EVALUATION OF PRODUCT DEVELOPMENT TECHNIQUES FOR A FROZEN FRUIT-BASED DESSERT

by

YA-HUI SHIH, M.S.

A DISSERTATION

IN

HOSPITALITY ADMINISTRATION

Submitted to the Graduate Faculty
Of Texas Tech University in
Partial Fulfillment of
the Requirements for
the Degree of

DOCTOR OF PHILOSOPHY

Approved

Linda Hoover
Chairperson of the committee

Janice Boyce

Leslie Thompson

Chih-Kang Wu

Accepted

Dean of the Graduate School

December 2005

Copyright 2005, Ya-Hui Shih

ACKNOWLEDGEMENTS

This dissertation would have not been finished without support. At this special moment, I would like to express my sincere appreciation to my major professor, Dr. Linda Hoover for her advice, encouragement, and especially for giving me the opportunity to think independently. Thanks also to my committee members, Drs. Leslie Thompson, Janice Boyce, and Chih-Kang (Kenny) Wu for their valuable advice, support, and guidance over the years. Thanks to everyone who helped make this project successful.

I would like to extend my appreciation to the faculty members and staff in the college of Human Sciences, and my friends in Lubbock and Taiwan for their friendship, love, and assistance. I have been fortunate to have them throughout my study years; they will be precious memories for me.

Finally, my deepest gratitude goes to my parents and my brother. Their unquestionable support and faith in me has been the motivation to keep me going though the many difficult times. As I look back over these past years, it is hard to believe that I have finally made it. Without them, it would not be possible for me to complete my degree.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

ABSTRACT vi

LIST OF TABLES viii

LIST OF FIGURES x

CHAPTER

I. PROBLEM STATEMENT AND LITERATURE REVIEW 1
- Problem Statement 1
  - Introduction 1
  - Propose and Objectives of the Study 4
- Literature Review 5
  - Cantaloupe Melon 5
    - Introduction 5
    - Previous Studies of Cantaloupe 7
    - Nutrition Compositions 8
  - Sorbet 9
    - Introduction 9
    - Frozen Dessert in Restaurants 11
    - Nutritional Information 12
    - Basic Components of Sorbet 13
  - Sensory Evaluation 14
    - Introduction 14
    - Types of Sensory Evaluation 15
    - Hedonic Scale 16
    - Food Action Rating Scale 16
    - Sensory Evaluation and Food Quality 17
  - Value Analysis 18
    - Introduction 18
    - Value 19
    - Value Analysis 20
    - Implementation of Value Analysis 22
    - Summary and Application of Value Analysis 23
- References 25

II. SENSORY EVALUATION OF CANTALOUPE SORBET – DETERMINING THE APPROPRIATE THICKENING AGENT 32
Abstract 32
Introduction 32
Literature Review 33
Methodology 35
Products and Processing 35
Trained Sensory Panel 37
Instrumental Evaluation 38
Statistical Analysis 38
Results and Discussion 39
Panelist Evaluation 39
Instrument Evaluation 40
Correlation between Instruments and Panelists 43
References 45

III. SENSORY EVALUATION AND VALUE ANALYSIS OF CANTALOUPE SORBET 47
Abstract 47
Introduction 48
Literature Review 50
Sorbet 50
Cantaloupe 51
Value Analysis 52
Methodology 53
Products and Processing 53
Trained Sensory Panel 54
Instrumental Evaluation 56
Consumer Panel 57
Value Analysis 58
Statistical Analysis 58
Results and Discussion 60
Trained Panelist Evaluation 60
Instrument Evaluation 64
Correlation between Instruments and Panelists 66
Consumer Panelist Evaluation 66
Value Analysis Evaluation 73
References 80

VI. THE SHELF LIFE OF CANTALOUPE PUREE AND THE CONVENIENCE METHOD OF PRODUCING CANTALOUPE SORBET IN A RESTAURANT 83
Abstract 83
Introduction 84

Literature Review 85
Cantaloupe 85
Methodology 87
Products and Processing 87
Trained Sensory Panel 88
Instrumental Evaluation 90
Statistical Analysis 91
Results and Discussion 91
Panelist Evaluation 91
Instrument Evaluation 97
Correlation between Instruments and Panelists 103
References 104

V. CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS 107
Conclusions 107
Findings of the Study 107
Implications 110
Recommendations 111
References 113

APPENDIX
A. CANTALOUPE SORBET – TRAINED PANEL EVALUATION SHEET FOR THE THICKENING AGENT 114
B. CANTALOUPE SORBET – TRAINED PANEL EVALUATION SHEET FOR THE FOUR MARKET FORMS AND SHELF LIFE STUDY 117
C. CANTALOUPE SORBET – CONSUMER PANEL EVALUATION SHEET 120

ABSTRACT

Satisfying customers' demands for good food at the lowest possible cost has always been the major challenge faced by the foodservice industry. In efforts to cope with this challenge, the industry has utilized the latest techniques of product development, including ingredient formats, sensory evaluation, and cost control. This has been especially true in the effort to meet customers' demands for a dessert using such fruits as cantaloupe. Individual Americans consume an average of 11 pounds of cantaloupe each year, mainly as fresh fruit during the five-month growing period, June to November. Transforming cantaloupe into sorbet would enable consumers to enjoy the freshness and flavor of cantaloupe at any time. To meet this goal, the following objectives were defined: 1) to determine an appropriate thickening agent for the sorbet; 2) to establish a cost reduction method for a restaurant offering cantaloupe sorbet as a dessert or a palate cleanser and apply value analysis techniques to the product; and 3) to determine convenient methods for producing cantaloupe sorbet in a restaurant and the shelf life of cantaloupe puree. If cantaloupe were transformed into a flavorful, relatively cheap sorbet, consumers would be able to enjoy a desirable dessert year round.

In the first experiment performed by trained panelists, sorbets containing 0.05% of xanthan gum received a higher overall quality rating then substances used in other cantaloupe sorbets. The second experiment revealed that both trained and consumer panelists agreed that sorbet made from frozen cantaloupe puree was considered as desirable as that produced from fresh cantaloupe. In addition, consumer panelists

indicated that 42.3% of customers would be willing to spend $2.00 to $2.99 in a restaurant to order cantaloupe sorbet as a dessert item. Value analysis results indicated, moreover, that frozen cantaloupe puree was an excellent choice for use in producing sorbet, with the added incentives of reducing working time, labor cost, and waste. The third experiment revealed that no difference was discernible between cantaloupe purees with and without sugar syrup, but the color intensity was affected by length of the storage period. Therefore, it was apparent that cantaloupe puree with sugar syrup was the better ingredient for producing cantaloupe sorbet in the restaurant during the off-season.

LIST OF TABLES

2.1	Means and standard deviations for trained panelist ratings of cantaloupe sorbet using different thickening agents	41
2.2	Correlations of characteristics of cantaloupe sorbet for trained panel	42
2.3	Means and standard deviations for instrument evaluation of cantaloupe sorbet using different thickening agents	44
3.1	Standard procedure to make cantaloupe sorbet from fresh cantaloupe	59
3.2	Means and standard deviations for trained sensory panelist ratings of cantaloupe sorbet from different sources	61
3.3	Correlations of characteristics of cantaloupe sorbet	63
3.4	Means and standard deviations for instrument evaluation of cantaloupe sorbet from different market forms	65
3.5	Demographic information of consumer panel participants evaluating different cantaloupe sorbets	67
3.6	Means and standard deviations for consumer sensory panelist ratings of cantaloupe sorbets from different sources	69
3.7	The frequency of price of consumer panel	70
3.8	The frequency of likely action of consumer panel	71
3.9	The relationship among characteristics of cantaloupe sorbet and price and likely action from customer	75
3.10	The results of value analysis of cantaloupe sorbet – from fresh cantaloupe	76
3.11	The results of value analysis of cantaloupe sorbet – from chilled cantaloupe	77

3.12 The results of value analysis of cantaloupe sorbet – from frozen chunks of cantaloupe 78

3.13 The results of value analysis of cantaloupe sorbet – from frozen puree of cantaloupe 79

4.1 Means and standard deviations for trained sensory panelist ratings of two different cantaloupe sorbets in six months 92

4.2 Correlations of the characteristics of cantaloupe sorbet 96

4.3 Means and standard deviations for the instrument evaluation of two different cantaloupe sorbets in six months 98

LIST OF FIGURES

2.1 Unit operations used to prepare cantaloupe sorbet samples 36

3.1 Procedure for preparing cantaloupe sorbet samples 55

4.1 Procedure for preparing cantaloupe sorbet samples 89

4.2 Relationship of storage time and panelist evaluated results of color intensity of cantaloupe sorbet 94

4.3 Relationship of storage time and panelist evaluated results of overall quality of cantaloupe sorbet 95

4.4 Relationship of storage time and instrumental results of the L* value of cantaloupe sorbet 100

4.5 Relationship of storage time and instrumental results of the hue angle of cantaloupe sorbet 101

4.6 Relationship of storage time and instrumental results of the chroma of cantaloupe sorbet 102

CHAPTER I

PROBLEM STATEMENT AND LITERATURE REVIEW

Problem Statement

Introduction

Sorbet is a frozen dessert consisting of sugar syrup and fruit puree, with natural thickening agents occasionally included to increase smoothness and prevent separation. Sorbet provides a rich, smooth, creamy product without fat or dairy ingredients (Hong & Nip, 1990). Fruit sorbets are considered supreme ingredients of any elegant dinner table, served between courses as a palate cleanser or as a dessert. Sorbets may be used in a wide variety of settings, including in ice cream shops and restaurants, and are frequently being billed as "the chef's signature dessert" to attract customers (Stogo, 1990).

The demand for sorbet is understandable. Consumers have discovered something unique in the flavor, taste, body texture, and high water content. Sorbets being made primarily of fresh fruit with no added dairy products are cholesterol and fat free, with an average of 110 calories per 113 g serving. Attributes of sorbets include: 1) they use only fruit puree and fruit pieces, 2) they are relatively expensive to produce because fresh, frozen, or pureed fruit is used, 3) they can be made from a wide array of fruits, and 4) they are perceived by consumers as an upscale product (Stogo, 1998).

Cantaloupe is one common fruit used to make sorbet because it provides unique refreshment. Cantaloupe is readily available for such use, since it is grown in many countries around the world. The United States (U.S.) is considered third in worldwide

production of cantaloupe and miscellaneous melons, behind only China and Turkey (Economic Research Service, USDA [ERS, USDA], 2003). Economically and practically, cantaloupe is an important crop in the U.S. The U.S. farm value of cantaloupe average $401 million during 2000-2002, and in 2003, the total U.S. cantaloupe crop yielded of 2,335 million pounds (ERS, USDA, 2003). California, Arizona, and Texas provide the majority of the U.S. cantaloupe crop; 79% of U.S. cantaloupe production is from these three states. Cantaloupe in season is one of the finest and most popular fruits on the American table because of its attractive color, unique flavor, and pleasant taste. U.S. cantaloupe consumption has increased modestly in recent years, rising from about 8 - 9 pounds per person during the early 1990's to 11 pounds per person in 2004 (Texas Department of Agriculture, 2004). This rise is attributed partly to the increased availability of imported cantaloupes from Mexico during the winter and spring months, which are considered to be the "U.S. off-season".

Most cantaloupe is marketed fresh during the primary season of June to November. Due to the unique flavor and attractive color, cantaloupe is mainly consumed as fresh fruit during the peak season. Cantaloupe can be cut into pieces and added to fruit salads or served with smoked meats or cheese. Fruit-cut produce fruit is the fastest growing food category in the U.S. (Beaulieu, Ingram, Lea, & Bett-Garber, 2004), and especially for melon, which are rapidly gaining a large share of the produce market (Bareuther, 2000). Cantaloupe is also used in making fruit soups, fruit salads, fruit pies, and fruit punches. Frozen cantaloupe melon balls are usually sold in supermarkets. Freezing maintains the nutrient content of food better than other methods. This provides

consumers with a better nutritional perception of the frozen product (Beck, 1993). Cantaloupe ice cream and sorbet provide additional means to increase utilization of cantaloupe during the peak season. The frozen desserts are delicious and can be served all year long. A cantaloupe sorbet is an inspired concept. In addition to unique aroma and tasty flavor, they provide excellent nutrition. Cantaloupe is a very good source of vitamins A and C, potassium, and dietary fiber, and cantaloupe sorbet provides nutritional value and refreshing taste to customers as a fat-free, low-calorie frozen dessert (Galeb, Wrolstad, & McDaniel, 2002).

Production costs are an important issue in the restaurant when fresh cantaloupe sorbet is prepared. Due mainly to labor costs, the expenses may be high if the restaurant provides fresh sorbet daily. Methods for increasing product value and reducing cost are important. Customers should be able to receive top quality foods when dining out, and the restaurant must find a way to provide high quality food without excessive cost. Therefore, the concept of value analysis becomes useful. Value analysis was developed by Lawrence D. Miles at General Electric around 1947 as a cost reduction method (Mehra & Bretz, 1981; Kermode, Sivaloganathan, & Shahin, 2000). Miles defined value analysis as a "problem-solving system implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills" (Lawrence D. Miles Value Engineering Reference Center, 2004).

Value analysis was initially developed and used in purchasing and then adapted for product design. After its introduction, value analysis was modified and successfully applied to a variety of fields, such as manufacturing, government, construction, and

service (Kermode, Sivaloganathan, & Shahin, 2000; Lawrence D. Miles Value Engineering Reference Center, 2004). When applied appropriately, value analysis should fulfill the goal of freeing the manager from viewing the task from a narrowly defined perspective, thus forcing the manager to identify the other subsystems in the organization (Mehra & Bretz, 1981).

Purpose and Objectives of the Study

The purpose of this study was to develop a frozen dessert item for restaurants by using a high-speed immersion freezing method and to apply a value analysis to reduce the cost of the product.

Three objectives of this study were to:

1. Determine an appropriate thickening agent for cantaloupe sorbet.
2. Determine a cost reduction method (for a restaurant) offering cantaloupe sorbet as a dessert and apply value analysis techniques to the product from four market forms.
3. Determine the quality of sorbet prepared from two frozen cantaloupe puree products – puree with sugar syrup or puree without sugar syrup, and examine the frozen shelf-life of the two pureed products by determine the quality of sorbets prepared from the products after storage intervals up to 180 days.

Literature Review

Cantaloupe Melon

Introduction

Existence of cantaloupe melons was unknown to ancient people. They grew similar fruits, but these seem to have been more reminiscent of the cucumber. In the first century AD, Pliny referred to fruit dropping off the stalk when ripe, which is typical of melons. However, the melon was not considered very tasty. In the third century, melons had become sweeter and aromatic enough to be eaten with spices; by the sixth century, they were distinguished separately from cucumbers. The first reference of very flavorful and tasty melons comes in the fifteenth and sixteenth centuries probably because of hybridization among many different strains (Flowerdew, 1996).

The first written record of muskmelons in the New World was in 1494; when Christopher Columbus found them on Isabella Island. In 1516 and 1535, muskmelons were found by Europeans in Central America and in Montreal, respectively. In 1540, the Spaniards found the Indians of New Mexico growing muskmelons. Based on this information, the muskmelon apparently was widespread in the New World thousands of years ago. The muskmelon is characterized by a sweet, juicy, aromatic flavor. Muskmelons were only grown in gardens for home use and were seldom seen in markets before the Civil War (Ryan, 1938).

The cantaloupe is part of the family *Cucurbitaceae* and genus *Cucumis*, which includes cucumbers, muskmelons, watermelons, pumpkins, and squash (Galeb, 1994). The cantaloupe was named for a place near Rome called Cantaloupo, where it was first

grown in Europe, and this name became universal (Ryan, 1938). *Cucumis melo* variety *cantaloupensis* is the true cantaloupe, characterized by a hard, rough, deeply grooved rind that is not netted with orange-red, sweet flesh (Bailey, 1939). *Cantaloupensis* is native to Europe, but in reality, this melon is not commonly found in the U.S. The melon known as "cantaloupe" in the U.S. is *Cucumis melo* variety *reticulates* (Mattern, 1990; Galeb, 1994) and is characterized by a relatively soft almost smooth rind covered with a cork-like netting, orange, greenish-orange, green or greenish-white flesh and with musky odor (Bailey, 1939). This melon is commonly but incorrectly called "cantaloupe" in the U.S. Because this usage has resulted in adoption of the name cantaloupe for this kind of melon, it is now considered its correct name (Munger & Robinson, 1991). Due to numerous similarities between groups and naming confusion between the cantaloupe and muskmelon, *reticulates* (netted) and *cantalupensis* (smooth) were combined into one group, *Cantalupensis* (Munger & Robinson, 1991).

