (p>0.05). Trained panelists did not detect any significant off-flavors in end code milks. Sensory evaluation significantly impacted consumers’
value for the milks, as the margin of difference between fresh and end product consumer bids decreased (p<0.05) from round 1 (based solely on package visual cues; before tasting) to round 2 (after tasting), when they realized that milk towards the end of code did not taste bad. 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.

**Introduction**

Consumers are known to use the printed date on the package to help make purchasing decisions. It is likely that consumers will make a decision of whether or not to purchase a product just based on that date. This can be a problem for the dairy industry because of the fairly short, 14-21 day, code date for fluid milk processed by HTST. Bacterial spoilage is the primary limiting factor in extending shelf life of fluid milk (Boor 2001). Bacterial spoilage is not harmful to consumers, but imparts undesirable changes in the aroma or taste of milk. Often consumers may throw away a product on the printed date, assuming the product inside has gone bad. What many consumers do not know is 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 of ideal freshness. In order to stay competitive in the dairy industry,
Chapman et al. (2001) recommended determining ways to extend the printed code date of fluid dairy milk.

An understanding of consumers’ value for the code date is needed. When a consumer chooses to purchase a product, they are revealing their willingness to pay for that product’s specific attributes. Revealed and stated preferences are traditional approaches to determine this value (Hanley et al. 2006). In addition to these methods, Lusk and Shogren (2009) have laid out the use of auctions to elicit non-hypothetical values for products. Auctions require consumers to submit private bids for different products. In the end, one product is chosen to sell at “market price” and the consumers who value that product above market price purchase it. Market price is determined by group size. Money is exchanged in auctions, so it is not simply a hypothetical approach.

The companion study to this one (Paterson and Clark submitted) found that marketing of milk products and package claims may play a bigger role in consumers’ value for milk than the flavor experience itself. Additional research is needed to understand consumers’ value for the printed code date. The objectives of this study are to determine consumers’ preferences and acceptability for 2% and skim milk with a fresh code date and near end code date as well as to understand consumers’ value for milk based on visual printed code date, blind sensory evaluation and educational message about code date. We hypothesize that milk samples with a fresh code date that is revealed to consumers will warrant higher auction bids, but not higher acceptability scores when blind tasted.
Materials and Methods

Timeline and Milk Production

The study was conducted from November 2012 to April 2013 in Ames, IA in the same fashion as the companion study (Paterson and Clark submitted). Milk samples were produced at Agropur Inc. Division Natrel USA, St. Paul, MN under the Schroeder brand name. Schroder was used to eliminate bias associated with brand name, as Schroeder brand milk is not available at grocery stores in Ames, IA. 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 (HDPE) 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 to 17 days (near end code date) and 3 days (fresh code date) after production, and held at 4°C in a commercial refrigerator until use.

Sample Preparation

Milk samples were held at production facility in the same manner as their typical production. Milk was transported in coolers the day of or day before the consumer panel. Milk was held in a commercial refrigerator until poured into sample evaluation cups for the trained panel and consumer participants.

Sensory Evaluation- Descriptive Analysis

Nine people over the age of 18 were recruited from the university to participate in sensory evaluation, these panelists also served as the trained panel for the companion study, which utilized the same attributes and methodology (Paterson
and Clark, submitted). Additional one-hour review sessions were conducted between experiments as needed to remind consumers of the attributes (cooked, feed, flat, foreign, lacks freshness, and oxidized) chosen for evaluation.

**Consumer Surveys and Sensory Evaluation**

Consumers (n=103) were recruited through online postings, emails, flyers and word of mouth. The criteria were to be over >18 and consume/purchase milk at least weekly. It was important to recruit consumers who had some previous experience with and perceptions of fluid dairy milk. Every session was conducted by use of a “script,” which was read by the investigator. The script was important to ensure consistency among each in-person session that was carried out. Panelists first signed consent forms and filled out a survey about purchasing and consumption behavior as well as demographics. Panelists were given as much time as needed to complete the survey. It is important not to make the panelists feel rushed or anxious.

Consumers were first shown the individual milks packaged with different printed code dates, then bid on those milks using the n\textsuperscript{th} price auction method before moving onto sensory evaluation.

The consumers were served four milk samples in two sets: two 2\% milk samples (one with near code date and one with far code date) and 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 (Appendix C). Consumers were encouraged to take notes on paper to help them remember what
they liked of disliked about samples. Samples were served to consumers randomly so that all sample orders were covered.

Afterwards, 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. Consumers were offered thirty dollars compensation for their time.

**Nth Price Auctions**

In order to understand 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 by practice rounds, in the same fashion as the companion study (Paterson and Clark submitted).

Consumers were asked to submit a value for each milk in a total of three rounds (Appendix E). In the first round, consumers were visually shown four milk samples (2% and skim, near end code and far out code) all packaged in lightblock HDPE. In the second round, consumers assigned values to samples they had blindly tasted immediately prior to the auction (same samples as visually shown). 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 an educational message regarding printed code date (Appendix G).

After the educational message and tasting, consumers were asked how much they were willing to pay for 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).

After completion of the activities and three rounds of auctions, one milk product was randomly selected as the product that would be available for purchase at “market price.” In the same fashion as the companion paper (Paterson submitted), the market price of the product was determined using the $nth$ highest price and n-1 highest bidders paid that price for the milk.

**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 using XLSTAT by Microsoft (2011).

**Results and Discussion**

**Trained 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. The main objective of trained sensory analysis in this study was to determine if near or end of code date milk had different levels of freshness because of storage.
Likely because of natural variability in milk source quality, trained panelists’ lacks freshness scores were higher (p<0.05) for 2% milk with a fresh date than near end code date in the first round of sessions that required only visual cues. Lacks freshness scores of all other samples in subsequent rounds did not significantly differ (Table 9). This indicates that although the samples differed on one day of production, there was not a difference in off-flavors from storage when milk was opened on the same date. Because the term “lacks freshness” was a catch-all term for any off-flavor not captured in the other five attributes, the off-flavor in the fresh sample could have resulted from breed, season, feed, or handling differences rather than spoilage itself.

Table 9. Trained panel lacks freshness attribute score for milk from different code dates.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Trained panel score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% November 20th</td>
<td>0.01&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% December 4th</td>
<td>4.11&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim November 20th</td>
<td>0.57&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim December 4th</td>
<td>3.67&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 16th</td>
<td>0.48&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 30th</td>
<td>0.41&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 16th</td>
<td>2.39&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 30th</td>
<td>0.83&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 30th</td>
<td>0.32&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% May 14th</td>
<td>2.04&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 30th</td>
<td>1.06&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim May 14th</td>
<td>0.68&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<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) Scored on a 15-cm line scale for intensity

**Consumer Acceptability and Preference**

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. Consumers’ were 70% female and 30% male ages 18 and up. 94% indicated they consumed dairy milk once a week or more. Besides consuming milk regularly, it is important that consumers were familiar with the milk market or had some experience purchasing milk; 79% of those surveyed were the primary purchasers in their households.

After the visual bidding was completed, consumers were asked to indicate acceptability of each blind-coded sample on a 7-point hedonic scale and indicate preference between pairs of samples. Consumer acceptability, coupled with the trained panel lacks freshness score, help indicate if consumers detected a specific difference. Similar to the trained panel results, acceptability scores (hedonic scale) did not differ significantly in any of the consumer sessions (Table 10). Consumers also did not have a significant preference for fresh or end of code milk when samples were blindly paired, except in the first session, where they preferred 2% skim milk with a near end code date over fresh date (p<0.05). This preference coincided with the higher lacks freshness score found by trained panelists. However, since it was the fresh sample with the off-flavor, storage itself did not affect preference, but an undefined cause.
Table 10. Consumer acceptability of milk from different printed code dates.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Acceptability Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% November 20th</td>
<td>4.79&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% December 4th</td>
<td>4.61&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim November 20th</td>
<td>4.44&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim December 4th</td>
<td>4.74&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 16th</td>
<td>5.32&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 30th</td>
<td>5.48&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 16th</td>
<td>4.71&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 30th</td>
<td>4.74&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% April 30th</td>
<td>5.38&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% May 14th</td>
<td>5.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim April 30th</td>
<td>4.75&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim May 14th</td>
<td>4.00&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<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)

Scored on a 7-point hedonic scale; 1=dislike very much, 7=like very much

**Nth Price Auctions**

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. Nth price auctions can be used to elicit a non-hypothetical willingness-to-pay value (Lusk and Shogren 2009). In this study consumers were asked to bid three different times based on 1) printed date on the package, 2) blind sensory evaluation and 3) educational message and revealed product identities. All products available to bid on were ½ gallon (lightblock HDPE) containers. Similar to the companion study, where totally different consumers were involved, consumers were not told to bring money nor expect to purchase a product.

Consumers’ values were not significantly different for ½ gallons of milk when analyzed independently within individual rounds of bidding (printed date, blind
sensory, and revealed identities). Values ranged from $0.72? to $1.09 per ½ gallon of milk (p > 0.05). However, there was a trend of increased value for the fresh date in rounds 1 and 3 for both 2% and skim (Table 11). Bids were closer together after blind tasting, indicating that the samples did not significantly differ in flavor, because one was not valued much higher than the other.

### Table 11. Consumer bids for milk from different printed code dates.

<table>
<thead>
<tr>
<th>Round</th>
<th>Skim “fresh” code bid</th>
<th>Skim “near-end” code bid</th>
<th>2% fresh code bid</th>
<th>2% “near-end” code bid</th>
</tr>
</thead>
</table>
| Round 1 | 1.05
| Round 2 | 0.72
| Round 3 | 0.90

*shared subscripts in the same column indicate no significant difference between samples; values in USD

Because of the trends noticed by researchers, it became more important to understand how much bids increased or decreased between bidding rounds (after package visualization, after sensory, and after educational message and package revelation) rather than simply at the end of each round. Analyzing the differences (margins) between rounds acts as an indicator of 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 12).
Table 12. Difference in consumer bid price for near end sample bid subtracted from fresh sample bid by round* (n=103).

<table>
<thead>
<tr>
<th>Treatment**</th>
<th>Margin (fresh bid minus near end bid, $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% Round 1</td>
<td>0.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Round 2</td>
<td>0.10&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 1</td>
<td>0.26&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 2</td>
<td>0.03&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Round 2</td>
<td>0.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Round 3</td>
<td>0.16&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 2</td>
<td>0.03&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 3</td>
<td>0.21&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Round 1</td>
<td>0.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2% Round 3</td>
<td>0.15&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 1</td>
<td>0.26&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skim Round 3</td>
<td>0.20&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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

** Comparisons made between rounds; shaded rows indicate each comparison
<sup>a</sup><sup>b</sup> superscripts with same fat content and within same round comparison are significantly different.