Cantaloupe belongs to a very wide family of tender, trailing annual vines, similar to cucumbers in habit. It has large leaves, tender prickly stems, and small, yellow flowers. Cantaloupe matures in 35 to 55 days from full bloom. The sugar content is the principal measure of maturity and an important aspect of fresh cantaloupes' quality (Galeb, 1994; Wagner, Dainello, & Parson, 2001; United States Department of Agriculture [USDA], 2003). Cantaloupe need at least 9% soluble solids (sugar) for U. S. No. 1 (good internal quality) (Suslow, Cantwell, & Mitchell, 2002). Commercially, cantaloupe are picked between the "3/4 to full slip" stage. Sugar content does not increase once the melon has been removed from the vine (Hubbard, Huber, & Pharr,

1990; Wagner, Dainello, & Parson, 2001; Suslow, Cantwell, & Mitchell, 2002; USDA, 2003). Cantaloupe can be any size, round or oval. The melon are characterized by a thick, inedible rind covering juicy flesh, which encloses a central cavity containing numerous flat, whitish seeds (Flowerdew, 1996). Optimum temperature for storage of cantaloupes is 2.2°C - 5°C, and the storage life is up to 21 days at 2.2°C although sensory quality may be reduced. Typically, the shelf life of cantaloupe ranges from 12 – 15 days (Wagner, Dainello, & Parson, 2001; Suslow, Cantwell, & Mitchell, 2002; Peet, 2002).

Previous Studies of Cantaloupe

Due to consumer demand for convenient food products, fresh-cut cantaloupe and other fruits have become rapidly growing segments of the food service and supermarket industries (Anonymous, 1998). According to Vance Research Services and Market Facts Incorporated (1990), 21% to 36% customers reported purchase of fresh-cut melons. Pursuant to this development, several researchers (O'Connor-Shaw, Roberts, Ford, & Nottingham, 1994; Ayhan & Chism, 1998; Portela & Cantwell, 2001; Bett-Garber, Beaulieu, & Ingram, 2002) investigated the shelf life of fresh–cut melons. Additionally, processed melons are commonly frozen to extend their shelf life so that they may be served during the off season. Frozen melons are subject to froze and thaw damage which leads to a decrease in eating quality. Therefore, sensory qualities, such as color, texture, and flavor, have been studied to enhance customer satisfaction of frozen products (Simandjuntak, Barrett, & Wrolstad, 1996; Rosenfeld & Nes, 2000). Furthermore, cantaloupes imported from Mexico have been associated with *Salmonella* outbreaks

(Mohle-Boetani et al., 1999). Mexican cantaloupe was associated with a *Salmonella* outbreak in 2000 which affected 47 people. Several states reported up to 30 cases of foodborne Salmonellosis due to contaminated cantaloupes purchased from retail stores and restaurants (Anonymous, 2001; Calvin, 2003).

Galeb, Wrolstad, and McDaniel (2002) studied the quality of cantaloupe juice concentrate and compared cantaloupe juices obtained from flesh and rind to juices made from flesh only. Their findings suggested that juice concentration stored at 25°C for 120 days showed extremely high rates of browning, sensory evaluation results demonstrated that rind aroma and flavor were removed during the concentration process, and clarified cantaloupe juice concentrate potentially be used as alternate sweetener and blended juice base. Beaulieu, Ingram, Lea, & Bett-Garber (2004) studied the effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe, and found that ¼-slip cantaloupe were not mature enough to optimize sensory attributes, such as sweetness, flavor, texture, and moisture.

Nutrient Compositions

Fruit is an important component in the trend toward a light, fresh, and healthy diet. Since cantaloupe is a tasty, flavorful, and low calorie fruit, it fits perfectly in this healthy trend. Cantaloupe is an excellent source of beta-carotene and potassium, and contributes a full and balanced range of very important nutrients, such as niacin, riboflavin, thiamin, and ascorbic acid (Galeb, Wrolstad, & McDaniel, 2002), with very few carbohydrates (Ballister, 2002). Cantaloupe is high in moisture content and low in

protein and fat. Mineral content exhibits wide variation. Anderson, Young, and Long (2005) also mentioned that cantaloupe is low in calories, low in sodium, and high in potassium. Other studies show that cantaloupe is a good source of vitamin C (Taper, McNeill, & Ritchey, 1985; Galeb, 1994) and rich in beta-carotene, a vitamin A precursor (Taper, McNeill, & Ritchey, 1985; Philip & Chen, 1988; Anderson, Young, & Long, 2005).

Sorbet

Introduction

Frozen desserts are popular worldwide. Total U.S. production of ice cream and related frozen desserts in 2003 amounted to about 1.4 billion gallons, which translates to about 20 quarts per capita (Cleary & Koppenhoefer, 2004). In 2002, the total U.S. ice cream and frozen desserts sales reached $20.5 billion. More than half of these sales ($12.5 billion) were spent on "away from home" frozen dessert purchases, such as in scoop shops, foodservice, and other retailers (Cleary & Koppenhoefer, 2004). Frozen desserts are among the most popular comfort foods sought by people during stressful times. Several forms are sold around the world, including ice cream, ice cream soda, sherbet, sorbet, and frozen bars.

Flavored ice is considered the first frozen dessert, predating ice cream and other dairy frozen desserts (Stogo, 1990). In the fourth century B.C., Alexander the Great enjoyed iced fruit nectar, and slaves were sent to the Apennines for ice and snow. Four hundred years later, Emperor Nero in Rome had runners along the Appian Way pass

buckets of snow hand over hand from the mountains to his dinner hall where it was then mixed with honey, fruit, and wine (Stogo, 1990; SunCream Dairies Mouth Watering, 2004). The Asian culture also has a place in the history of the first frozen desserts. At the end of the thirteenth century, Marco Polo returned from the Far East with recipes of concoctions made from snow, juice, and fruit pulp (White, 2000).

Frozen desserts are believed to have been brought to France in 1533 by Catherine de Medici when she left Italy to marry the Duke of Orleans, who later became Henry II. By the end of the 17th century, sorbet was popular in Paris and spread to England and the rest of Europe where the sorbet was enjoyed by commoners and courtiers alike. In addition, the French are responsible for the culinary tradition of using sorbet as a palate cleanser between courses of a meal (SunCream Dairies Mouth Watering, 2004).

In the middle 1990s, a new attitude swept through the U.S. in general, and the frozen dessert industry in particular, when the American public began being more health-conscious. American began to look for products low in cholesterol, fat, and calories. Since they were aware of health and weight issues, sorbet became an after-meal dessert instead of a palate refresher (Herrmann, Sterngold, & Warland, 1990). After sorbets spread rapidly to the U.S. from 1994 to 1996, the sale of sorbets increased 208% (International Ice Cream Association, 1998). Currently, Haagen-Dazs, Ben & Jerry's, and Blue Bell offered sorbet product in the market with different flavors, such as lemon, mango, chocolate, and orange.

Frozen Desserts in Restaurants

In restaurants, the highest profit food items are typically desserts. Desserts are considered add-on sales because they increase the amount of customers' average check. In addition, desserts are the last chances that the chef has to impress customers with his/her skills. The chef is thus induced to develop a high quality dessert item as his/her signature items. The resulting sales and profits of the restaurant are boosted (Eaton, 1982). On the other hand, restaurant consumers may like to have something sweet to finish up the whole dining experience. Some customers may intentionally "save room" for the desserts. Sloan (2002) suggested that joyful experiences commonly have been the reasons that motivate Americans to dine out. Dessert reveals a sweet but complete ending to any meal. On the other hand, most items on the dessert menu of any restaurant are high in fat and calories. Customers are increasingly concerned about health and weight issues (American Dietetic Association, 2003). In addition, Steward and Tinsley (1995) suggested that American consumers consider health, price, taste, appearance, and brand as influential factors of their food choice. Eighty-one percent of customers (or 180 million) use low-calorie, reduced-sugar, and sugar-free foods and beverages (Hubrich, 2005), which compels restaurants to capitalize on these customer preferences.

Nutritional Information

Due to its nutritional value and refreshing taste, sorbet has become a common dessert choice of people interested in health, athletics, and weight control. In this respect, fruit sorbet has become a delicious alternative to ice cream. This product contains both

the nutritional value of fruit and the refreshing taste of frozen dessert (Guven & Karaca, 2002). Consumers have discovered something unique in sorbets: flavor, taste, and excellent texture. Made without dairy products, sorbet passes the nutrition test of being cholesterol and fat free, with an average of 110 calories per 113 g serving (Stogo, 1998).

Basic Components of Sorbet

Several ingredients are needed to make a sorbet; they include water, sugar, fruit and/or fruit extracts, citrus juice, and a stabilizer. Water is an important ingredient of sorbet. Water freezes into hard ice by itself, but when it is stirred and frozen with the other ingredients, such as sugar, it results in a frozen slush. Sugar is used to add sweetness, enhance flavor, promote smoothness, build body, and influence the freezing point. Sugar is necessary for desirable body, flavor, and texture. Too much sugar will result in a soft and sticky product, but too little will result in hard and crumbly sorbet. In addition, if too much sugar is used, the freezing time increases (Stogo, 1998). Instead of adding water and sugar separately, sugar syrup is commonly used in making sorbet. Syrup binds the final product together and aids in promoting a snow-like texture in sorbet. The main function of syrup is to aid in the freezing process, not to sweeten the sorbet. Sugar syrup is made from granulated sugar mixed with boiling water until the sugar is dissolved creating a clear syrup. With a higher sugar-to-water ratio, heavy syrup is prepared. The heavier the syrup, the longer it takes to freeze the sorbet, and in most cases, the smoother the product. The syrup will lower the freezing temperature of the sorbet and prevent it from turning into a solid ice block (Stogo, 1990).

Fresh fruit is used to create a sorbet product in order to create a taste as close to the fruit as possible. In this regard, frozen fresh fruit is ideal for sorbet production. Generally, a frozen fruit product is expected to have a consistent taste all year long because the fruit is packed and frozen during the growing season. This consistency provides a significant advantage over fresh fruit which tastes differently depending on the time of the year. In addition, a good sorbet should have a balance of flavors. In order to neutralize the sweetness of the syrup and to enhance the fruit flavor, fresh citrus juices, such as lemon, lime, or orange are added (Stogo, 1998).

Thickening agents (stabilizers) form a group of compounds, usually polysaccharide gums, which are responsible for adding viscosity to the mix and the unfrozen phase of the sorbet. The primary purpose of thickening agents in this product is to produce smoothness in body and texture, reduce ice crystal growth during storage, extend shelf life, provide uniformity of the product, and provide resistance to melting (University of Guelph, 2005). Fruit consisting mostly of fiber or pulp content requires less stabilization than citrus fruit such as orange, grapefruit, and lime, which are primarily water based. Pulp gives body to the product, the more body there is, the less thickening agent is needed. Examples of thickening agents are locust bean gum, guar gum, and xanthan gum (Stogo, 1998).

Sensory Evaluation

Introduction

In 1981, the committee on sensory evaluation of the Institute of Food Technologists defined sensory evaluation as "a scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing." (Institute of Food Technologists, 1981). Sensory evaluation is also a way to determine ways to use human senses and perceptions as measuring instruments. In 1990, Peryam stated that psychology, physiology, sociology, and statistics are the primary sources of sensory evaluation. The human mind and body play an integral part in the processes of sensory analysis. When people analyze food products, they may use all five senses – sight, smell, taste, hearing, and touch. The physiological basis of each of these senses has an impact on methods to be used in sensory analysis and provide insight into presence of others which are likely to occur when using analytical methods depending on physiological limits and individual variation (Carpenter, Lyon, & Hasdell, 2000). Sensory evaluation, therefore, plays an important role in measuring characteristics and acceptability of food products.

The earliest development of sound sensory and statistical procedures is due to investigators such as Sylvia Cover of the Texas Agricultural Experiment Station. Several of Cover's publications on the sensory attributes of beef, as related to selected histological, chemical, and physical data, spanned from approximately 1936 to 1962 (Pangborn, 1989).

Types of Sensory Tests

The Sensory Evaluation Division of the Institute of Food Technologists (1981) classified two major types of sensory tests - analytical and affective. Analytical tests are used for laboratory evaluation of products in terms of differences or similarities and for identification and quantification of sensory characteristics. Discriminative and descriptive data are included in analytical tests. Discriminative tests include two areas of study - difference and sensitivity. Difference tests were the first recognized method of determining whether samples can be differentiated at certain significant levels of statistical probability. Difference tests consisted of paired comparison, duo-trio, rating scales, and triangle tests, and are used to determine whether or not two products are different (McIlveen & Armstrong, 1996; Meilgaard, Civille, & Carr, 1999). Sensitivity tests measure the ability of individuals to detect sensory characteristics, these involved threshold and dilution techniques. Descriptive analysis may be applied in the areas of new product development, quality control, storage stability, and correlation of sensory evaluation with chemical and physical tests (The Sensory Evaluation Division of the Institute of Food Technologists, 1981; Meilgaard, Civille, & Carr, 1999). Since the attributes of a food product are identified, described, and quantified, trained panelists are required in this technique. Panelists are screened for selected personal traits, interests, and ability to discriminate differences among test samples.

Affective tests are used to evaluate preference and the acceptance of products. Commonly, a large number of consumers are required in order to determine preference for given samples. Pilgrim (1957) defined food preferences in sensory evaluation as the

degree of like or dislike for food. Cardello and Schutz (2000) described preference to be a behavioral measure, which is the choice of one sample over another. Preference tests can only be used to determine a customers' favorite sample from the number of testing samples, but not differences per se; discriminative tests should be used for this purpose. The testing methods employ untrained customers and larger sample sizes than required in analytical test methods; test participants may be composed of 100 – 300 consumers.

Hedonic Scale

The 9-point hedonic test is a rating scale to measure the degree of likeness of food products, and has been used for many years for sensory evaluation in the food industry to determine acceptance of the food product. A hedonic rating test can yield both absolute and relative information about the test samples. Absolute information is derived from the degree of likeness indicated for each sample, and relative information is derived from the direction and degree of difference between or among the sample scores (The Sensory Evaluation Division of the Institute of Food Technologists, 1981). The usage of the hedonic test has been validated in the scientific literature (Stone & Sidel, 1993). Reliability and validity of the 9-point hedonic scale in the assessment of several hundred food items have been confirmed (Resurreccion, 1998).

Food Action Rating Scale

Measurement of food preferences as a predictor of consumer acceptance is an important component of new food product development. The Food Action Rating Scale

is the most popular. This scale was devised by Schultz (1965) to measure acceptance of a product by a population. The scale was tested and yielded highly reliable results with different groups of people (Schultz, 1965). This scale is not applicable for rating specific characteristics; rather it is a measure of general attitude toward food products. This includes action and affective-type statements. Nine levels are represented in the scale. One or more samples may be tested. Samples are presented sequentially in order, and consumers are asked to decide which of the statements on the scale best represents their attitude (Resurreccion, 1998).

Sensory Evaluation and Food Quality

Emphasis on quality management rather than maximizing profits, has paved the way to minimizing costs. Providing a consistently high quality of product, the profits can be maximized because the customer is more inclined to come back to the restaurant to enjoy high quality foods. Sensory evaluation can have a great influence on improving the organoleptic attributes of a product, including appearance, flavor, and texture. Additionally, it can also provide the development technologist with useful information in order to help achieve and control quality, at a level which is particularly acceptable to the consumers (McIlveen & Armstrong, 1996). Finally, sensory evaluation can also contribute directly or indirectly to other activities such as cost reduction, product reformulation, determination of consumers' reactions, and quality maintenance and evaluation (Bovell-Benjamin & Guinard, 2003).

This sensory evaluation approach is designed to assist the food industry in establishing links between production of a food product and its consumption. Customers will always evaluate foods to ensure the quality before consumption. Therefore, it is necessary for the food industry to apply sensory techniques to interpret consumer responses (McIlveen & Armstrong, 1996).

Evaluation Scale

Overall quality of the sorbet was measured by the characteristics of the sorbet which are color intensity, sweetness, cantaloupe flavor intensity, mouth feel, and crystallization. Pervious study of chilled cantaloupe (Shih, Thompson, Hoover, Wu, & Park, 2002) and the literature overview of cantaloupe (Yamaguchi, Hughes, Yabumoto, & Jennings, 1977; Mutton, Cullis, & Blakeney, 1981; Bett-Garber, Beaulieu, & Ingram, 2002; Beaulieu, Ingram, Lea, & Bett-Garber, 2004) investigated that color, sweetness, and cantaloupe flavor were strongly correlated with the overall quality of cantaloupe fruit. Additionally, mouth feel and crystallization had been widely used as a basis for determining the quality of frozen desserts (Moskowitz, 2001; Guven & Karaca, 2002; Minhas, Sidhu, Mudahar, & Singh, 2002).

Value Analysis

Introduction

The use of value analysis in the U.S. has grown considerably in the last decade (Sperling, 2001). It is a management tool which can be applied to making products and/or providing services, and for improving returns on investment, in addition to

providing an analytical approach for examining the relationships between the performance or service, and the cost of making the necessary performance or satisfaction. When value analysis is correctly applied, customers receive the best value of the product while keeping the product profitable. This technique has been known by many names, including value analysis, value engineering, value control, value assurance, and value improvement (Farm, 1980).

Value analysis was developed during World War II in the U.S. by Lawrence D. Miles. When an original material became scarce due to the war, it became necessary to look for alternative materials, but these alternative materials also became unavailable. Instead of searching for other alternative materials, an "alternative method" to produce the product was developed. This "functional analysis" process produced low-cost products without reducing quality; after the war, this system was maintained resulting in both eliminating unnecessary costs and improving product design (Palmer, Kelly, & Male, 1996).

Value

Value is a very broad term. According to Kermode, Sivaloganathan, and Shahin (2000), value is defined as follows:

$$\text{Value} = (\text{function cost} / \text{actual cost})$$

Function cost is equal to "the lowest possible cost for reliably providing the required function at the desired time and place and with the essential quality," which is the same as the performance of the product. *Actual cost* is equal to "the cost of providing the

function in the existing design," and *value* is equal to efficiency of the design, such as "how well the product provides the function." A product or service is generally considered to have good value if that product or service has appropriate performance and cost. Thus, value can be increased by either increasing the performance or decreasing the cost (Miles, 1972). However, used in the concept of value analysis, it is a measure of the relationship between efficiency and cost. As a result, the value of a product is determined by two factors: performance and cost. A product is considered to have good value if it has appropriate measures of performance and cost (Mehra & Bretz, 1981).

Value Analysis

Miles (1972) defined value analysis as "a problem-solving system implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills. It was an organized creative approach which was aimed at efficient identification of unnecessary cost, i.e., cost which provided neither quality nor use nor life nor appearance nor customer features." (Lawrence D. Miles Value Engineering Reference Center, 2004). Value analysis is typically applied in the product/service during pre-design stages in order to identify and remove unnecessary cost.

When value analysis was applied to products, this assisted in the orderly use of better approaches, alternative materials, newer processes, and abilities of particular suppliers. It focused on engineering, manufacturing, and purchasing attention for one purpose – the same product performance with lower cost. Value of the product should not be reduced. In general, 15 to 25% of manufacturing costs were determined to be

unnecessary without any reduction in customer values by the use of this problem-solving system in the significant decision area (Lawrence D. Miles Value Engineering Reference Center, 2004). As for the procedure of applying value analysis to a product, the first step was to identify the function of the product under careful consideration. Next, the quality of the product was identified. An examination of alternative methods of achieving this function followed. Finally, the method producing had the lowest cost was chosen (Pawar, Forrester, & Glazzard, 1993).

Miles (1972) proposed five basic steps for the implementation of value analysis technique. A brief description of the steps is listed as follows:

1. Information – this step includes the information required to understand the product and its function. The information is gathered, but no interpretation is given at this point.
2. Analysis – understanding of this information is vital to this step. Necessary function analysis should be performed.
3. Creativity – also called the speculation step. In order to be effective, the new knowledge should be added in this step.
4. Judgment – also called the decision step. The newly generated idea should be evaluated, the cost reevaluated, and the final decision made.
5. Development – this step requires convincing the final decision-maker of the validity of the new approach and includes the action steps which must follow acceptance of the proposed method (Mehra & Bretz, 1981).

Implementation of Value Analysis

Acharya, Pfrommer, and Zirbel (1995) suggested that when implementing value analysis, the multidisciplinary approach should be used to create alternatives for the client's consideration. This process involves seven steps as follows:

1. Team selection – people who are familiar with the value analysis process and the product should be included in the team.
2. Information – technical and cost-related information is gathered in this step.
3. Brainstorming – includes discussion of cost-saving alternatives accumulated in gathered information.
4. Evaluation alternatives – selected alternatives, which can provide cost savings and be implemented in the product, are to be analyzed.
5. Developing alternatives – each selected alternative should be well studied to determine if its appropriateness for product.
6. Making recommendations – all alternatives should be presented to the team and the best one or two selected for the product.
7. Implementing – the cost-saving method should be applied to the product.

Kermode, Sivaloganathan, and Shahin (2000) extended value analysis to eight steps in order to make the underlying approach explicit.

1. Pre-study – plan and prepare for the value analysis function; all resources are needed. Groups and people involved with the product must be gathered.

2. Information – gathering complete, accurate information about the product; materials and labor are needed. Market research should be done by this point.
3. Analysis – the goal here is complete understanding of the product functions and their analysis. Function and cost analysis should be conducted.
4. Creation – to generate solutions for the problem; creative methods should be obtained.
5. Evaluation – selection of the best plan for further development with use of decision analysis.
6. Development – goal is to present the proposal for improvement and definition of the cost; changes from the proposal should be evaluated and justified.
7. Presentation – aim here is to gain the acceptance of senior management for the proposed changes; the accepted or rejected ideas for future research should be listed.
8. Implementation – effectuate changes accepted during the presentation step; the problem situation should be improved.

Summary and Application of Value Analysis

A number of changes have taken place since value analysis techniques were developed, but the basic idea of the value of a product has not changed. In today's competitive environment, if a product does not have sound values, chances of its continued existence in the marketplace will rapidly decrease. Furthermore, good value means an increase in performance effectiveness and profit margin. Value analysis

techniques, therefore, can significantly benefit an organization (Mehra & Bretz, 1981). Value analysis enjoys a half-century of history as a successful technique for improving the value of projects, products, and processes. Manufacturing was the first industry to apply value analysis, followed by engineering, education, management, construction, transportation, and service industries (Lawrence D. Miles Value Engineering Reference Center, 2004).

Although value analysis is related primarily to industry, it possesses broad implication for foodservice as well. For example, value analysis of a menu item in the restaurant may suggest that without decreasing from final product quality, some features may be eliminated (Spears, 2000). In foodservice industry, value analysis is used more frequently in evaluating existing product and thus is readily applicable in the industry. Value analysis of a main course in the foodservice organization may determine cost deduction methods, such as purchasing semi-finished materials to reduce labor cost (Spears, 2000).

References

Acharya, P., Pfrommer, C., & Zirbel, C. (1995). Think value engineering. *Journal of Management in Engineering,* (*11/12*), 13-17.

American Dietetic Association (2003). Position of the American Dietetic Association and Dietitians of Canada: Vegetarian diets. *Journal of the American Dietetic Association, 103,* 748-765.

Anderson, L., Young, L., & Long, E. (2005). Diet and hypertension. Retrieved June 1, 2005, from Colorado State University Cooperative Extension Web Site: http://www.ext.colostate.edu/pubs/foodnut/09318.html

Anonymous (1998). Researchers forecast healthy future for retail fresh-cut sales. *Fresh-cut, 6,* 14-15.

Anonymous (2001). State health director advises consumers to scrub cantaloupe before eating. Office of Public Affairs. Retrieved August 14, 2004, from www.dhs.ca.gov

Ayhan, Z. & Chism, G. W. (1998). The shelf-life of minimally processed fresh cut melons. *Journal of Food Quality*, *21*, 29-40.

Bailey, L. H. (1939). The standard cyclopedia of horticulture. New York: The Macmillan Co.

Ballister, B. (2002). The fruit and vegetable stand. In *The complete guide to the selection, preparation and nutrition of fresh produce* (Rev. ed., pp. 314-315). New York: Peter Mayer Publishers, Inc.

Bareuther, C. M. (2000). Magnifying melon sales, *Produce Bus*, May, 60-68.

Beaulieu, J. C., Ingram, D. A., Lea, J. M., & Bett-Garber, K. L. (2004). Effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe. *Journal of Food Science, 69*, S250-S258.

Beck, S. (1993). Event, happiness, news and photos of the frozen food industry. *Frozen Food Digest,* April/May, 73-93.

Bett-Garber, K. L., Beaulieu, J. C., & Ingram, D. A. (2002). Effect of storage on sensory properties of fresh-cut cantaloupe varieties. *Journal of Food Quality*, *26,* 323-335.

Bovell-Benjamin, A. C. & Guinard, J. X. (2003). Novel approaches and application of contemporary sensory evaluation practices in iron fortification programs. *Critical Reviews in Food Science and Nutrition*, *43*(3), 379-400.

Calvin, L. (2003). International trend and food safety. Economic Research Service. United States Department of Agriculture. Retrieved December 11, 2004, from USDA web site: www.ers.usda.gov

Cardello, A. V., & Schutz, H. (2000). Prediction of food acceptance, consumption, and satisfaction in specific eating situations. *Food Quality Preferences*, *11*, 201-216.

Carpenter, R. P., Lyon, D. H., & Hasdell, T. A. (2000). *Guidelines for sensory analysis in food product development and quality control* (2nd ed.). Maryland: Aspen Publishers, Inc,

Cleary, M., & Koppenhoefer, K. (2004). Just the facts: Ice cream sales and trends. Retrieved September 22, 2004, from IDFA website: http: www.idfa.org/facts/icmonth/page2.cfm.

Eaton, W. (1982). Profitable chilled desserts are easy to make and serve. *Foodservice Marketing*, *10,* 62-63, 67.

Economic Research Service, USDA (2003). Commodity highlight: Cantaloupe. Retrieved June 1, 2005, from Vegetables and Melon Outlook, USDA web site: http://www.ers.usda.gov/Briefing/Vegetables/vegpdf/cantaloupHigh.pdf

Farm, D. (1980). *Value analysis: A way to better products and profits, an AMA management briefing.* New York: AMACOM.

Flowerdew, B. (1996). *The complete book of fruit – A practical guide to growing and using fruits and nuts.* New York: Penguin Group.

Galeb, A. D. S. (1994). *Use of ion-exchange and direct osmotic concentration technologies for processing cantaloupe juice* (Doctoral dissertation, Oregon State University, 1994). *Dissertation Abstracts International*, 54, 09B.

Galeb, A. D. S., Wrolstad, R. E., & McDaniel, R. (2002). Composition and quality of clarified cantaloupe juice concentration. *Journal of Food Processing Preservation, 26*, 39-56.

Guven, M., & Karaca O. B. (2002). The effects of varying sugar content and fruit concentration on the physical properties of vanilla and fruit ice-cream-type frozen yogurts. *International Journal of Dairy Technology*, *55*(1), 27-31.

Herrmann, R. O., Sterngold, A. H., & Warland, R. H. (1990). *Consumers' shift toward lower fat dairy products* (Marketing Research Report No 10). The Pennsylvania State University, Department of Agricultural Economics and Rural Sociology.

Hong, G. P., & Nip, W. K., (1990). Functional properties of precooked Taro flour in sorbet. *Food Chemistry*, *36,* 261-270.

Hubbard, N. L., Huber, S. C., & Pharr, D. M. (1990). Sucrose metabolism in ripening muskmelon fruit as affected by leaf area. *Journal of the American Society for Horticultural Science, 115,* 798-902.

Hubrich, B. (2005). National survey reveals major increase in number of people dieting. Retrieved April 05, 2005, from Calorie Control Council Web site: http://www.caloriecontrol.org/pr03-02-05.html

Institute of Food Technologists (1981). Sensory evaluation guides for testing food and beverage products. *Food Technology, 35*(11), 232-233.

International Ice Cream Association (1998). *The latest scoop*. Washington, DC: International Ice Cream Association.

Kermode, G. R., Sivaloganathan, S. & Shahin, T. M. (2000). Value analysis – the technique: state of the art and future directions. *Journal of Engineering Manufacture, 214*(B4): 301-312part B.

Lawrence D. Miles Value Engineering Reference Center. What is value engineering? Retrieved April 10, 2004, from Lawrence D. Miles Value Engineering Reference Center web site: http://www.wisc.edu/wendt/miles

Mattern, V. (1990). East meets west. *Rodale's Organic Gardening, 37*(5), 39-43.

McIlveen, H., & Armstrong, G. (1996). Sensory analysis and the food industry: can computers improve credibility? *Nutrition & Food Science*, *1*(1/2) 36-40.

Mehra, S., & Bretz, R. W. (1981). Value analysis: A technique for implementing systems thinking in the organization. *The Institute of Management Sciences*, *11*(2), 48-52.

Meilgaard, M., Civille, G. V., & Carr, B. T. (1999). *Sensory evaluation techniques* (3rd ed.). New York: CRC Press.

Miles, L. D. (1972). *Techniques of value analysis and engineering.* (2nd ed.). New York: McGraw-will, Inc.

Minhas, K. S., Sidhu, J. S., Mudahar, G. S., & Singh, A. K. (2002). Flow behavior characteristics of ice cream mix made with buffalo milk and various stabilizers. *Plant Foods for Human Nutrition, 57*(1), 25-40.

Mohle-Boetani, J. C., Reporter, R., Werner, S. B., Abbott, S., Farrar, J., Waterman, S. H., & Vugia, D. J. (1999). An outbeak of *Salmonella* serogroup Saphra due to cantaloupes from Mexico. *Journal of Infectious Diseases*, *180*, 1361-1364.

Moskowitz, H. (2001). Learning from the competition through category appraisal: One practitioner's keys to faster and more efficient product development. *Food Service Technology*, *1*, 103-118.

Munger, H. M., & Robinson, R. W. (1991). *Nomenclature of Cucumis melo L.* (Report No 14). Cucurbit Genetics Cooperative.

Mutton, L. L., Cullis, B. R., & Blakeney, A. B. (1981). The objective definition of eating quality in Rockmelons (*Cucumis melo*). *Journal of Science Food Agriculture*, *32*, 285-291.

O'Connor-Shaw, R. E., Roberts, R., Ford, A. L., & Nottingham, S. M. (1994). Shelf life of minimally processed honeydew, kiwifruit, papaya, pineapple, and cantaloupe. *Journal of Food Science*, 59, 1202-1206, 1215.

Palmer, A., Kelly, J., & Male, S. (1996). Holistic appraisal of value engineering in construction in United States. *Journal of Construction Engineering and Management*, *12*, 324-328.

Pangborn, R. M. (1989). The evaluation of sensory science and its interaction with IFT. *Food Technology*, *9*, 248-256.

Pawar, K., Forrester, P., & Glazzard, J. (1993). Integrated manufacturing systems. *Bradford*, *4*(3), 14-22.

Peet, M. (2002). Muskmelon – harvest and Post-harvest. Retrieved June 14, 2002, from Crop Profiles – Muskmelon web site: www.cals.ncsu.edu/sustainable/peet/profiles/muskharv.htnl

Peryam, D. R. (1990). Sensory evaluation – The Early Days. *Food Technology*, *44*(1), 86-91.

Philip, T., & Chen, T. (1988). Development of a method for the quantitative estimation of provitamin A carotenoids in some fruit. *Journal of Food Science, 53*, 1703-1705.

Pilgrim, F. T. (1957). The components of food acceptance and their measurement. *American Journal of Clinical Nutrition*, *5*, 171-173.

Portela S. I., & Cantwell, M. I. (2001). Cutting bland sharpness affects appearance and other quality attributes of fresh-cut cantaloupe melon. *Journal of Food Science*, *66*, 1265-1270.

Resurreccion, A. V. A. (1998). *Consumer sensory testing for product development*. Maryland: Aspen Publishers, Inc.

Rosenfeld, H., & Nes, A. (2000). Prediction of sensory quality of strawberry jam by means of sensory quality attributes of fresh fruit. *Journal of the Science of Food and Agriculture, 80*, 1895-1902.

Ryan, M. E. (1938). *The cantaloupe: Its history and cultural methods*. Colorado: The Rocky Ford Cantaloupe Seed Breeders Association.

Schultz, H. (1965). A food action scale for measuring food acceptance. *Journal of Food Science*. *30*, 365-374.

Shih, Y., Thompson, L. D., Hoover, L. C., Wu, C., & Park, O. (2002). The impact of initial chilling of cantaloupe on shelf life: A back of the house issue. Proceedings of the 8th Graduate Education & Graduate Student Research Conference in Hospitality and Tourism, 608-610.

Simandjuntak, V., Barrett, D. M., & Wrolstad, R. E. (1996). Cultivar and frozen storage effects on muskmelon (*Cucumis melo*) colour, texture and cell wall polysaccharide composition. *Journal of the Science of Food and Agriculture, 71*(3), 291-296.

Sloan, A. E. (2002). Fast and casual: Today's foodservice trends. *Food Technology*, *56*(9), 34-35.

Sperling, R. B. (2001). It's much more than a set of cost-cutting measures. *IIE Solutions*, August,45-52.

Spears, M. C. (2000). *Foodservice organization: A managerial and systems approach* (4th ed.). Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Steward, B., & Tinsley, A. (1995). From qualitative to quantitative: Development of an instrument to assess food choice influences of young adults. *Ecology Food Nutrition, 34*, 171-181.

Stone, H., & Sidel, J. L. (1993). *Sensory evaluation practices* (2nd ed.). San Diego: Academic Press.

Stogo, M. (1990). *Frozen desserts – A complete retailer's guide*. New York: Van Nostrand Reinhold.

Stogo, M. (1998). *Ice cream and frozen desserts – A commercial guide to production and marketing.* New York: John Wiley & Sons, Inc.