All differences in margins were positive (Table 12), which means that the bids for fresh milks were always higher than the bids for near end milks. However, it is important to note that the margin of difference in bids 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 margin of difference in bids were lowest in round 2 (after they tasted milk but could not see code dates) suggests that consumers rely on the visual of printed code dates in their decision-making. Stated in a different way, as panelists received more information, they were not willing to pay as much more (as big of a margin) for a fresh milk over an end milk as they were at the beginning of the session. 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 a higher margin of difference for fresh milk than for near-end code milk. Then, after the sensory
experience revealed little difference in quality, bids moved closer together and the
total value for fresh milk decreased rather than value for near-end code milk
increasing. In the 3rd round of the session, consumers were given an educational
message about code date and the sample identities were revealed to them. At that
point, the sensory experience, combined with the educational message, influenced
their final bids. The bids for fresh milk increased from the 2nd round because they
were aware of the printed date, however panelists did not increase their total bids
to the level of their initial 1st round value because they did not want to pay that
much more overall. Once consumers had more information and the code date was
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.

Several factors were likely involved in the total value (bid), including milk at
home, money in pocket, and no perceived difference in flavor of the samples. These
findings underline the impact printed code date has on consumer value. When
consumers purchase milk based on the printed date, it is most likely not because of
actual off-flavor, but rather the perception of freshness that weighs on their
purchasing decision.

In the post-survey, panelists were asked how the information presented
would affect their purchasing and if they would pay more for a father out code date
or less for a closer code date. Eighty-five participants (82%) indicated that prior to
the session, they checked for the farthest out code date more than half the time they
shop. Additionally, 80% of the consumers indicated they would purchase a near end
code date milk if it cost less. Understanding consumers’ behaviors could indicate
that extending the shelf life of milk 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 or perception about freshness rather than an actual sensory experience. This research shows that consumers respond to code dates, even if they do not fully understand the meaning of them on the products they purchase. Although many consumers (82%) 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 during tasting. Consumers bid higher for milk that had a far away code date than a close code, even after tasting revealed they could not tell the difference, and an educational message taught about the meaning of code date. However, the margin of difference between prices they would pay for fresh and end code milk decreased after an educational message about code date. The higher bid was not because they preferred the taste, but rather likely because they valued the printed date and length of time they perceived that their milk could stay “fresh” in their refrigerator. This indicates that the dairy industry should work with consumers and producers to disseminate information about the use of code date and what it indicates about product freshness.
References


CHAPTER 5

USE OF ONLINE SURVEYS AND CHOICE-BASED CONJOINT ANALYSIS TO UNDERSTAND MILLENNIAL CONSUMERS’ VALUE FOR SPECIFIC ATTRIBUTES OF NEW DAIRY-BASED BEVERAGES.

Abstract

The decline of fluid milk consumption is a problem for the dairy industry. Millennial consumers are choosing to leave the fluid dairy milk category and switch to drinking milk alternatives or other beverages over fluid milk. The objective of this research was to understand Millennial consumers’ value for specific product attributes in a dairy-based beverage system that may encourage them to return to the fluid dairy category. Online surveys were carried out using Qualtrics software. Millennial aged participants were recruited to participate in online surveys by word of mouth and e-mail within 30 minutes of Ames, IA. The first survey was sent to nearly 10,000 people around Ames, IA, including Millennials on Iowa State University Campus. The responses collected (n=1105) were used to identify low and non-consuming Millennials. Those select participants (n=197) were then invited to participate in the second survey that focused on dairy consumption and preferences for possible new product attributes or ideas. The same participants were invited to participate in an online choice-based conjoint analysis activity after the second survey (n=64), which utilized their survey responses to form several tasks of product profiles. In conjoint analysis, flavor and base composition were the most important attributes, although consumers’ decisions are complex and all attributes had some importance. Within flavor and base composition, consumers desired common flavors such as chocolate or strawberry over an unflavored
product and preferred a mix of dairy milk and milk alternative as the base over dairy milk alone or drinkable yogurt. Millennial consumers also valued the convenience of a single serve or package of multiple single serve size packages.

**Introduction**

Dairy consumption is encouraged through the Dietary Guidelines for Americans (2010). There are many documented studies about the essential nutrients and health benefits of milk (Kliem et al. 2011, Haug 2007, Varnam 2001). Although dairy milk is critical to human health, consumption of fluid milk has steadily declined in the last several years (USDA, ERS 2016).

A major reason for decline in consumption is the prevalence of cow’s milk allergy (CMA) as well as lactose maldigestion and lactose intolerance. Cow’s milk allergy is the most common allergy among children (Katz et al. 2013). Often consumers will chose total avoidance when they perceive an allergy. It is estimated that 25% of Americans will alter their diet due to an allergy (Scurlock 2005).

Lactase is the enzyme needed to breakdown lactose into glucose and galactose. Lactose maldigestion and lactose intolerance are a problem for consumers when they lack adequate lactase activity. This can lead to discomfort and symptoms such as abdominal pain and flatulence (Matthews 2005, He et al 2006). In one study, 40% of respondents surveyed said they chose not to drink milk because of self-described intolerance (Black et al. 2002).

Allergy, maldigestion and intolerance of dairy milk have led to an increase in demand for functional beverages like milk alternatives (Sethi 2016). Examples of milk alternatives include: oat milk, rice milk, soymilk, almond milk, coconut milk
and hemp milk. Some consumers do not look to replace dairy milk with a milk alternative but turn to other beverages entirely. Consumption for other beverages such as sugar-sweetened carbonated drinks as well as juice have seen dramatic increases (Popkin 2010, Storey 2006).