SunCream Dairies Mouth Watering (2004). Sorbet. Retrieved May 1, 2005, from SunCream Dairies Mouth Watering web site: http://www.suncreamdairies.com

Suslow, T. V., Cantwell, M., & Mitchell, J. (2002). Cantaloupe – Recommendations for maintaining postharvest quality. Retrieved June 16, 2002, from Cantaloupe Produce Facts web site: http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/cantaloupe.html

Taper, L. J., McNeill, D. A., & Ritchey, S. J. (1985). Yields and nutrient of selected fresh fruits. *Journal of American Dietetic Association, 85*(6), 718-720.

Texas Department of Agriculture (2004). Cantaloupe season. Retrieved October 15, 2004, from Texas Department of Agriculture Web site: http://www.agr.state.tx.us/education/tips/com_cantaloupe.htm.

The Sensory Evaluation Division of the Instituted of Food Technologists, (1981). Sensory evaluation guides for testing food and beverage products, *Food Technology, 35*(11), 50-57.

United States Department of Agriculture (2003). An economic assessment of cantaloupe executive summary. Retrieved October 14, 2003, from USDA web site: www.rma.usda.gov/pilots/feasible/txt/cantaloupe.txt

University of Guelph, (2005). Ingredients. Retrieved March 30, 2005, from University of Guelph Web site: www.foodsci.uoguelph.ca/dairyedu/icingr.html.

Vance Research Service and Market Facts, Inc. (1990). *Fresh trends 90': A profile of the fresh produce consumer*. Reports 1,4.

Wagner, A. B., Dainello, F. J., & Parson, J. M. (2001). Harvesting and handling. Retrieved June 14, 2002, from Texas A&M University, extension, veghandbook web site: http://aggie-horticulture.tamu.edu/extension/veghandbook/chapter10/chapter10.html.

White, P. (2000). The flavors of ice – A cool cornucopia of cold creations. *School Foodservice & Nutrition,* May, 64-68.

CHAPTER II

SENSORY EVALUATION OF CANTALOUPE SORBET – DETERMINING THE APPROPRIATE THICKENING AGENT

Prepared for Journal of Food Science

Y. Shih, L. D. Thompson, and L. C. Hoover

Abstract

Sorbet is a flavored ice made of sugar syrup and fruit puree only, and sometimes an additional natural thickening agent will be used to improve the smoothness and prevent separation. Most studies are focused on ice cream, and sorbet is poorly understood. The purpose of this study was to investigate by sensory and instrument evaluation an appropriate thickening agent for the cantaloupe sorbet product. A variety of thickening agents were tested in the study including guar gum, xanthan gum, and a combination of both gums. The amount of thickening agents were 0.05% (based on the total weight of the ingredients). The cantaloupe sorbets containing 0.05% of xanthan gum received a higher overall quality then other cantaloupe sorbets.

Key words: Cantaloupe, sorbet, thickening agent, sensory evaluation, gum.

Introduction

Frozen desserts are very popular dessert in American society. Typically Americans consume 20 quarts of ice cream and related frozen desserts per year. Most studies have focused on ice cream, and sorbet is poorly understood. Sorbet is a flavored

ice made primarily of sugar syrup and fruit puree. Sometimes an additional natural thickening agent is used in order to improve smoothness and prevent separation. Sorbet is a rich, smooth and creamy product without the use of fat or dairy ingredients (Hong & Nip, 1990). Fresh-fruit sorbets are usually served as a palate cleanser between courses. Since Americans have become more aware of health and weight issues in recent years, sorbet has became an after-meal dessert rather than a palate refresher (Herrmann, Sterngold, & Warland, 1990) because it is low in cholesterol, fat, and calories. In the American market, sorbet sales increased 208% in 1996 over 1994 (International Ice Cream Association, 1998).

Sorbet can suffer a quality defeat in which it is easy to break apart or crumbles. This defect can be remedied by using a thickening agent. Consequently, the purpose of this study was to identify an appropriate thickening agent for the sorbet as determined by sensory and instrument evaluation.

Literature Review

The quality of sorbet depends mainly upon ingredients used in the mix, which include water, sugar, fruit, citrus juice and a thickening agent (Stogo, 1998). When well made, the ingredients interact with each other and create a delightful taste. The thickening agent is an important factor in enhancing sorbet quality. Ice crystal size and distribution play an important role in the sorbet's final quality. The thickening agent can reduce the number of crystals or the size of crystals or both during the production period (Minhas, Sidhu, Mudahar, & Singh, 2002) and also retard melting at the consumption

stage (Guven, Karaca, & Kacar, 2003). Thickening agents play an important role in sorbet. Their primary purpose is to produce smoothness in body and texture, reduce ice crystal growth during storage, extend shelf life, and provide uniformity of product and resistance to melting (University of Guelph, 2005). Thickening agents commonly used in sorbet have included guar gum, locust bean gum, and xanthan gum.

According to Whistler and Daniel (1990), a gum is any water-soluble polysaccharide which is extractable from land or marine plants or from microorganisms, that possesses the ability to contribute viscosity or gelling ability to its dispersions. Polysaccharide gums are used widely as thickening agents in food. Guar gum is the endosperm of polysaccharide of the seed of *Gyamopsis tetragonolobus*, family Leguminosae. It dissolves rapidly in cold water producing a highly viscous solution. Because guar gum can produce high viscosity solutions, it is often used in concentrations of 1% or less in foods. Salt and large amounts of sucrose will reduce viscosity of the solution. It is commonly used in cheeses, ice cream, and meat products such as sausage.

Xanthan gum is an extracellular polysaccharide elaborated by several *Xanthomonas* species. It is readily soluble in hot or cold water and produces highly viscous solutions at low concentration. Xanthan gum is compatible with most food salts and acids, and functions with guar gum to increase viscosity. It is usually used in beverages, canned foods, and frozen foods (Whistler & Daniel, 1990).

Methodology

Products and Processing

Twelve kilogram of cantaloupe (variety: *Mission*), free of visual defects, are obtained from a local food distributor in Lubbock, Texas. The cantaloupe was stored at 4°C for at least 24 hours before processing. These experiments were conducted during the summer of 2004.

Four portions of sugar syrup were prepared; each made from 142 g of sugar and 59 ml of water. Three treatments were added to these three sugar syrups. The first one contained 0.05% Rhodigel 80 xanthan gum (based on the total weight of the total ingredients), and the second contained 0.05% of Jaguar 4500 guar gum (based on the total weight). The third contained 0.025% each of xanthan gum and guar gum (based on the total weight). The last was the control, which had no thickening agent. After the syrup reached the boiling point, it was boiled for two additional minutes, and then cooled to room temperature.

The cantaloupes were washed, peeled, seeded, and cut into pieces. Four portions of 0.68kg of cantaloupe each were pureed by blender for 2 minutes and then packaged in Ziploc®. Next, the cantaloupe puree and syrup were poured into an ice cream maker, and 7.4ml of lemon juice were added to enhance flavor. Then, the ice cream maker was activated, and when the mixture started to firm and looked frothy, the ice cream maker was turned off. The approximate time spent was 25 minutes. The finished product was extruded (transferred) into a storage box and transferred into a –18°C freezer. The procedure of preparing cantaloupe sorbet is shown in Figure 2.1.

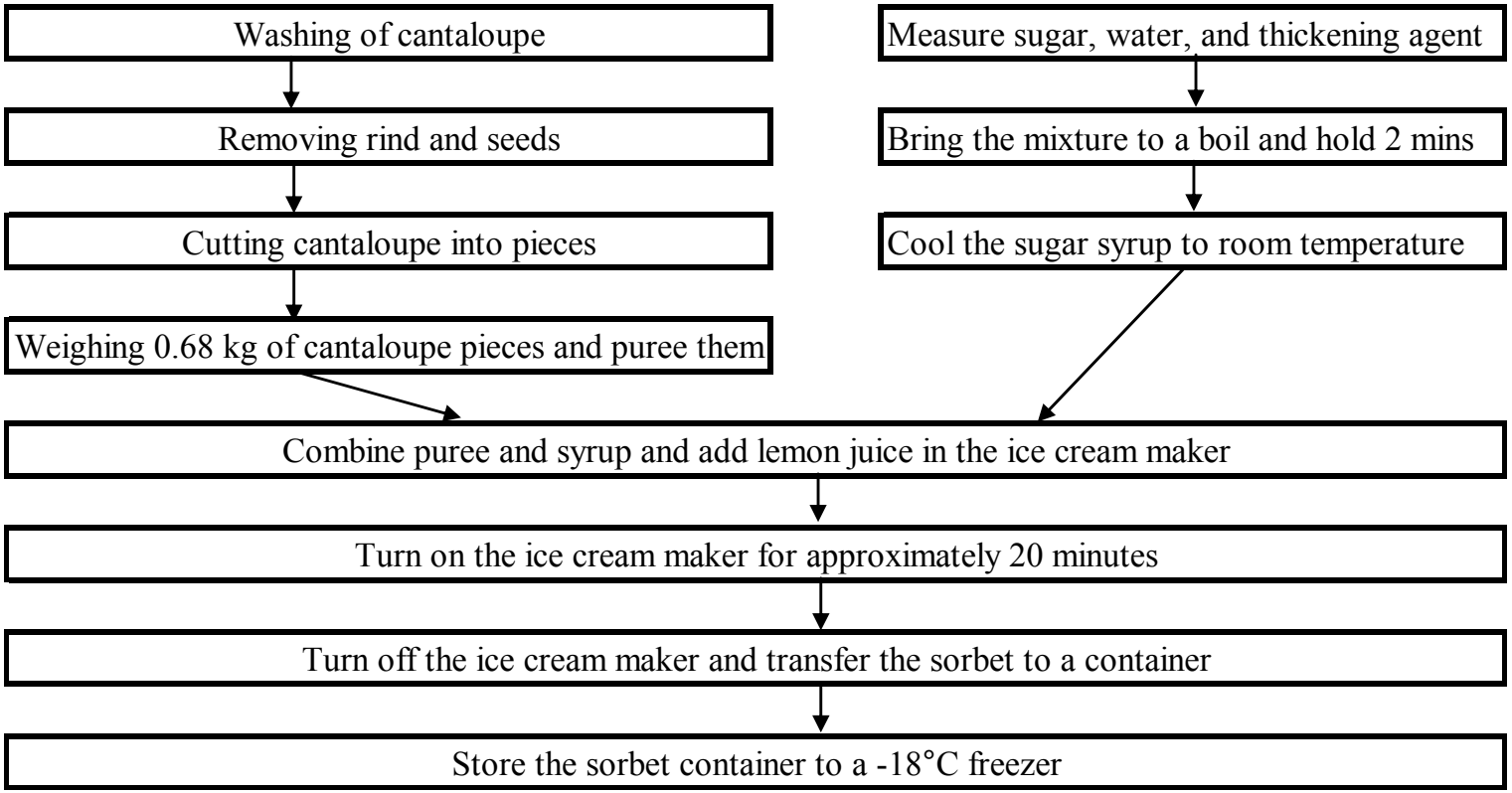

Figure 2.1 Unit operations used to prepare cantaloupe sorbet

Trained Sensory Panel

An eight-member panel was recruited to evaluate the samples. Panelists were graduate students, faculty, or staff in the College of Human Sciences with varying degrees of sensory evaluation experience. They were trained for at least three hours within a three-day period to evaluate characteristics of the cantaloupe sorbet such as color intensity, sweetness, cantaloupe flavor intensity, mouth feel, crystallization, viscosity, and overall quality (Yamaguchi, Hughes, Yabumoto, & Jennings, 1977; Mutton, Cullis, & Blakeney, 1981; Rosenfeld & Nes, 2000; Moskowitz, 2001, Bett-Garber, Beaulieu, & Ingram, 2002, Guven & Karaca, 2002; Beaulieu, Ingram, Lea, & Bett-Garber, 2004). To achieve consistent results, the panelists and panel trainer discussed their results after tasting each individual sample. When panelists had consistent results for evaluating samples, the sensory evaluation session was conducted. Panelists received a small gift as an incentive.

All panel sessions were conducted in a sensory lab with partitioned booths. Samples were presented separately in 57 ml plastic cups with a lid and served in random order to the panelists. A three-digit random code was assigned to each sample to be evaluated by panelists. Bottled water and unsalted crackers were provided for rinsing between samples. The panelists were served one sample of sorbet at a time and were instructed to evaluate the sample individually.

Instrumental Evaluation

Three instrumental evaluations were conducted. Separate samples were prepared for instrument evaluation. Total soluble solids (°Brix) was determined by using a refractometer (model number BRIX 35HP from Leica Microsystems Inc). The pH value of the sample was determined by using a pH meter (model number IQ 150 from Scientific Instruments, Inc). A colorimeter (model number Chroma Meter CR-400 from Konica Minolta Photo Imaging U.S.A., Inc.) was used to determined the Hunter L* (brightness), a* (red - green component), and b* (yellow – blue component) value of the samples, and the chromatic attributes: Chroma ($C^* = (a^* + b^*)^{1/2}$) and hue angle ($H^* = \tan^{-1} (b^*/a^*)$).

Statistical Analysis

A completely randomized design (Meilgaard, Civille, & Carr, 1999) with three replications was used in this experiment. The Statistical Package for the Social Sciences program was used to perform the statistical analysis. The significance of differences among means was calculated by an analysis of variance, Least Significant Difference (LSD) and Tukey's multiple range tests at $p < .05$. Additionally, correlation and regression analyses were employed to determine the relationship between characteristics of cantaloupe sorbet.

Results and Discussion

Panelist Evaluation

Panelists detected the differences among treatments in the characteristics of color, sweetness, and overall quality (Table 2.1). Sorbet without any thickening agent had brighter color than the sorbets with thickening agents ($p < .05$). This indicated that thickening agents have a certain degree of interaction with components of cantaloupe sorbet, which interaction will lead to visual differences between the sorbet with and without thickening agents. Sorbets containing the different thickening agents were similar in color intensity. As for sweetness, the sorbet without any thickening agent tended to be sweeter than the rest ($p < .05$) which suggested that thickening agents might interact with the components of water and sugar in the sorbet. Therefore, panelists determined that sorbet without thickening agents was significantly sweeter than sorbet with thickening agents. Additionally, no difference was found in sorbets containing the different thickening agents.

In overall quality, sorbets with xanthan gum and the mix of xanthan gum and guar gum received significantly higher scores than the sorbet without thickening agents ($p < .05$) which suggested that panelists believe that the quality of sorbets without thickening agents was not as pleasing as the sorbet containing xanthan gum and the mixed gums. As for overall quality of the sorbet with guar gum, it was intermediate to sorbet without thickening agent and sorbets with xanthan gum and the mixed gums. As for the other characteristics of cantaloupe sorbet, which were melon flavor intensity, mouth feel,

crystallization, and viscosity, the panelists could not detect any differences among the treatments.

Correlations among sensory attributes of cantaloupe sorbet are shown in Table 2.2. Correlation analysis revealed that there was a slightly positive correlation between sweetness and melon flavor ($r = .17$, $p < .01$), sweetness and mouth feel (($r = .20$, $p < .01$), and sweetness and overall quality ($r = .11$, $p < .01$). These results indicated that when the score of sweetness increased, the scores of melon flavor intensiry, mouth feel, and overall quality also increased. In addition, correlation analysis results also suggested that overall quality was positively correlated with melon flavor ($r = .54$, $p < .01$) and mouth feel ($r = .32$, $p < .01$). These results indicated that if the scores of melon flavor and mouth feel increased, the score of overall quality increased as well.

Instrument Evaluation

Table 2.3 illustrates results of the instrument evaluation. The significant difference among treatments in the pH value, total soluble solids, and L* value were determined. The sorbet without any thickening agent had the lowest pH value of the four treatments. The pH value for sorbet without thickening agents was, however, significantly different from the sorbet containing xanthan gum ($p < .05$), but the same as the sorbets containing Guar gum and mixed gums. Galeb (1994) reported that the pH value of cantaloupe juice was almost neutral (6.5). The average pH value of cantaloupe sorbets was 6.19, which was lower than that of the juice in Galeb's report. During the

Table 2.1 Means and standard deviations for trained panelist ratings of cantaloupe sorbet using different thickening agents (control = no thickener; guar= 0.05% guar gum; xanthan = 0.05% xanthan gum; mix = .025% guar gum + .025% Xanthan gum.)

Treatment	Color[1]	Sweetness[1]	Melon flavor[1]	Mouth feel[1]	Crystallization[1]	Viscosity[1]	Overall quality[1]
Control	7.06[a]±.83	7.44[a]±.79	6.60±1.16	6.04±1.41	4.60±1.38	3.78±1.16	6.22[a]±1.24
Guar	6.28[b]±.81	7.14[b]±.77	6.57±1.11	6.15±1.43	4.20±1.42	3.95±1.47	6.62[ab]±1.12
Xanthan	6.44[b]±.69	7.14[b]±.75	6.77±.98	6.19±1.42	4.20±1.33	3.88±1.13	6.86[b]±1.09
Mix	6.28[b]±.91	7.17[b]±.77	6.60±.98	6.43±1.40	4.21±1.40	3.83±1.22	6.80[b]±1.05

[1]9 = extremely bright, sweet, strong melon flavor, smooth, much crystallization, hard to separate, and good; 1 = extremely pale, cannot detect sweetness, no melon flavor, extremely grainy, no crystallization, extremely easy to separate, and extremely poor.

[a, b] Means within a column with different superscripts were different ($p < .05$)

N = number of samples = 288

Table 2.2 Correlations of sensory characteristics of cantaloupe sorbet from trained panel

Characteristic	Color	Sweetness	Melon flavor	Mouth feel	Crystallization	Viscosity	Overall quality
Color	---	.131*	.118*	.023	.059	.068	.025
Sweetness		---	.170**	.198**	.026	.023	.113*
Melon flavor			---	.142*	-.047	.059	.537**
Mouth feel				---	-.118*	-.084	.321**
Crystallization					---	.011	-.054
Viscosity						---	.049
Overall quality							---

* Correlation was significant at the 0.05 level (2-tailed).
** Correlation was significant at the 0.01 level (2-tailed).
N = number of samples = 288

sorbet-making processing, lemon juice was added to enhance the flavor, resulting in drop of the pH level in the cantaloupe sorbet.

Based on the results of the total soluble solids (°Brix), the sorbet containing xanthan gum had less total soluble solids than the others ($p < .05$). Gum and sugar compete for available water molecules (Whistler & Daniel, 1990), and this suggests that xanthan gum interacted with water and sugar in the cantaloupe sorbet and resulted in significant difference among the treatments. As for the colorimeter evaluation, in the L* value, the results suggested that sorbet containing guar gum was significantly lighter than the sorbet without thickenings agents ($p < .05$). The L* values of the sorbet without thickening agents and the sorbets containing Xanthan gum and mixed gums were similar. There was no significant differences among hue angle, but significant difference was found in chroma ($p < .05$). This result indicated that the hue angle of the sorbets was similar, but the intensity of the color was greater in the sorbets containing the gums than the control.

Correlation between Instruments and Panelists

In order to determine the relationship between instrument and panelist evaluation, correlation analysis was performed (Data not shown). The results suggested that chroma value negatively correlated with color score from the panelists ($r = -.36$, $p < .05$). A review of the data showed that as the chroma value increases, the color score from the panelists decreased. There was no other significant correlation between the instrument results and the panelist results.

Table 2.3 Means and standard deviations for instrument evaluation of cantaloupe sorbet using different thickening agents

Treatment	pH value	°Brix	L*	Hue angle	Chroma
Control	$6.02^{a}\pm.10$	$25.21^{a}\pm.34$	$61.18^{a}\pm2.87$	$75.63\pm.85$	$28.97^{a}\pm1.32$
Guar	$6.15^{ab}\pm.15$	$25.17^{a}\pm.59$	$67.75^{b}\pm.3.56$	$76.15\pm.50$	$30.48^{b}\pm1.11$
Xanthan	$6.21^{b}\pm.12$	$24.51^{b}\pm.42$	$64.21^{ab}\pm5.10$	$76.04\pm.44$	$31.05^{b}\pm1.44$
Mix	$6.19^{ab}\pm.15$	$25.07^{ab}\pm.57$	$64.84^{ab}\pm3.17$	$76.10\pm.47$	$30.97^{b}\pm1.58$

[a, b] Means within a column with different superscripts were different ($p < .05$)
N = number of samples = 72

References

Beaulieu, J. C., Ingram, D. A., Lea, J. M., & Bett-Garber, K. L. (2004). Effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe. *Journal of Food Science*, *69*, S250-S258.

Bett-Garber, K. L., Beaulieu, J. C., & Ingram, D. A. (2002). Effect of storage on sensory properties of fresh-cut cantaloupe varieties. *Journal of Food Quality*, *26*, 323-335.

Galeb, A. D. S. (1994). *Use of ion-exchange and direct osmotic concentration technologies for processing cantaloupe juice* (Doctoral dissertation, Oregon State University, 1994). *Dissertation Abstracts International*, 54, 09B.

Guven, M., & Karaca, O. B. (2002). The effects of varying sugar content and fruit concentration on the physical properties of vanilla and fruit ice-cream-type frozen yogurts. *International Journal of Dairy Technology*, *55*(1), 27-31.

Guven, M., Karaca, O. B., & Kacar, A. (2003). The effects of the combined use of stabilizers containing locust bean gum and of the storage time on Kahramanmaras-type ice creams. *Society of Dairy Technology*, *56,* 223-228.

Herrmann, R. O., Sterngold, A. H., & Warland, R. H. (1990). *Consumers' shift toward lower fat dairy products* (Marketing Research Report No 10). The Pennsylvania State University, Department of Agricultural Economics and Rural Sociology.

Hong, G. P., & Nip, W. K. (1990). Functional properties of precooked Taro flour in sorbet. *Food Chemistry*, *36*, 261-270.

International Ice Cream Association (1998). The latest scoop. Washington, DC: International Ice Cream Association.

Meilgaard, M., Civille, G. V., & Carr, B. T. (1999). *Sensory evaluation techniques* (3rd ed.). New York: CRC Press.

Minhas, K. S., Sidhu, J. S., Mudahar, G. S., & Singh, A. K. (2002). Flow behavior characteristics of ice cream mix made with buffalo milk and various stabilizers. *Plant Foods for Human Nutrition, 57*(1), 25-40.

Moskowitz, H. (2001). Learning from the competition through category appraisal: One practitioner's keys to faster and more efficient product development. *Food Service Technology*, *1*, 103-118.

Mutton, L. L., Cullis, B. R., & Blakeney, A. B. (1981). The objective definition of eating quality in Rockmelons (*Cucumis melo*). *Journal of Science Food Agriculture*, *32*, 285-291.

Rosenfeld, H. J., & Nes, A. (2000). Prediction of sensory quality of strawberry jam by means of sensory quality attributes of fresh fruits. *Journal of Science Food Agriculture, 80*, 1895-1902.

Stogo, M. (1998). *Ice cream and frozen desserts – A commercial guide to production and marketing.* New York: John Wiley & Sons, Inc.

University of Guelph (2005). Ingredients. Retrieved March, 30, 2005, from University of Guelph Web site: www.foodsci.uoguelph.ca/dairyedu/icingr.html.

Whistler, R., & Daniel, J. R. (1990). Functions of polysaccharides in foods. In L. A. Branen, M. P. Davidson, & S. Salminen (Ed.), *Food Additives* (pp. 395-423). New York: M. Dekker, Inc.

Yamaguchi, M., Hughes, D. L., Yabumoto, K., & Jennings, W. G. (1977). Quality of cantaloupe muskmelons: Variability and attributes. *Scientia Horticulturae, 6,* 59-70.

CHAPTER III

SENSORY EVALUATION AND VALUE ANALYSIS OF CANTALOUPE SORBET

Prepared for Journal of Food Science

Y. Shih, L. C. Hoover, L. D. Thompson, and J. B. Boyce

Abstract

Each year, individual Americans consume an average of 5 kg of cantaloupe. Cantaloupe is mainly consumed as fresh fruit during the five-month growing period, June to November. From December to May fresh cantaloupe availability is limited. There is an answer to this shortage. If cantaloupe were transformed into sorbet, consumers would be able to enjoy the freshness and flavor of cantaloupe year-round. Sorbets are primarily made of fruit puree without any dairy product. They are cholesterol and fat free with few calories, which presents wide appeal for those following current trends of "light, fresh, and healthy." Purpose of this study is to 1) determine desired characteristics of cantaloupe sorbet, 2) evaluate customer acceptance of cantaloupe sorbet, and 3) analyze time, labor cost, and amount of waste developed in producing sorbet from four market forms – fresh, chilled, frozen chunks, and frozen puree. Trained panelists found that sorbet made from cantaloupe puree was considered as desirable as that made from fresh cantaloupe. Consumer panelists agreed that sorbet made from frozen cantaloupe puree was perceived as having the same overall quality as that made from fresh cantaloupe. They indicated that 42.3% of customers would be willing to spend $2.00 to $2.99 in a restaurant to order cantaloupe sorbet as a dessert item. As for value analysis, results

suggested that cantaloupe frozen puree was a good choice for use in producing sorbet, with the added incentives of reducing working time, labor cost, and waste.

Key Words: cantaloupe, sorbet, sensory evaluation, consumer, value analysis, dessert.

Introduction

Sorbet is a frozen dessert consisting of sugar syrup and fruit puree, with natural thickening agents occasionally included to increase smoothness and prevent separation. It provides a rich, smooth, creamy product without objectionable fat or dairy ingredients (Hong & Nip, 1990). Fruit sorbets can be the highlight of any elegant dinner table, served as a palate cleanser or as a dessert. Sorbets are made primarily of fresh fruit with no added dairy products. Consumers have discovered something unique in the flavor, taste, body texture, and high water content. In addition, sorbets are cholesterol and fat free, with an average of 110 Calories per 113 g serving. Attributes of sorbets include: 1) use of only fruit puree and fruit pieces, 2) relatively expensive to producte because fresh, frozen, or pureed fruit is used, 3) possibility of production from a wide array of fruits, and 4) their perception by consumers as an upscale product (Stogo, 1998). According to Cleary and Koppenhoefer (2004), in 2002, the total sales of U.S. ice cream and frozen desserts reached $20.5 billion. More than half of these sales ($12.5 billion) were spent on "away from home" frozen dessert purchases, such as in ice cream stores or foodservice facilities.

In restaurants, the highest profit food items are typically desserts; they are considered add-on sales which will increase the customers' average check amounts. Additionally, desserts represent the last opportunity for the chef to impress customers with his/her skills in food preparation. The chef is thus involved in developing a high quality dessert item as the signature offering of the restaurant, resulting in increased sales and thus profits (Eaton, 1982). Restaurant consumers also may like to have something sweet to finish up the whole dining experience, and some may intentionally "save room" for dessert. Therefore, a possible frozen dessert item such as cantaloupe sorbet in the restaurant could satisfy the customer's needs. The cost will likely be higher, however, if fresh sorbet is served rather than a pre-manufactured product. As such a cost reduction method for the in-house preparation of cantaloupe sorbet was investigated. The three objectives of this study were:

1) Determination by a trained panel of characteristics of cantaloupe sorbets prepared from four market forms of cantaloupe (fresh, chilled, frozen, and frozen puree).
2) Determination by a consumer panel of acceptance of these four sorbets.
3) To analyze the time, labor cost, and waste of cantaloupes in making the sorbets from the four market forms.

Literature Review

Sorbet

Sorbets are made from sugar syrup, fruit and/or fruit extracts, citrus juice plus a thickening agent. Typically used ingredients are described below (Stogo, 1998).

Sugar syrup binds the final product together and also aids in promoting a snow-like texture. Main function of the syrup is to contribute to the freezing process, not to sweeten the sorbet. Sugar syrup is made from granulated sugar mixed with water and boiling until the sugar is dissolved and becomes clear syrup. Heavy syrup with a higher sugar-to-water ratio is usually prepared. The heavier the syrup, the longer it takes to freeze the sorbet, and in most cases, the smoother the product. The syrup will lower the freezing temperature of the sorbet and prevent it from turning into a solid ice block.

Fruit puree is used to create a product which approaches public food tastes as closely to fruit as possible. Frozen fresh fruit is ideal for sorbet production in this regard. Generally, a frozen fruit product is expected to have a consistent taste all year long because the fruit is packed and frozen during each growing season. This consistency provides a significant advantage over fresh fruit, which tastes differently depending on the time of the year. Additionally, citrus juice is commonly used to create a good balance of flavors neutralizing sweetness of the syrup and to enhancing flavor of the fruit used. Fresh citrus juices, such as lemon, lime, or orange, are added.

Thickening agents improve product consistency and stabilization. The primary purpose of thickening agents is to produce smoothness in body and texture, reduce ice crystal growth during storage, extend shelf life, and provide uniformity of product and

resistance to melting (University of Guelph, 2005). Fruit consisting mostly of fiber or pulp content requires less stabilization than citrus fruit such as oranges, grapefruits, and limes which are primarily water based. Pulp gives body to the product – the more body there is, the less thickening agent is needed. Examples of thickening agents are locust bean gum, guar gum, and xanthan gum (Stogo, 1990).

Cantaloupe

Cantaloupe is grown in many countries. Economically and practically, cantaloupe is an important crop in the U.S. The U.S. is ranked third in production of cantaloupe and miscellaneous melons, behind only China and Turkey (Economic Research Service, USDA [ERS, USDA], 2003). The U.S. farm value of cantaloupe averaged $401 million per year during 2000-2002. In 2003, the total U.S. cantaloupe crop yielded of 1,059 million kg (ERS, USDA, 2003). The top three cantaloupe-producing states are California, Arizona, and Texas producing 79% of U.S. cantaloupe. Cantaloupe in season is one of the finest and most popular fruits on the American table because of its attractive color, unique flavor, and pleasant taste. Americans consume 5 kg of cantaloupe per capita annually (Texas Department of Agriculture, 2004).

Commonly, cantaloupe is marketed fresh during the primary season of June to November. Because of the unique flavor and attractive color, cantaloupe is mainly consumed as a fresh fruit during the peak-growing season. Cantaloupe can be made into frozen melon balls and is delicious served with a meal or as a dessert. In addition, cantaloupe can also be used in salads, served with smoked meats, or cottage cheese. It is

used in making fruit soups, fruit salads, fruit pies, and fruit punches as well. Of course, cantaloupe ice cream and sorbet are other ways to use cantaloupe. In the U. S., Blue Bell Ice Cream had a cantaloupe flavor ice cream in July 2004 and it was a huge success. Additionally, Haagen-Dazs just announced its cantaloupe flavor ice cream in Asia in the summer of 2005. The successful stories from Blue Bell and Haagen-Dazs may have great impact for the frozen dessert market regarding cantaloupe flavor ice cream.

Value Analysis

Production costs become an important issue when fresh cantaloupe sorbet is prepared in a restaurant. Due mainly to labor costs, the expenses may increase dramatically if the restaurant provides fresh sorbet everyday. A method for increasing product value and reduce cost becomes an important subject, and the concept of value analysis takes on added importance. Value analysis was developed by Lawrence D. Miles at General Electric around 1947 during World War II as an improvement of cost reduction methods (Mehra & Bretz, 1981). Due to war time material shortages, development of alternative methods of production was vital. This "functional analysis" process produced low-cost products without reducing quality. After the war, this system of both removing unnecessary cost from products and improving product design was maintained (Palmer, Kelly, & Male, 1996).

Miles (1972) described value analysis consisting of five basic steps: informational, analysis, creativity, judgment, and development. In the informational stage, information required to understand the product and its function is gathered, but no

interpretation is given at this point. In the analysis stage, the information is interpreted and the necessary function analysis is performed. In the creativity stage, the new knowledge must be added in order to be effective. In the judgment stage, the newly generated idea is evaluated, the cost is re-evaluated, and the final decision is made. In the development stage, the major step lies in convincing the final decision maker of the validity of the new approach, including the steps, which must follow acceptance of the proposed method (Mehra & Bretz, 1981).

Value analysis applied to products assists in the orderly use of better approaches, alternative materials, newer processes, and abilities of particular suppliers. It focuses on engineering, manufacturing, and purchasing with the purpose of consistent performance with lower cost. Use of this problem-solving system in the significant decision stage has resulted in elimination of 15 to 25% of manufacturing costs without any reduction in customer satisfaction (Miles, 2004). In applying value analysis to a product, the first step was to identify the function of the product under careful consideration. Quality of the product was also identified, followed by an examination of alternative methods in order to achieve this function. Finally, the method producing the lowest cost was chosen (Pawar, Forrester, & Glazzard, 1993).

Methodology

Materials and Processing

Forty-six kilograms of cantaloupe (variety: *Mission*) was obtained from a local food distributor in Lubbock, Texas. The cantaloupe was stored at 4° C for 24 hours

before processing. The ingredients of cantaloupe sorbet included: 0.68 kg of cantaloupe, 7 ml of lemon juice, sugar syrup (142 g of sugar and 57 ml of water), and thickening agent (xantahn gum; 0.05% of total weight of the total ingredients).

Four sorbets prepared from market forms (fresh, chilled, frozen chunks, and frozen puree of cantaloupe) were prepared ahead and then packaged in Ziploc®. . Frozen chunks and puree were frozen by Superchill at -21° C for 1.5 hours and then were transferred to -18° C freezer before used. The frozen chunks and frozen puree were thawed in a 4° C refrigerator for 24 hours before being used, and the chilled chunks were processed the day before the sorbet was prepared. The fresh chunks were processed on the day the sorbet was prepared.

Four portions of sugar syrup were prepared and the thickening agent was combined with sugar syrup separately. Syrup along with cantaloupe puree and lemon juice were poured into an ice cream maker. The product was mixed until it began to firm up and look frothy (approximately 20 - 25 minutes). The finished product was extruded into a plastic storage container and then held in a –18° C freezer for storage. Figure 3.1 shows the procedure for preparing cantaloupe sorbet samples.