Conjoint analysis methodology helps to paint a picture of a consumers’ value for a product. It is critical that all characteristics that make up a product (package, size, shape, color, aroma, brand, etc.) are considered when determining consumers’ values for goods and services. Often, approaches that are used to understand consumers’ value are very singular in nature (Cardello 2007). This is useful to understand preference as a whole, but does not help the researcher understand the value of individual attributes or characteristics. Conjoint analysis looks at the joint effects of different levels of two or more attributes on the value judgments of a consumer within a set of product profiles (Rao 2014).

Choice-based conjoint analysis (CBC) has become the most popular method (Orme 2009). CBC closely mimics a consumers’ purchasing behavior. Participants in CBC are asked to choose which product profile they would purchase out of a set of profiles. The part-worths for each attribute that make up that product profile can be determined based on the profiles they choose after repeated exposure across several tasks. Part-worths are also refereed to as utilities or utility scores. CBC offers the dairy industry a realistic idea of what beverage attributes are valued by consumers and possible beverage ideas to encourage more milk consumption among Millennial-aged consumers.
The objectives of this study were two-fold. First, was to understand what combinations of levels and attributes Millennials value the most in a dairy based beverage system. Second, was to determine these levels and attribute combinations to create a dairy-based beverage that low and non-milk Millennial-aged consumers would consider coming back to the category to try in an effort to increase milk consumption.

**Materials and Methods**

**Panelist Recruitment**

Panelists were recruited via e-mail, word of mouth, personal communication and online postings such as Craigslist. The only requirement for participation was to be between the approximate ages of 18 and 35, which is loosely defined by most researchers as Millennial-aged. Consumers were only told the survey was to be about total beverage consumption, not milk focused specifically. This was important so consumers did not have preconceived notions about participation due to their like or dislike of dairy beverages.

**Online Consumer Surveys**

Two online surveys were carried out using Qualtrics Survey software (Provo, Utah). This software was chosen for its user-friendly capabilities as well as because it was licensed by the university. The survey software also allowed for several different types of question formats. Question format was important so consumers did not feel restricted in their answers to some questions. These surveys provided the basis of product attributes and levels for the following CBC analysis. For
Panelist compensation, upon completion of the survey consumers were entered into a drawing for one of three $50.00 gift cards.

The first consumer survey included demographic as well as purchasing and consumption questions about the general beverage category. The questions varied in format from multiple choice, select up to, as well as write in. The survey was not timed, and they were allowed to stop and continue at any time. They were only allowed to take the survey once.

For this study, Millennials who identified as low or non-consumers of milk were asked to participate in a follow up survey; identification was based on how often they indicated drinking milk in the survey. It was important to focus the Millennials who indicated little to no consumption because this audience represented the biggest opportunity to increase consumption.

The second consumer survey honed in on consumers’ preferences for different levels of possible dairy based beverage attributes. The survey also aimed to understand what factors most influenced consumers’ decision to stop purchasing dairy milk as well as what could be done to entice them to try the category again.

**Choice-Based Conjoint (CBC) Analysis**

Conjoint Analysis is used to elicit consumers’ value for products. Typically, consumers view several tasks that are made up of product profiles. Within each profile, attributes are shown at varying levels. CBC relies on consumers to choose the product profile within each set that they would be most likely to purchase in a store; choosing a no option is also allowed. This can be used in market simulation to
understand how your beverage would fit in the market. It also provides insight for pricing as well as new product development.

Five attributes each with four levels were chosen for this research. It is important to consider panelist fatigue when determining attributes and levels. Although many programs may handle dozens of levels and attributes, that often creates too many tasks for participants to complete. The attributes and levels were carefully chosen by the researchers based on Millennial’s responses to possible concepts in the original first two online surveys. Attributes that were chosen commonly or repeatedly by consumers were. Although more than five attributes with four levels may have appealed to consumers, this was an appropriate amount for participants to handle in one sitting for this study.

Participants were first asked how desirable several individual beverage attributes were to them. The software program, Sawtooth Software Discover (Orem, Utah) platform, complied a set of tasks for each participant based on their indicated desire for individual attributes. Consumers viewed several screens, each with a different set of profiles. The 5 attributes and 4 levels used for this study were identified through prior phases of study, personal communication and current literature and are shown in Table 13. Sawtooth’s Discover platform then determined importance of overall attributes and utilities of each level. A utility is a score given to each level within a single attribute, such as 2%, 1%, whole and non-fat would be levels within the single attribute of fat content. Utility score then can be used in market simulation of a product, or to understand generally which attributes were desired the most and which were desired the least. Utility scores in
Software Discover are zero-centered, so there may be positive and negative values.

The distance between values is an indicator or the levels that were preferred.

**Table 13. Dairy Based Beverage Possible Attributes and Levels**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavor</td>
<td>Unflavored (plain)</td>
</tr>
<tr>
<td></td>
<td>Seasonal (pumpkin, eggnog)</td>
</tr>
<tr>
<td></td>
<td>Common (chocolate, strawberry, vanilla)</td>
</tr>
<tr>
<td></td>
<td>Trendy (chai tea)</td>
</tr>
<tr>
<td>Base Composition</td>
<td>Dairy milk only</td>
</tr>
<tr>
<td></td>
<td>Dairy milk + milk alternative mixture</td>
</tr>
<tr>
<td></td>
<td>Drinkable yogurt</td>
</tr>
<tr>
<td></td>
<td>Lactose free dairy milk</td>
</tr>
<tr>
<td>Added Benefits</td>
<td>Caffeine</td>
</tr>
<tr>
<td></td>
<td>High Protein</td>
</tr>
<tr>
<td></td>
<td>Electrolytes</td>
</tr>
<tr>
<td></td>
<td>Probiotics</td>
</tr>
<tr>
<td>Package Size</td>
<td>Half-gallon</td>
</tr>
<tr>
<td></td>
<td>Gallon</td>
</tr>
<tr>
<td></td>
<td>Single serve</td>
</tr>
<tr>
<td></td>
<td>Single serve multi-pack</td>
</tr>
<tr>
<td>Package Style</td>
<td>Cardboard</td>
</tr>
<tr>
<td></td>
<td>Plastic</td>
</tr>
<tr>
<td></td>
<td>Squeezable pouch</td>
</tr>
<tr>
<td></td>
<td>Metal/tin can</td>
</tr>
</tbody>
</table>