Trained Sensory Panel

A panel of eight members was selected to evaluate the samples. Panelists were graduate students, faculty, or staff in the College of Human Sciences with varying degrees of sensory evaluation experience. The panelists were trained for at least three

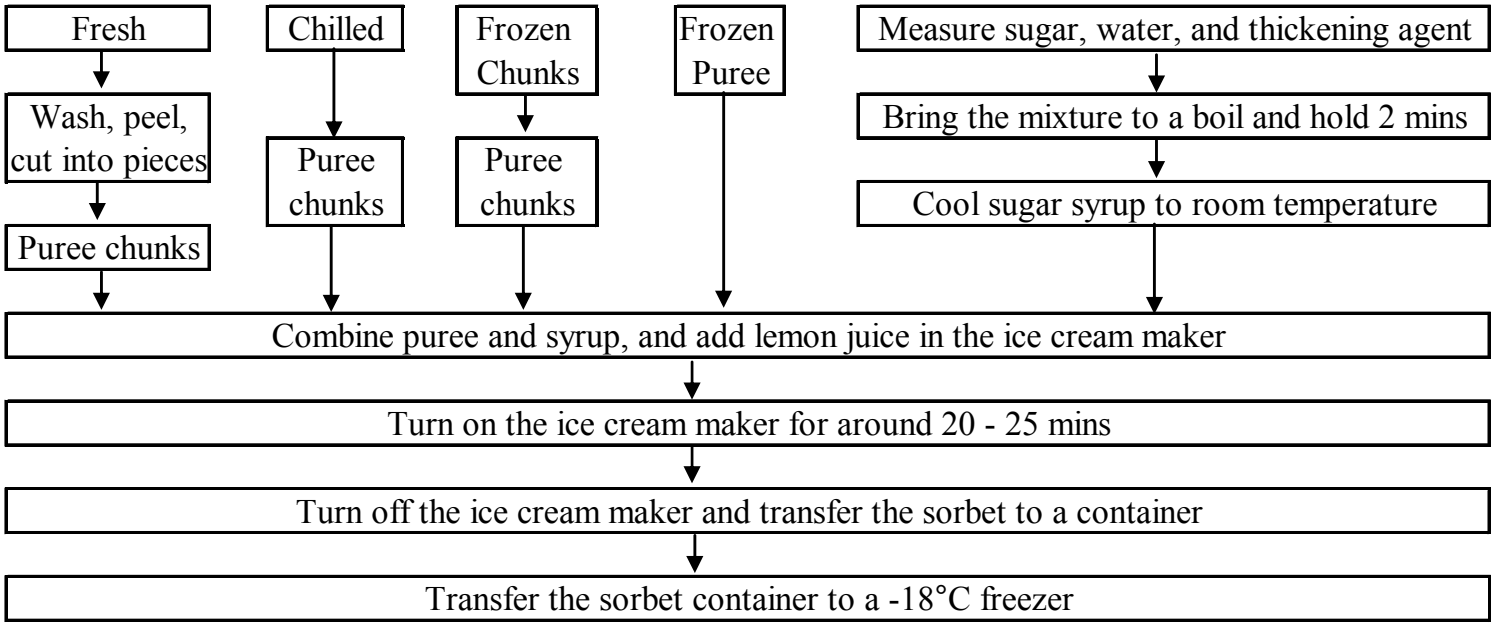

Figure 3.1 Procedure for preparing cantaloupe sorbet samples

hours within a three-day period before being asked to evaluate the sample. They were trained to evaluate the cantaloupe sorbet for color intensity, sweetness, cantaloupe flavor intensity, mouth feel, crystallization, and overall quality (Yamaguchi, Hughes, Yabumoto, & Jennings, 1977; Mutton, Cullis, & Blakeney, 1981; Rosenfeld & Nes, 2000; Moskowitz, 2001; Bett-Garber, Beaulieu, & Ingram, 2002; Guven & Karaca, 2002; Beaulieu, Ingram, Lea, & Bett-Garber, 2004). To achieve consistent results, the panelists discussed their results after tasting each individual sample. When panelists were consistent after training, the sensory evaluation session was conducted. Panelists received a small gift as an incentive.

All panel sessions were conducted in a sensory lab with partitioned booths. Samples were presented separately in 57 ml plastic cups with a lid and served in random order to the panelists. A three-digit code was assigned to each sample to be evaluated. Bottled water and unsalted crackers were provided for rinsing between samples. The panelists were served one sample of sorbet at a time and were instructed to evaluate it individually.

Instrumental Evaluation

Three instrumental evaluations were conducted. Separate samples were prepared for instrument evaluation. Total soluble solids (°Brix) was determined by using a refractometer with model number BRIX 35HP from Leica Microsystems Inc. The pH value of the sample was determined by using a pH meter with model number IQ 150 from Scientific Instruments, Inc. A colorimeter, model number Chroma Meter CR-400

from Konica Minolta Photo Imaging U.S.A., Inc., determined the Hunter L* (brightness), a* (red - green component), and b* (yellow – blue component) value of the sample, and the chromatic attributes: chroma ($C^* = (a^* + b^*)^{1/2}$) and hue angle ($H^* = \tan^{-1} (b^*/a^*)$).

Consumer Panel

Consumer acceptance is vital to the success on developing new products. As part of value analysis, consumer panel sessions were conducted after the trained panel session in order to evaluate a consumer's possible acceptance of the four different cantaloupe sorbets. One-hundred-and-ten consumer panelists were recruited through an e-mail invitation to the study; they were students, faculty, or staff at Texas Tech University. Before conducting the sensory evaluation, the consumers received a short explanation regarding sensory evaluation procedures. Due to the limited space and sample preparation time, consumer sensory sessions were divided into two days. Consumers had up to 30 minutes per session to evaluate four samples. After each session, consumers received a box of chocolate as an incentive.

Consumers evaluated the degree of likeness of the characteristics of cantaloupe sorbets, such as color, sweetness, cantaloupe flavor intensity, mouth feel, crystallization, and overall acceptability with a 9-point hedonic scale (9 = extremely like to 1 = extremely dislike) along with the market-related questions. Schutz's (1965) Food Action Rating Scale was utilized to predict customers' acceptance of the product. Demographic information, which included age, gender, ethnic origin, household income, and education level, was also collected in the survey.

Samples were presented separately in 57ml plastic cups with lids, which were labeled with 3-digit random numbers. Spring water and crackers were provided for rinsing between samples. Samples were thawed at room temperature for about 3 minutes before serving to consumers.

Value Analysis

Value analyses of the four market forms (fresh, chilled, frozen, and frozen puree) were conducted. A detailed procedure of making cantaloupe sorbet is listed in Table 3.1. Kitchen staff of an upscale restaurant followed the procedure in making cantaloupe sorbet from the four market forms. The researcher videotaped the sorbet-making process and recorded the time consumed in each step. Before the experiment, the kitchen staff was instructed to follow detailed procedures and was also asked to weigh the cantaloupe and its waste. The labor cost of making cantaloupe sorbet was determined by rate of pay.

Statistical Analysis

Trained Panel

A complete randomized design (Meilgaard, Civille, & Carr, 1999) was used in this experiment. The Statistical Package for the Social Sciences (SPSS) program was utilized to perform the statistical analysis. analysis of variance was conducted and means were separated by Least Significant Difference (LSD) or Tukey multiple range tests at $p < .05$ (Meilgaard, Civille, & Carr, 1999). Additionally, a correlation statistic was

employed to determine the relationship between the characteristics of the cantaloupe sorbet.

Table 3.1 Standard procedure to make cantaloupe sorbet from fresh cantaloupe

A. Making sugar syrup
1. Weigh 142 g of sugar and 57 ml of spring water.
2. Add thickening agent
3. Put into saucepan and wait until the syrup boils; hold for 2 minutes.
4. Transfer into a small bowl and wait for it to cool to room temperature.
B. Cutting cantaloupe
5. Wash and weigh cantaloupe, cut cantaloupe into chunks, and weigh its waste.
6. Weigh out 0.68 hg cantaloupe chunks.
7. Puree chunks for 1.5 minutes in blander.
C. Making sorbet
8. Prepare 7 ml of lemon juice
9. Put ice and rock salt into outside layer of ice cream maker
10. Put cantaloupe puree, sugar syrup, and lemon juice into the ice cream maker
11. Turn on the ice cream maker and wait for 20-25 minutes
12. Turn the ice cream maker off and transfer sorbet into container, and store it in –18 °C freezer

Consumer panel

The SPSS program was utilized to analyze the data from the consumer panel section. Descriptive and frequency analysis were employed to determine information concerning the distributions of the variables. T-tests were used to compare means to determine whether sufficient evidence existed to infer that the means of the corresponding population distributions also differed. The ANOVA was performed to determine whether a significant difference existed among treatments, LSD and Tukey's multiple range tests at $p < .05$. In addition, correlation and regression statistics were performed to determine the relationship among the characteristics of cantaloupe sorbet.

Value Analysis

Time of production of cantaloupe sorbets from four market forms was measured, and the average time spent in making cantaloupe sorbet by two kitchen employees was determined as well. Total labor costs of producing cantaloupe sorbet in the restaurant were calculated by the rate of pay times average time spent.

Results and Discussion

Trained Panelist Evaluation

Panelists detected significant differences among treatments for the characteristics of color, mouth feel, and overall quality (Table3.2). Panelists determined that the sorbet made from non-frozen sources of cantaloupe (fresh and chilled chunks) were significantly paler than sorbets from frozen sources (frozen chunks and frozen puree)

Table 3.2 Means and standard deviations for trained sensory panelist ratings of cantaloupe sorbet prepared from different market forms.

Treatment	Color[1]	Sweetness[1]	Melon flavor[1]	Crystallization[1]	Mouth feel[1]	Overall quality[1]
Fresh chunks	5.95[a]±.88	7.21±.72	6.63±.98	2.73±.74	6.81[a]±.71	7.03[a]±.79
Chilled chunks	6.17[a]±.89	7.25±.64	6.88±1.03	2.49±.84	7.29[b]±.78	7.37[a]±.93
Frozen chunks	6.65[b]±.80	6.96±.76	6.60±.84	2.73±.68	5.85[c]±1.24	6.32[b]±.96
Frozen puree	6.64[b]±.88	7.05±.93	6.57±.98	2.48±.89	6.91[ab]±.89	7.01[a]±.74

[1]9 = extremely bright, sweet, strong melon flavor, smooth, much crystallization, and good; 1 = extremely pale, cannot detect sweetness, no melon flavor, extremely grainy, no crystallization, and extremely poor.
[a, b, c] Means within a column with different superscripts are different ($p < .05$).
N = number of samples = 252

($p < .05$). An LSD post-hoc test suggested that sorbet made from frozen sources had a brighter, more intense color than sorbet from non-frozen sources. The mouth feel of sorbet made from fresh chunks and frozen puree were similar with slightly smooth to smooth consistency. Mouth feel of the sorbet made from frozen chunks tended to be "neither smooth nor grainy." As for sorbet made from chilled chunks, the panelists indicated the mouth feel was "smooth." An LSD post-hoc test revealed that the sorbet made from frozen chunks was the grainiest of the four. In overall quality, the results suggested that the sorbet made from frozen chunks was significantly lower in quality than the sorbet made from fresh chunks, chilled chunks, and frozen puree ($p < .05$). The results suggested that the sorbet made from fresh chunks, chilled chunks, and frozen puree of cantaloupe received the same overall quality score. As for the remainder of characteristic of the cantaloupe sorbet, which are sweetness, melon flavor intensity, and crystallization, no differences were found among treatments.

Correlation analysis results (Table 3.3) revealed that there was a positive correlation between sweetness and melon flavor intensity ($r = .36$, $p < .01$) which suggests that when the score of sweetness increased, the score of melon flavor increased as well. The relationship between overall quality and sweetness, melon flavor, crystallization, and mouth feel ($r = .42$, $r = .50$, $r = -.20$, $r = .61$, $p < .01$), respectively, indicated that overall quality was positively correlated with sweetness, melon flavor, and mouth feel, and was slightly negatively correlated with increased presence of crystallization.

Table 3.3 Correlations of characteristics of cantaloupe sorbet form trained panel

	Color	Sweetness	Melon flavor	Crystallization	Mouth feel	Overall quality
Color	---	.020	.108	-.104	-.093	.063
Sweetness		---	.358**	-.070	.256**	.416**
Melon flavor			---	-.131	.161**	.495**
Crystallization				---	-.266**	-.191**
Mouth feel					---	.606**
Overall quality						---

** Correlation is significant at the 0.01 level (2-tailed).
N = number of samples = 252

Instrument Evaluation

Results of the instrument evaluation determined that there were significant differences among treatments in the total soluble solids (°Brix), L* value, and hue angle (Table 3.4). Based on results of the total soluble solids, the sorbet made from frozen chunks had less total soluble solids than the others ($p < .05$). This suggested that small cantaloupe pieces might influence total soluble solids of the sorbet and result in significantly lower sweetness among the treatments.

As for the colorimeter evaluation results, in L* value, results suggested that the sorbet made from frozen puree was significantly paler than sorbets from the other three sources ($p < .05$). Sorbets made from fresh chunks, chill chunks, and frozen chunks revealed the same brightness of color. As for the hue angle, the sorbet made from fresh chunks was significantly different from sorbet made from frozen puree ($p < .05$). The sorbet made from frozen puree had the lowest hue angle value. Silva and Chamul (1991) suggested that the freezing and thawing process might result in the loss of β-carotene in frozen cantaloupe. Simandjuntak, Barrett, and Wrolstad (1996) reported the same results for color changes in frozen cantaloupe. β-carotene is responsible for the orange color of cantaloupe, which explains the decreasing of Hue angle in the sorbet made from frozen puree.

Table 3.4 Means and standard deviations for instrument evaluation of cantaloupe sorbet from different market forms.

Treatment	pH value	°Brix	L*	Hue angle	Chroma
Fresh Chunks	5.70±.06	23.13[a]±.64	58.64[a]±2.57	79.22[a]±.99	26.01±1.54
Chilled Chunks	5.72±.06	23.11[a]±.63	60.21[a]±1.45	78.10[ab]±1.41	27.24±1.03
Frozen Chunks	5.61±.15	21.98[b]±.94	57.08[a]±2.25	78.07[ab]±.72	25.97±1.50
Frozen Puree	5.72±.05	22.92[a]±.54	55.22[b]±3.11	77.75[b]±.84	26.45±1.52

[a, b] Means within a column with different superscripts are different ($p < .05$).
N = number of samples = 72

Correlation between Instruments and Panelists

Correlation analysis was employed in order to determine the relationship between the instrument and panelists evaluation. Results suggested that the L* value negatively correlated with the color score from the panelists (r = -.35, p < .05) and the Hue angle value negatively correlated with the color score from the panelists (r = -.40, p < .05) as well. A review of the data revealed that as the L* and Hue angle values increased, the color score from the panelists decreased. No other significant correlation results were found between the instrument results and the panelist results.

Consumer Panelist Evaluation

One-hundred-and-ten consumers participated in the study; 69.1% were female and 30.9% male; more than 50% of the consumers were 21 to 40 years of age. The majority of the participants were White (61.8%) with one large ethnic group - Asian (21.8%). As for income level, under $25,000 represented 47.3% of participants. The results of demographic information are shown in Table 3.5.

Based on frequency analysis, 42.3% of consumers were willing to spend $2.00 - $2.99 in a restaurant to purchase cantaloupe sorbet as a dessert, 27.5 % of customers, as well, would spend $3.00 - $3.99 on cantaloupe sorbet. Results suggested that cantaloupe sorbet in a restaurant setting could provide a potentially profitable product. Additionally, about 87.5% of the consumers revealed a positive intention of consuming cantaloupe sorbet (which included will eat cantaloupe sorbet every opportunity they have, eat cantaloupe sorbet very often, eat cantaloupe sorbet frequently, like cantaloupe sorbet and

Table 3.5 Demographic information of consumer panel participants evaluating different cantaloupe sorbets.

Trait	Category	Number	Percent (%)
Gender			
	Female	76	69.1
	Male	34	30.9
Age			
	Under 21	10	9.1
	21-30	41	37.3
	31-40	22	20
	41-50	20	18.2
	51-60	14	12.7
	Over 60	3	2.7
Ethnicity			
	African American	4	3.6
	American India or Alaskan Native	1	0.9
	Asian or Pacific islander	24	21.8
	Hispanic	9	8.2
	White	68	61.8
	Other	4	3.6
Income level			
	Under $25,000	52	47.3
	$25,000 - $49,999	23	20.9
	$50,000 - $74,999	21	19.1
	Over $74,999	14	12.7
Total		**110**	**100**

will eat it in the future, and will eat cantaloupe sorbet if available). Results suggested that most customers would consume cantaloupe whenever it was available.