**Results and Discussion**

**Online Consumer Surveys**

**Beverage Consumption and Purchasing Survey**

In the first survey, 45% of the responding Millennial consumers indicated purchasing milk less than once a week or no longer purchase it, or never have.

Responses indicate that flavored dairy milk was purchased even less. Reasons consumers chose as having an influence on what beverages they purchased included lifestyle, routine/familiarity and trust in the brand. However, the most common factors were flavor preference, nutritional habits and price. This was in line with
their responses to factors that influenced them to stop purchasing a beverage. The most commonly chosen answers were affordability, wanting to lose weight or watch calories, bad taste and getting sick of it. This is logical based on what is known about Millennial consumers. Millennials tend to be price conscious, interested in nutrition and like the notion of their beverages playing a role in their lifestyle.

When asked what would increase their willingness to try a new beverage, participants could choose three responses from a list of as well as write in their own response. The three most common answers were a lower price, recommendation of a friend and nutritional benefits. Not far behind was new flavor, a coupon, environmentally friendly packaging and reported benefits for hydration or exercise recovery. The top beverages consumed by this group were milk, juice, at home beverages (such as coffee, tea, juice) and coffee shop prepared beverages. Those who listed milk as a top 3 beverage in their routine were not targeted for survey 2 or the conjoint analysis activity.

**Milk Consumption and Purchasing Survey**

At the beginning of this survey, Millennials were made aware of the research purpose to understand attitudes toward dairy based beverages in an effort to increase consumption. Of the 197 Millennials identified as low to non-consumers of milk who were asked to participate in the second survey, 65% indicated purchasing milk every 2 weeks or less. Because of milk’s relatively short shelf life, this supports the self-selection as someone who does not consume milk routinely. Based on responses, reasons given for this lack of consumption included lactose intolerance or milk allergy, dislike of milk’s taste, too many calories, and a relatively short shelf
life compared to other beverages. Approximately 75% stated that printed date on the package has an effect on what they ultimately decide to purchase. High protein, better nutrition, longer shelf life, curiosity, and addition of probiotics were noted as the main concepts that would increase their willingness or desire to try a new dairy based beverage.

**Choice-Based Conjoint**

CBC analysis was utilized to understand what attributes and levels made up a consumer's decision to purchase a product. Conjoint methods also are useful to understand the tradeoffs consumers are willing to make for a good or service. The responses from the second survey played the biggest role in choosing attributes and levels to test. Attributes are reported as level of importance (Figure 1). Importances are assigned a percentage; the total percentage of each attribute will total 100.

In this study, findings from the five attributes tested showed similarity in perceived importance. This could be an indication that researchers chose attributes that appealed to Millennial consumers. The most important attributes to Millennial consumers were flavor (23%) and base composition (24.2%). This indicates that these attributes are the most important when making a purchasing decision regarding a dairy based beverage in the store. Consumers indicated flavor being of interest in the initial surveys; so the importance assigned to that attribute aligns with initial responses from the larger group. The attributes with lowest importance were package size (17%) and style (16.9%). Due to the closeness of attribute importance scores, individual levels within each attribute may provide
more insight into what dairy based beverage characteristics Millennials want to get in a new product.

**Figure 1.** Importance of each attribute on consumers’ overall product profile choice (n = 64).

Sawtooth Discover performs analysis and creates utilities, also known as part-worths, for each of the levels within an attribute. The higher the utility, the more it was liked. Utilities are often zero-centered, so some scores can be negative and some can be positive. A negative utility does not always mean that attribute was strongly disliked, it was just not as important as other utilities when given an option.

The most desirable level in the flavor attribute was defined as common, with the example of chocolate provided (Figure 2). Strawberry and vanilla flavors would also fit into this category. The least desirable level was unflavored/plain. Due to the survey responses indicating some level of willingness to try or desire toward a flavored product, unflavored receiving a low utility score is not surprising.
Figure 2. Utility scores for flavor attribute (n=64).

Base composition had four possible levels: dairy milk only, a combination of dairy milk and a milk alternative, drinkable yogurt, and lactose-free dairy milk. Milk alternative only was not an option given because it does not provide an opportunity to increase dairy milk consumption. The highest utility score was for a dairy milk/milk alternative mix followed by dairy milk only (Figure 3). Because of the increasing prevalence with lactose intolerance and milk allergy, this is unexpected. The desire for dairy milk base or partial dairy milk base indicates these Millennials are still willing to consume dairy milk again; however, they may expect new or different characteristics. Because of the rising popularity and marketed trendiness of milk alternatives, that may explain the desire to have a mixed product.
Consumers preferred a single serve style package or a single serve multipack. Both gallon and half-gallon containers had lower utility scores, with gallon being the least well received (Figure 4). It seems consumers either prefer the convenience factor of a smaller package or they believe they will not drink a large portion. Although not directly asked to consumers, this could be related to code date or how often consumers do their shopping. It terms of package style, millennial consumers preferred plastic packaging (Figure 5). Most beverages, especially those in single serve packages, are packaged in some variation of plastic packaging. Desire for plastic packaging was expected. Because consumers in the first surveys indicated some interest in the packaging of their products, it was tested as an attribute. It does not seem a new packaging style would draw extra consumers to purchase or consume additional dairy.

**Figure 3.** Utility scores for base composition attribute (n=64).
Nutrition was a recurring positive theme among consumers. Consumers acknowledged purchasing beverages for nutrition, watching their calories, and decreasing consumption due to calories, weight or doctor’s recommendation. A dairy-based beverage provides a great environment for additional benefits to appeal to millennials. Caffeine, high protein, electrolytes and probiotics were the levels tested. High protein in a new dairy based beverage was the most desired (Figure 6). Surprisingly, electrolytes was the least desired level even though consumers had
indicated post exercise/activity nutrition was important. Electrolyte addition could have been a trade off to accommodate for high protein addition since both can be related the exercise, activity and nutrition.

**Figure 6.** Utility score for added benefits attribute (n=64).

**Conclusion**

The decline in milk consumption is a problem for the dairy industry. Because of the size of the millennial generation, their unique buying behaviors, and the constant marketing of new products toward them, it is important to gain an understanding about the type of dairy-based beverage they would be interested in purchasing. Some Millennials have never purchased dairy milk, used to but have stopped, or currently purchase less than once a week. This creates a gap that the dairy industry needs to attempt to narrow. Millennials verbalize that they pay attention to flavor, nutrition, and price when asked. In conjoint analysis, flavor and base composition were the most important attributes, although decisions of
consumers are complex and all attributes had close importance. Within flavor and base composition, consumers desired common flavors such as chocolate or strawberry over an unflavored product and preferred a mix of dairy milk and milk alternative as the base over dairy milk alone and drinkable yogurt. Millennial consumers also valued the convenience of a single serve or package of multiple single serve size containers. This indicates that flavored dairy-based beverages are an opportunity for growth and more research is needed to understand why Millennials desire a partial milk alternative.
References


CHAPTER 6

GENERAL CONCLUSIONS

The overall objectives of this study were to understand consumers’ preferences and value for milk in different package types and with different code dates as well as gain an understanding of the attributes millennial consumers would be interested in purchasing in a new dairy based beverage in an effort to increase overall dairy milk consumption. The first study investigated the effects of packaging and light exposure on consumers’ value and acceptability of fluid milk. Results indicated that although a trained panel could detect oxidized off-flavor in samples packaged in translucent HDPE and exposed to light, consumers could not detect a difference in samples during sensory evaluation. Consumers’ value for milk did not differ until presented with an educational message about possible off-flavors induced by light and the opportunity to purchase milk that had been “Certified Fresh Taste”.

The aim of the second study was to understand consumers’ preferences and value for milk based on the printed code date on the package. Trained panelists detected no difference in lacks freshness off-flavor in samples with a fresh or near end printed code date. Similar to the trained panel, consumers indicated no difference in acceptability (hedonic scale) of samples. Consumers were willing to pay a higher margin for a fresh printed code date when they could visually see the package, but when served samples blindly, consumers’ margin of willingness to pay for a fresh sample decreased. These findings indicate consumers valued and used
printed code date to make purchasing decisions, yet visual and marketing aspects of the product were more important than flavor.

The purpose of the third study was to identify possible beverage characteristics that would appeal to Millennial consumers who currently do not, or rarely consume dairy beverages. Millennials indicate they pay attention to flavor, nutrition, and price when asked. Conjoint analysis found that consumers truly make complex decisions and not a single attribute dictated their purchases. Flavor and base composition seem to be the most important for consideration in a newer beverage. Single serve packaging was identified as a desirable characteristic; however, a new packaging material was not. These findings suggest that some types of flavored dairy based beverages have potential for increased market share among this segment of consumers. Millennials identified a desire for a high protein beverage. More research is needed to understand their stated desire for a partial milk alternative. Although high protein dairy based beverages already exist, possible opportunity for expansion could be to market these beverages to other groups besides those who regularly work out.

Overall, these studies demonstrated that consumers make complex purchasing decisions for dairy products that are based on more than flavor. Consumers’ values changed based on visual and marketing cues more than sensory characteristics. Millennials are an important demographic for dairy industry growth. More attention to development of novel items in the dairy case including dairy-non-dairy blended beverages may increase market share among this segment of the population.
Next Steps

Future research should focus on creating new products for consumers to taste. Although conjoint analysis is valuable and creates an understanding of attributes and levels that consumers prefer, it is important to understand their preference and acceptability based on taste and packaging after the new product concepts are created. Importances as well as utility scores from this study should be used as a foundation for development of new products. Due to consumers’ lack of differentiation of off-flavors in milk samples, code date and package type do not need to be a priority, rather new flavor options, marketing strategies, package size and protein benefits should be given consideration.
## APPENDIX A. TRAINED PANEL EVALUATION BALLOT

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Panelist #</th>
</tr>
</thead>
</table>

### Cooked

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>

### Feed

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>

### Flat

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>

### Foreign (describe __________________________)

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>

### Lacks Freshness (describe __________________________)

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>

### Oxidized (what kind? __________________________)

<table>
<thead>
<tr>
<th>slight</th>
<th>definite</th>
<th>pronounced</th>
</tr>
</thead>
</table>
APPENDIX B. CONSUMER PURCHASING AND CONSUMPTION SURVEY

Please check the circle next to the answer that best describes your situation.