Consumer panelists evaluated the degree to which they liked six characteristics (color, sweetness, melon flavor, crystallization, mouth feel, and overall quality) and two market-related questions (price and likely action). The results are listed in Table 3.6. Three differences were found among treatments in the characteristics of color, melon flavor, and overall quality. As for the color, the results revealed that panelists preferred sorbet made from non-frozen sources (fresh and chilled chunks) over sorbets from frozen sources (frozen chunks and frozen puree). The flavor of sorbet made from frozen chunks was liked least and the panelists preferred sorbets made from fresh, chilled chunks, and frozen puree. Consumers indicated that sorbets made from fresh chunks, chilled chunks, and frozen puree had similar overall quality and was preferable to sorbet made from frozen chunks.

As for the price (Table 3.7), no difference was found among treatments, which suggested that any of these four sources of sorbets would receive the same price when served in a restaurant. The mode of price was '2', which represented 42.3% of customers who were willing to spend $2.00-$2.99 in the restaurant to order cantaloupe sorbet as a dessert item. No significant difference was found in the item of likely action as well. The mode of likely action (Table 3.8) were '5' and '6', which suggested that the likely action of 58.2% of the customers were "I like this food and would eat it now and then" and "I would eat this food if available but would not go out of my way."

Table 3.6 Means and standard deviations for consumer sensory panelist ratings of cantaloupe sorbets from different sources.

Treatment	Color[1]	Sweetness[1]	Melon flavor[1]	Crystallization[1]	Mouth feel[1]	Overall quality[1]
Fresh chunks	$7.21^{a}\pm1.38$	6.34 ± 1.68	$6.60^{b}\pm1.88$	6.27 ± 1.78	6.53 ± 1.67	$6.66^{ab}\pm1.56$
Chilled chunks	$7.31^{a}\pm1.35$	6.48 ± 1.82	$6.76^{b}\pm1.6$	6.45 ± 1.54	6.69 ± 1.59	$6.85^{b}\pm1.40$
Frozen chunks	$6.79^{b}\pm1.33$	6.22 ± 1.01	$5.95^{a}\pm2.25$	6.10 ± 1.78	6.24 ± 2.01	$6.05^{a}\pm2.04$
Frozen puree	$7.00^{b}\pm1.44$	6.35 ± 1.06	$6.52^{b}\pm2.01$	6.47 ± 1.96	6.66 ± 1.96	$6.49^{ab}\pm1.99$

[1]9 = like extremely; 1 = dislike extremely

[a, b, c] Means within a column with different superscripts are different ($p < .05$).

N = number of samples = 440

Table 3.7 The frequency of price of consumer panel

Price	Frequency	Percent (%)
$1.00~$1.99	100	22.7
$2.00~$2.99	186	42.3
$3.00~$3.99	121	27.5
Other	33	7.0
Total	440	100

Table 3.8 The frequency of likely action of consumer panel

Likely action	Frequency	Percent (%)
I would eat this only if forced to	6	1.4
I would eat this if there were no other choices	11	2.5
I would hardly ever eat this	18	4.1
I don't like it but would eat it on an occasion	20	4.5
I would eat this food if available but would not go out of my way	132	30.0
I like this food and would eat it now and then	124	28.2
I would eat this food frequently	81	18.4
I would eat this food very often	35	8.0
I would eat this food every opportunity I had	13	3.0
Total	440	100.0

According to Table 3.9, correlation analysis results of the consumer evaluation of cantaloupe sorbet, all of the characteristics of cantaloupe were significantly correlated with each other ($p < .01$). As for the price, it was slightly positively correlated with sweetness, melon flavor, and overall quality of the cantaloupe sorbet (r = .11, r = .10, r = .12, $p < .05$) respectively. These results suggested that sweetness, flavor, and overall quality of cantaloupe sorbet would affect the customers' willingness to pay for sorbet as a dessert in a restaurant. The more they liked the sweetness, flavor, and overall quality of the sorbet, the higher price they were willing to spend. Likely action was significantly correlated with all characteristics of cantaloupe sorbet and the price they were willing to pay ($p < .01$).

A linear regression analysis was employed in order to predict the amount of variance in overall quality of cantaloupe treatments. Stepwise method was utilized because it would remove the "weakened" variable. Sometimes a variable which qualified to enter lost some of its predictive validity when other variables entered the equation. The linear regression equation of the overall quality for consumer evaluation with $R^2 = 0.81$ was listed below:

*Overall Quality = 0.18 + 0.45*flavor + 0.20*mouth feel + 0.19*sweetness +*

*0.15*crystallization*

The R square value indicated that about 81% of the variance in overall quality by the four-predictor variables, which were flavor, mouth feel, sweetness, and crystallization.

Although the overall quality significantly correlated with all characteristics such as color, sweetness, flavor, crystallization, and mouth feel, only four characteristics were

included in the equation, and color was excluded in the equation. The color clearly indicates the taste customers will expect. According to Stommel, Abbott, Saftner, and Camp (2005), in tomato fruit, color has on perception of fruit quality, flavor, juiciness, and overall eating quality. Correlation results (Table 3.9) indicated that color was slightly significantly correlated with overall quality witch suggested that initially, color influenced the customers' decision regarding overall quality of the sorbet. However, after the customers tasted and evaluated the product, color was not as important as it has been. The remainder of characteristics had more influence on overall quality of the sorbet than color.

Value Analysis Evaluation

Value analyses of the four market forms (fresh, chilled, frozen, and frozen puree) were conducted in the restaurant during summer, 2004. Two kitchen staff members followed the procedure to make cantaloupe sorbet from the four market forms, and the entire process was videotaped. Results (Table 3.10 – 3.13) indicated that it took approximately 40 minutes to make the cantaloupe sorbet from 0.68 kg fresh cantaloupe but only 30 minutes to make the same amount of cantaloupe sorbet from 0.68 kg of frozen cantaloupe puree.

The average wages of kitchen staff members was $9.00. In regard to labor costs, the difference of making sorbet from 0.68 kg of fresh cantaloupe and 0.68 kg of frozen cantaloupe puree was $0.90. Additionally, 0.45 kg of cantaloupe waste was obtained from the sorbet made from fresh cantaloupe, and as for the sorbet made from frozen

puree the waste was only an empty plastic bag. This result suggested that frozen cantaloupe puree was an excellent choice for making cantaloupe sorbet in terms of reducing working time, labor cost, and waste in a restaurant.

Table 3.9 The relationship among characteristics of cantaloupe sorbet and price and likely action from customer.

	Color	Sweetness	Flavor	Crystallization	Mouth feel	Overall quality	Price	Action
Color	---	.313(**)	.306(**)	.390(**)	.352(**)	.341(**)	-.028	.210(**)
Sweetness		---	.741(**)	.437(**)	.498(**)	.743(**)	.110(*)	.545(**)
Flavor			---	.479(**)	.545(**)	.840(**)	.104(*)	.597(**)
Crystallization				---	.715(**)	.628(**)	.080	.387(**)
Mouth feel					---	.688(**)	.020	.460(**)
Overall quality						---	.115(*)	.650(**)
Price							---	.149(**)
Action								---

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N = number of samples = 440

Table 3.10 Value analysis of cantaloupe sorbet – from fresh cantaloupe

Procedures	Staff 1[1]	Staff 2[1]	Average[1]
A. Making sugar syrup	4:30	5:00	4:45
1. Weigh 142 g of sugar and 57 ml of spring water.			
2. Add thickening agent			
3. Put into saucepan and wait until the syrup boils; hold for 2 minutes.			
4. Transfer into a small bowl and wait for it to cool to room temperature.			
B. Cutting cantaloupe	7:30	8:10	7:50
5. Wash and weight cantaloupe, cut cantaloupe into chunks, and weight its waste.			
6. Weigh out 0.68 kg cantaloupe chunks.			
7. Puree chunks for 1.5 minutes.			
C. Making sorbet	26:00	27:40	26:50
8. Prepare 7 ml of lemon juice			
9. Put ice and rock salt into outside layer of the ice cream maker			
10. Put cantaloupe puree, sugar syrup, and lemon juice into the ice cream maker			
11. Turn on the ice cream maker and wait for 20-25 minutes			
12. Turn off the ice cream maker and transfer sorbet into container, and store it in –18 °C freezer			
Total time spent	**38:00**	**40:50**	**39:50**
Total labor cost	**0.40 * $9.00 = $3.60**		
Waste	**1 lb of rind and seed from fresh cantaloupe**		

[1]: min:sec

Table 3.11 Value analysis of cantaloupe sorbet – from chilled cantaloupe

Procedures	Staff 1[1]	Staff 2[1]	Average[1]
A. Making sugar syrup	4:00	4:40	4:20
1. Weigh 142 g of sugar and 57 ml of spring water.			
2. Add thickening agent			
3. Put into saucepan and wait until the syrup boils; hold for 2 minutes.			
4. Transfer into a small bowl and wait for it to cool to room temperature.			
B. Puree cantaloupe chunks	2:20	3:00	2:40
5. Puree chunks for 1.5 minutes.			
C. Making sorbet	26:00	27:00	26:30
6. Prepare 7 ml of lemon juice			
7. Put ice and rock salt into outside layer of the ice cream maker			
8. Put cantaloupe puree, sugar syrup, and lemon juice into the ice cream maker			
9. Turn on the ice cream maker and wait for 20-25 minutes			
10. Turn off the ice cream maker and transfer sorbet into container, and store it in –18 °C freezer			
Total time spent	**32:20**	**34:40**	**33:30**
Total labor cost	**0.34 * $9.00 = $3.06**		
Waste	**An empty plastic bag**		

[1]: min:sec

Table 3.12 Value analysis of cantaloupe sorbet – from frozen chunks of cantaloupe

Procedures	Staff 1[1]	Staff 2[1]	Average[1]
A. Making sugar syrup	3:40	4:20	4:00
1. Weigh 142 g of sugar and 57 ml of spring water.			
2. Add thickening agent			
3. Put into saucepan and wait until the syrup boils; hold for 2 minutes.			
4. Transfer into a small bowl and wait for it to cool to room temperature.			
B. puree cantaloupe chunks	2:00	3:00	2:30
5. Puree chunks for 1.5 minutes.			
C. Making sorbet	25:30	27:00	26:15
6. Prepare 7 ml of lemon juice			
7. Put ice and rock salt into outside layer of the ice cream maker			
8. Put cantaloupe puree, sugar syrup, and lemon juice into the ice cream maker			
9. Turn on the ice cream maker and wait for 20-25 minutes			
10. Turn off the ice cream maker and transfer sorbet into container, and store it in –18 °C freezer			
Total time spent	**31:10**	**34:20**	**32:45**
Total labor cost	**0.33 * $9.00 = $2.97**		
Waste	**An empty plastic bag**		

[1]: min:sec

Table 3.13 Value analysis of cantaloupe sorbet – from frozen puree of cantaloupe

Procedures	Staff 1[1]	Staff 2[1]	Average[1]
A. Making sugar syrup	3:40	4:20	4:00
1. Weigh 5 ounces of sugar and 2 ounces of spring water.			
2. Add thickening agent			
3. Put into saucepan and wait until the syrup boils; hold for 2 minutes.			
4. Transfer into a small bowl and wait for it to cool to room temperature.			
B. Making sorbet	25:00	26:00	25:30
5. Prepare 0.25 ounce of lemon juice			
6. Put ice and rock salt into outside layer of the ice cream maker			
7. Put cantaloupe puree, sugar syrup, and lemon juice into the ice cream maker			
8. Turn on the ice cream maker and wait for 20-25 minutes			
9. Turn off the ice cream maker and transfer sorbet into container, and store it in –18 °C freezer			
Total time spent	**28:40**	**30:20**	**29:30**
Total labor cost	**0.30 * $9.00 = $2.70**		
Waste	**An empty plastic bag**		

[1]: min:sec

References

Beaulieu, J. C., Ingram, D. A., Lea, J. M., & Bett-Garber, K. L. (2004). Effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe. *Journal of Food Science, 69*, S250-S258.

Bett-Garber, K. L., Beaulieu, J. C., & Ingram, D. A. (2002). Effect of storage on sensory properties of fresh-cut cantaloupe varieties. *Journal of Food Quality*, *26,* 323-335.

Cleary, M., & Koppenhoefer, K. (2004). Just the facts: Ice cream sales and trends. Retrieved September 22, 2004, from IDFA website: http: www.idfa.org/facts/icmonth/page2.cfm.

Eaton, W. (1982). Profitable chilled desserts are easy to make and serve. *Foodservice Marketing*, *10,* 62-63, 67.

Economic Research Service, USDA (2003). Commodity highlight: Cantaloupe. Retrieved June 1, 2005, from Vegetables and Melon Outlook, USDA web site: http://www.ers.usda.gov/Briefing/Vegetables/vegpdf/cantaloupHigh.pdf

Guven, M., & Karaca, O. B. (2002). The effects of varying sugar content and fruit concentration on the physical properties of vanilla and fruit ice-cream-type frozen yogurts. *International Journal of Dairy Technology*, *55*(1), 27-31.

Hong, G. P., & Nip, W. K. (1990). Functional properties of precooked Taro flour in sorbet. *Food Chemistry, 36,* 261-270.

Mehra, S., & Bretz, R. W. (1981). Value analysis: A technique for implementing systems thinking in the organization. *The Institute of Management Sciences, 11*(2), 48-52.

Meilgaard, M., Civille, G. V, & Carr, B. T. (1999). *Sensory Evaluation Techniques* (3rd ed.). New York: CRC Press.

Miles, L. D. (1972). *Techniques of value analysis and engineering* (2nd ed.). New York: McGraw-Will, Inc.

Miles, L. D. (2004). What is value engineering? Retrieved March 14, 2004, from Miles Value Engineering Reference Center Web Site: http://www.wisc.edu/wendt/miles

Moskowitz, H. (2001). Learning from the competition through category appraisal: One practitioner's keys to faster and more efficient product development. *Food Service Technology, 1*, 103-118.

Mutton, L. L., Cullis, B. R., & Blakeney, A. B. (1981). The objective definition of eating quality in rockmelons (*Cucumis melo*). *Journal of the Science of Food and Agriculture, 32*, 385-391.

Palmer, A., Kelly, J., & Male, S. (1996). Holistic appraisal of value engineering in construction in United States. *Journal of Construction Engineering and Management, 12,* 324-328.

Pawar, K., Forrester, P., & Glazzard, J. (1993). Integrated manufacturing systems. *Bradford*, *4*(3), 14-22.

Rosenfeld, H., & Nes, A. (2000). Prediction of sensory quality of strawberry jam by means of sensory quality attributes of fresh fruit. *Journal of the Science of Food and Agriculture, 80,* 1895-1902.

Schultz, H. (1965). A food action scale for measuring food acceptance. *Journal of Food Science, 30*, 365-374.

Silva, J. L., & Chamul, R. S. (1991). Yield, color and sensory attributes of pasteurized watermelon juice. *Journal of Food System, 6*, 141–146.

Simandjunak, V., Barrett, D. M., & Wrolstad, R. E. (1996). Cultivar and frozen storage effects on Muskmelon (*Cucumis melo*) colour, Texture and cell wall polysaccharide composition. *Journal of the Science of Food and Agriculture, 71*(3), 291-296.

Stogo, M. (1990). *Frozen desserts – A complete retailer's guide*. New York: Van Nostrand Reinhold.

Stogo, M. (1998). *Ice cream and frozen desserts – A commercial guide to production and marketing.* New York: John Wiley & Sons, Inc.

Stommel, J., Abbott, J. A., Saftner, R. A., & Camp, M. J. (2005). Sensory and objective quality attributes of Beta-carotene and Lycopene-rich tomato fruit. *Journal of the American Society for Horticultural Science, 130,* 244-251.

Texas Department of Agriculture (2004). Cantaloupe season. Retrieved December 10, 2004, from Texas Department of Agriculture web site: http://www.agr.state.tx.us/education/tips/com_cantaloupe.htm.

University of Guelph (2005). Ingredients. Retrieved March, 30, 2005, from University of Guelph Web site: www.foodsci.uoguelph.ca/dairyedu/icingr.html.

Yamaguchi, M., Hughes, D. L., Yabumoto, K., & Jennings, W. G. (1977). Quality of cantaloupe muskmelons: Variability and attributes. *Scientia Horticulturae*, *7*, 59-70.

CHAPTER IV

SHELF LIFE OF CANTALOUPE PUREE AND CONVENIENCE METHOD OF PRODUCING CANTALOUPE SORBET IN A RESTAURANT

Prepared for Journal of Food Science

Y. Shih, L. C. Hoover, L. D. Thompson, and C. Wu

Abstract

Due to its refreshing taste, smooth consistency, and fat-free content, cantaloupe sorbet could easily become a popular new dessert item in restaurants. It would generate special appeal for Americans, who have become increasingly aware of health and weight issues. Determining shelf life of cantaloupe puree is of utmost importance in view of the long off-season – seven months during which fresh cantaloupe is unavailable – and because of the importance of ensuring eating quality of the sorbet throughout the year. Another important consideration is determination of the production costs involved in preparation of the product. Frozen cantaloupe purees with and without sugar syrup were tested in this study, the purpose of which was to determine a convenient method for producing cantaloupe sorbet, along with determination of the puree's shelf life. The results indicated that no difference was found between treatments (purees with and without sugar syrup) but the color intensity would be affected by the storage period. Therefore, cantaloupe puree with sugar syrup clearly is the better ingredient for producing high-quality sorbet during off-season.