1. In which county in Iowa do you currently live?
   - Boone
   - Story
   - Polk
   - Other: __________
   - Prefer not to answer

2. What is your gender?
   - Female
   - Male
   - Prefer not to answer

3. Within what age range does your age fall?
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55 and above
   - Prefer not to answer

4. What is the number of people in your household?
   - 1
   - 2
   - 3
   - 4 or more
   - Prefer not to answer

5. What is the highest level of education you have completed?
   - Less than high school
   - High school/GED
   - Some college
   - 2-year college degree (Associate)
   - 4-year college degree (BA, BS)
   - Master's Degree
   - Doctoral Degree
   - Professional Degree (M.D., J.D.)
   - Prefer not to answer

6. Within what range does your annual household income fall?
   - $15,000 – $29,999
   - $30,000 – $44,999
   - $45,000 – $59,999
   - $60,000 – $74,999
   - $75,000 – $89,999
   - $90,000 and above
   - Prefer not to answer
7. How often do you drink milk (i.e. consume milk as a beverage, rather than use in coffee, cereal, recipes, etc)?
   - Less than once a week
   - Once a week
   - Multiple times a week
   - Once a day
   - Multiple times a day

8. How often do you consume milk?
   - Less than once a week
   - Once a week
   - Multiple times a week
   - Once a day
   - Multiple times a day

9. How often do you purchase milk?
   - Less frequently than every 14 days
   - Approximately every 10-14 days
   - Approximately once a week
   - Multiple times a week

10. Where do you most commonly purchase milk?
    - Large/national grocery stores (WalMart, Target, K-Mart, etc.)
    - Medium-large/regional grocery store (Dahls, HyVee, Fareway, etc.)
    - Small/local grocery store (Ajl's and other “mom and pop” stores)
    - Specialty store (Whole Foods, Wheatsfield, ethnic grocery stores, etc)
    - Convenience stores (Kwik Trip, Casey’s, etc.)
    - Other: __________________

11. Do you typically purchase milk in:
    - Glass
    - Plastic jugs
    - Cardboard/paperboard containers

12. Do you typically purchase:
    - Skim
    - 1% milkfat
    - 2% milkfat
    - Whole Milk
    - Other: _______ (e.g. chocolate, etc.)

13. What most influences the milkfat content you buy?
    - Family member’s preference
    - Nutritional attributes
14. What size of milk package do you purchase most?
   - Single-serve
   - Quart
   - Half-gallon
   - Gallon

15. Do you go out of your way to purchase milk in any of the following categories (check all that apply)
   - Ultrapasteurized
   - Non-homogenized
   - Organic
   - From cows not treated with rBST
   - Local

16. Does price drive which milk product you choose?
   - No
   - Yes

17. Do you generally purchase the same brand of milk?
   - No
   - Yes

18. How often do you try something different in the milk category? (brand, packaging, etc.)
   - Never (I am loyal to one product)
   - Less than once a month
   - Monthly
   - Weekly

19. How much does advertising on the television or radio affect your milk purchasing behavior?
   - Not at all
   - A little
   - Moderately
   - Very much

20. How much does advertising at a store or on a milk package affect your milk purchasing behavior?
   - Not at all
   - A little
   - Moderately
   - Very much
21. What would increase your willingness to try something different in the milk category?
   - Lower price of milk products you have not tried before
   - Higher price of the milk product you usually buy
   - Attractive packaging
   - More information about nutrition
   - More information about the cows/farm
   - More information about processing
   - Stays fresh in my refrigerator longer
   - Other: ____________________

22. How informed do you think you are about milk processing techniques?
   - Very uninformed
   - Somewhat uninformed
   - Neither informed or not
   - Somewhat informed
   - Very informed

23. How much do you think processing of milk affects milk quality (flavor) attributes?
   - Has no effect
   - Has a small effect
   - Affects moderately
   - Affects a lot

24. How much do you think processing of milk affects nutritional attributes?
   - Has no effect
   - Has a small effect
   - Affects moderately
   - Affects a lot

25. How often do you check the code date (often marked “best by”, printed on the package) when you purchase milk?
   - Never
   - Less than half of the time
   - About half of the time
   - Every time

26. How often do you consciously look for milk with the farthest out code date?
   - Never
   - Less than half of the time
   - About half of the time
   - Every time

27. How much do you think milk quality (flavor) is affected by the code date?
   - Has no effect
   - Has a small effect
   - Has a moderate effect
○ Affects a lot

28. Have you ever tasted “bad” milk?
  ○ No
  ○ Yes
If yes, please describe what was bad about it: _______________________

29. Would you pay more for milk with a code date farther away?
  ○ No
  ○ Yes

30. 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
  ○ Slightly likely
  ○ Moderately likely
    Very likely
APPENDIX C. CONSUMER PREFERENCE AND ACCEPTANCE TEST (EXAMPLE)

Panelist Number_____

Instructions:
You will be presented two sets of samples. The two samples within each pair differ. You may not notice a difference, but must select your preference. We are also interested in how much you dislike or like each sample; you will be asked to indicate liking on this same sheet. You may write down notes about each sample on the blank sheet of paper. You do not need to turn that paper in to us right away. You will be able to use that information to bid on milk samples for the next stage of the study.

PREFERENCE TEST 1

In front of you are two milk samples with 3-digit random numbers. Please taste EACH sample, from left to right. You do not need to swallow the sample, but must taste it. You may expectorate into the cuspidor. Circle the ONE number that corresponds to the sample that you PREFER. You must select one sample, even if you must guess.

777 899

ACCEPTABILITY TEST 1 (same samples as above)

Please indicate acceptability of each sample by circling the number that best corresponds to your degree of liking.

Sample 777

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike very much</td>
<td></td>
<td></td>
<td></td>
<td>Like very much</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample 899

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike very much</td>
<td></td>
<td></td>
<td></td>
<td>Like very much</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D. CONSUMER POST SURVEY

Please check the circle next to the answer that best describes your situation.

1. How much do you spend on milk each month?
   ______________________________________________

2. What is your current stock of milk at home?
   o Almost out; coming here I knew I had to buy milk really soon.
   o Half-empty; I have to buy milk soon, but the situation is not urgent.
   o Plenty of milk in the fridge; I just bought it very recently.
   o Other: ___________________________________________

3. How did you first hear about this study?
   o Ad in a grocery store
   o Word of mouth (friend, family, etc.)
   o E-mail invitation
   o Other: ___________________________________________

4. Before today, how much did you know about the effect light exposure has on milk flavor and nutritional attributes?
   o Nothing
   o A bit, though much less than I know now
   o Somewhat, but I’ve learned important new things today
   o Almost as much as I know now
   o I knew about these impacts before; I did not learn anything new

5. After hearing about light oxidation today, how interested are you in consuming milk that has not been oxidized?
   o Not at all
   o A little
   o Moderately
   o Very much

6. If other people are presented the same information as you have heard today, how interested do you think they would be in consuming milk that has not been oxidized?
   o Not at all
   o A little
   o Moderately
   o Very much
7. How much will what you have heard today about light-induced oxidation impact what milk product you purchase and consume?
   - Not at all
   - A little
   - Moderately
   - Very much

8. How much do you think the information presented in this study would impact how other people that have participated in this study purchase and consume milk?
   - Not at all
   - A little
   - Moderately
   - Very much

9. If light-blocking plastic jugs were available at the stores where you normally purchase milk, and it would cost you no more than $0.05 more to buy compared to regular plastic jugs, how often do you think you would buy milk in such packaging?
   - Whenever I buy milk
   - Most of the time I buy milk
   - Sometimes
   - Rarely
   - I will not be buying milk in light-blocking plastic jugs

10. If “Certified Fresh Taste” milk was available in stores where you normally purchase milk, how would your consumption behavior change:
    - I would drink about the same amount of milk
    - I would drink a bit more milk
    - I would drink a lot more milk

11. How much money do you think you would be willing to spend each month on milk, if “certified fresh” milk was available in stores where you normally purchase milk?
APPENDIX E. CONSUMER $^n$th PRICE AUCTION BALLOTS (EXAMPLES)

(1$^{st}$ auction presented in packaging study)

Panelist # ______

<table>
<thead>
<tr>
<th>Product</th>
<th>My Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Fat Milk (2%), Plastic</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Plastic</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Paperboard</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Paperboard</td>
<td></td>
</tr>
</tbody>
</table>

(2$^{nd}$ auction presented in packaging study)

<table>
<thead>
<tr>
<th>Product</th>
<th>My Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Fat Milk (2%), Plastic,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 549</td>
<td></td>
</tr>
<tr>
<td>Skim Fat Milk (2%), Plastic,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 324</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Paperboard,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 535</td>
<td></td>
</tr>
<tr>
<td>Skim Fat Milk (2%), Paperboard,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 604</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Plastic,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 535</td>
<td></td>
</tr>
<tr>
<td>Skim Fat Milk (2%), Plastic,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 604</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Paperboard,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 549</td>
<td></td>
</tr>
<tr>
<td>Skim Fat Milk (2%), Paperboard,</td>
<td></td>
</tr>
<tr>
<td>Tastes Like Sample 324</td>
<td></td>
</tr>
</tbody>
</table>
(3rd auction presented in packaging study)

<table>
<thead>
<tr>
<th>Product</th>
<th>My Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Fat Milk (2%), Plastic, Regular</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Plastic, Regular</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Paperboard Regular</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Paperboard Regular</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Plastic Certified Fresh Taste</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Plastic Certified Fresh Taste</td>
<td></td>
</tr>
<tr>
<td>Reduced Fat Milk (2%), Paperboard Certified Fresh Taste</td>
<td></td>
</tr>
<tr>
<td>Skim Milk, Paperboard Certified Fresh Taste</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX F. LIGHT AND PACKAGING EDUCATIONAL MESSAGE

Now that you have bid on the samples you tasted, we will provide you with some information regarding milk. At this point, until instructed to turn the page, please remain on the STOP page.

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? Well, 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.
APPENDIX G. CODE DATE 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 from day of production when unopened. It is possible that milk opened on the date printed on the package may taste good for up to another 7 days beyond that date.

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.
Date: 6/5/2015
To: Dr. Stephanie Clark
2553 Food Sciences Bldg

From: Office for Responsible Research

Title: Consumer Perceptions about Fluid Milk and Dairy Beverage Concepts

IRB ID: 15-211

Study Review Date: 6/5/2015

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

(6) Taste and food quality evaluation consumer acceptance studies if:
- Wholesome foods without additives are consumed; or
- A food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe by the Food and Drug Administration (FDA) or approved by the Environmental Protection Agency (EPA) or the Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA).

The determination of exemption means that:

- You do not need to submit an application for annual continuing review.
- You must carry out the research as described in the IRB application. Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. Only the IRB or designees may make the determination of exemption, even if you conduct a study in the future that is exactly like this study.

Please be aware that approval from other entities may also be needed. For example, access to data from private records (e.g., student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. An IRB determination of exemption in no way implies or guarantees that permission from these other entities will be granted.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.