Key words: cantaloupe, sorbet, shelf life, and sensory evaluation.

Introduction

Attractive color, unique composition, and pleasant flavor have made in-season cantaloupe one of the tastiest and most popular fruits on the American table. Cantaloupe is a very important crop in the United States (U.S.); typical Americans consume 5 kg a year (Texas Department of Agriculture, 2004). In the U.S., most cantaloupes are consumed as fresh fruit because of the five-month growing season, June to November. Cantaloupe can be made into frozen melon balls and served as a dessert. It also has become the foundation of soups, fruit salads, fruit punches, cantaloupe ice cream and sorbet.

Sorbet is made of sugar syrup and fruit puree; it is a rich, smooth, and creamy product without dairy ingredients (Hong & Nip, 1990). Fruit sorbets are served as a palate cleanser between main courses or as a dessert to serve as the climax of the meal. Consumers discover a unique quality in sorbets: a combination of flavor, taste, body, and texture. Sorbets are made primarily of fresh fruit without dairy products; they are cholesterol and fat free with an average of 110 calories per 113 g serving (Stogo, 1998). Making sorbet from cantaloupe is an excellent idea because this combines two qualities American's favor – cantaloupe and frozen dessert. Cantaloupe is a very good source of vitamins A and C, potassium, and dietary fiber, providing nutritional value and refreshing taste as a fat-free, low-calorie frozen dessert (Galeb, Wrolstad, & McDaniel, 2002).

Some restaurants serve sorbet as their "chef's signature dessert" to attract customers (Stogo, 1990). According to Shih, Hoover, Thompson, and Boyce (2005), 42.3% of customers were willing to spend $2.00 - $2.99 to order cantaloupe sorbet as a

dessert. Economically, it is wise to offer cantaloupe sorbet in a restaurant because dessert is the highest-profit food item on the menu. In addition, convenience is very important in terms of making a sorbet in a restaurant. It takes time, space, and labor to prepare sugar syrup. Shih, Hoover, Thompson, and Boyce (2005) determined that the most efficient method of cantaloupe sorbet preparation is to make the cantaloupe sorbet from frozen cantaloupe puree. This sorbet presented the same eating quality as product made from fresh cantaloupe. In addition, because cantaloupe is a seasonal fruit, cantaloupe puree can be made during peak-season and preserved for use in the off-season. Because knowledge of the shelf life of frozen cantaloupe puree is necessary to ensure the quality and safety of the product. The purpose of this study was two fold: first, to determine the quality of sorbet prepared from two frozen cantaloupe puree products – puree with sugar syrup or puree without sugar syrup. A second purpose was to examine the frozen shelf-life of the two pureed products by determine the quality of sorbets prepared from the products after storage intervals up to 180 days.

Literature Review

Cantaloupe

Cantaloupe belongs to a large family of tender, trailing annual vines, very similar to cucumbers. It has large leaves, tender prickly stems, and small, yellow flowers. Cantaloupe matures in 35 to 55 days from full bloom. Sugar content is the principal measure of maturity and an important aspect of fresh cantaloupe's quality (Galeb, 1994; Wagner, Dainello, & Parson, 2001; Unite States Department of Agriculture, 2003).

Optimum temperature for the storage of cantaloupes is 2.2°C - 5°C, and storage life is up to 21 days at 2.2°C; although, sensory quality may be reduced. Typically 12 – 15 days of shelf life are attainable while manutaining good quality (Wagner, Dainello, & Parson, 2001; Suslow, Cantwell, & Mitchell, 2002; Peet, 2002).

Fresh-cut cantaloupe and other fruits are rapidly growing segments of the food service industry and supermarkets (Anonymous, 1998) because today's consumers are looking for convenient food products. According to Vance Research Services and Market Facts Incorporated (1990), 21% to 36% customers have had the experience of purchasing fresh-cut melons. Several studies (O'Connor-Shaw, Roberts, Ford, & Nottingham, 1994; Ayhan & Chism, 1998; Portela & Cantwell, 2001, Bett-Garber, Beaulieu, & Ingram, 2002) have investigated the shelf life of fresh–cut melons. Melons are usually frozen to extend their shelf life so that they may be served during the off-season, although frozen melons are subject to damage which leads to a decrease in eating quality. Sensory qualities such as color, texture, and flavor are studied in order to increased the level of customer satisfaction concerning frozen products (Simandjuntak, Barrett, & Wrolstad, 1996; Rosenfeld & Nes, 2000; Park, 2004). Galeb, Wrolstad, and McDaniel (2002) studied the quality of cantaloupe juice concentrate which determined the difference between cantaloupe juices obtained from flesh and rind and juices from flesh only. Beaulieu, Ingram, Lea, and Bett-Garber (2004) studied the effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe which suggested that ¼-slip cantaloupe were not mature enough to optimize sensory attributes, such as sweetness, flavor, texture, and moisture.

Compared to these methods of consuming cantaloupe, cantaloupe puree has not been thoroughly studied. This can be produced during the peak-season and frozen for use throughout the year. There is no study which focuses on utilizing cantaloupe puree to create a value-added product. Cantaloupe puree can be made into ice cream, sorbet, frozen-bars, sauce, soup and so on, and it is clearly apparent that more study is needed in this area.

Methodology

Materials and Processing

Cantaloupe (variety: *Mission*) was obtained from a local food distributor in Lubbock, Texas. The cantaloupe was stored at 4° C for 24 hours before processing. The cantaloupes were washed, peeled, seeded, and cut up. In each replication, ten 0.68 kg batches of cantaloupes were pureed (there were three replications in this study). The thickening agent was added to five cups of sugar syrup which were mixed into five bags of puree before the puree was bagged. Then, these ten bags of puree were frozen to -18° C using a rapid immersion freezing method; five bags were cantaloupe puree only and the other five were cantaloupe puree with sugar syrup. When the temperature was achieved, the samples were transferred into a –18° C chest freezer for at least 24 hours before experiments were conducted. The ingredients of cantaloupe sorbet included: 0.68 kg of cantaloupe, 7 ml of lemon juice, sugar syrup (142 g of sugar and 57 ml of water), and a thickening agent (xantahn gum; 0.05% of total weight of the total ingredients).

Sorbets prepared from the frozen puree that were stored frozen one day, seven days, 30 days, 90 days, and 180 days. At each sampling trial, one set of cantaloupe puree (two bags; one with sugar syrup and one without sugar syrup) (with three replications) was thawed in a 4° C refrigerator for 24 hours before use. For the puree without syrup, separate sugar syrup was prepared. Puree and syrup were poured into the ice cream maker, and 7 ml of lemon juice was added. For the puree with syrup, the mixture was poured into the ice cream maker, and 7 ml of lemon juice were added. Next, the ice cream maker was turned on. As the mixture started to firm up and look frothy, the ice cream maker was turned off. The approximate time spent was 20 - 25 minutes. The finished product was extruded into a storage box and transferred to a –18° C freezer. Figure 4.1 shows the unit procedure for preparing cantaloupe sorbet samples.

Trained Sensory Panel

A panel of eight members was selected to evaluate the samples. Panelists were graduate students, faculty, or staff in the College of Human Sciences with varying degrees of sensory evaluation experience. They were trained for at least three hours within a three-day period as preparation for the evaluation process. They were trained to evaluate the characteristics of the cantaloupe sorbet for color intensity, sweetness, cantaloupe flavor intensity, mouth feel, crystallization, and overall quality (Yamaguchi, Hughes, Yabumoto, & Jennings, 1977; Mutton, Cullis, & Blakeney, 1981; Rosenfeld & Nes, 2000; Moskowitz, 2001; Bett-Garber, Beaulieu, & Ingram, 2002; Guven & Karaca, 2002; Beaulieu, Ingram, Lea, & Bett-Garber, 2004).

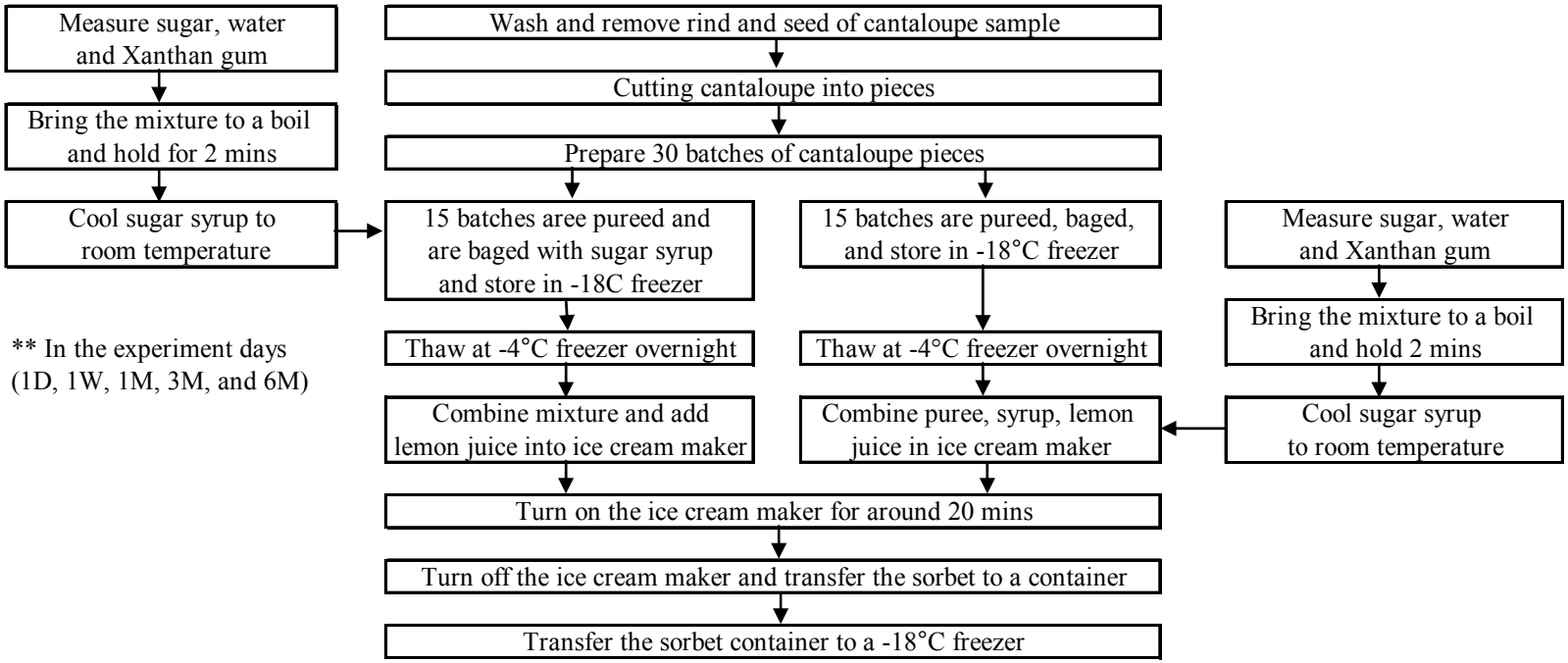

Figure 4.1. Procedure for preparing cantaloupe sorbet samples

To achieve consistent results, the panelists discussed their results after tasting each individual sample. When panelists reached agreement on each characteristic, the sensory evaluation session was conducted. Panelists received a small gift as an incentive. The trained panelists re-evaluated the finished product one day, one week, one month, three months and six months later. In the experiments conducted at three and six months, the panelists were re-trained in order to refresh their memory before conducting evaluation.

All panel sessions were conducted in a sensory panel room with partitioned booths. Samples were presented separately in 2-ounce plastic cups with lids and served in random order to the panelists. A three-digit code was assigned to each sample to be evaluated by panelists. Spring water and crackers were provided for rinsing between samples. The panelists were served one sample of sorbet at a time and were instructed to evaluate it individually.

Instrumental Evaluation

Separate samples were prepared for instrument evaluation for three instrumental evaluations. The total soluble solids (°Brix) was determined by using a refractometer with model number BRIX 35HP from Leica Microsystems, Inc. The pH value of the sample was determined by using a pH meter with model number IQ 150 from Scientific Instruments, Inc. A colorimeter, model number Chroma Meter CR-400 from Konica Minolta Photo Imaging U.S.A., Inc., determined the Hunter L* (brightness), a* (red -

green component), and b* (yellow – blue component) value of the sample, and the chromatic attributes: Chroma ($C^* = (a^* + b^*)^{1/2}$) and hue angle ($H^* = \tan^{-1} (b^*/a^*)$).

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) program was utilized to perform the statistical analysis. Means of the main effects, and interactions were separated by LSD multiple range test (Geoffrey, 1991) at $p < .05$. Additionally, a correlation statistic was employed to determine the relationship among the characteristics of cantaloupe sorbet.

Results and Discussion

Trained Panelist

Panelists evaluated cantaloupe sorbet for color intensity, sweetness, cantaloupe flavor intensity, mouth feel, crystallization, and overall quality (Table 4.1). No interaction between treatments (purees with and without sugar syrup) and storage period was found for all the characteristics of cantaloupe sorbet. No treatment effect was found in the study, but the storage affect was apparent ($p < .05$). These results suggested that there was no significant difference between cantaloupe puree with and without sugar syrup during six months of storage time. However, product quality was altered during storage. With color and overall quality of cantaloupe sorbet ($p < .05$) being affected. As for the other characteristics of cantaloupe sorbet, which were melon flavor, mouth feel,

Table 4.1 Means and standard deviations of trained sensory panelist ratings of cantaloupe sorbets prepared from two frozen puree products in six month storage period.

Storage period (day)	Treatment	Color[1]	Sweetness[1]	Melon flavor[1]	Crystallization[1]	Mouth feel[1]	Overall quality[1]
1	With syrup	6.26[a]±1.05	7.19±.80	6.38±.83	3.88±1.31	6.30±1.01	6.17[a]±.57
	Without syrup	6.08[a]±1.09	6.90±1.06	6.34±.75	3.24±1.24	6.36±1.15	6.22[a]±.82
7	With syrup	6.10[a]±1.06	7.01±.85	6.44±.60	3.33±.93	6.50±.93	6.36[a]±.73
	Without syrup	6.37[a]±1.08	6.90±.58	6.63±.81	3.60±1.26	6.27±1.12	6.46[ab]±.60
30	With syrup	6.32[a]±.72	7.35±.84	6.73±.78	3.56±1.06	6.67±.98	7.01[b]±.88
	Without syrup	6.30[a]±.84	7.31±.82	6.67±.95	3.77±1.25	6.63±.83	6.84[b]±.92
90	With syrup	6.93[b]±.92	7.31±.76	6.47±1.02	3.04±1.29	6.77±.98	6.96[b]±.99
	Without syrup	6.53[ab]±.87	7.10±1.05	6.36±.99	3.36±1.40	6.49±1.10	6.58[ab]±.97
180	With syrup	7.28[b]±.74	7.22±.86	6.79±.82	3.53±.85	6.62±.95	6.53[a]±.96
	Without syrup	6.84[b]±.72	7.20±.78	6.77±.85	3.30±.86	6.66±.86	6.94[b]±.92

[1]9 = extremely bright, sweet, strong melon flavor, smooth, much crystallization, and good; 1 = extremely pale, cannot detect sweetness, no melon flavor, extremely grainy, no crystallization, and extremely poor.
[a, b, c, d] Means followed by different letters were different for day.
N = number of samples = 210

and crystallization, the panelists detect no differences in sorbets prepared from the frozen puree treatment.

Although a contrast was found in the first month of the sorbet made from cantaloupe puree without sugar syrup, the color intensity was significantly increased during the one month to three-month period, and continued to increase in the sixth month. In the sorbet made from cantaloupe puree with sugar syrup, color intensity was somewhat lower in the first week of storage time, and then increased significantly from the first to the sixth month (Figure 4.2). The panelist results revealed that the longer the storage period, the brighter the color of cantaloupe sorbet.

As for the overall quality of the cantaloupe sorbet, results suggested that the eating quality of the sorbet made from cantaloupe puree without sugar syrup reached the first high point in the first month, then dropped in the third month, and then went back to the second high point. In the sorbet made from the cantaloupe puree with sugar syrup, however, eating quality reached the highest point in the first month, and then continued to drop in the other two study periods (Figure 4.3). After one month of storage period, both cantaloupe sorbets received the highest score from the panelists and both decreased in the third month of storage period. In the sixth month, however, score of the sorbet made from cantaloupe puree without sugar syrup increased while the sorbet made from cantaloupe puree with sugar syrup decreased.

Results of the relationship between each characteristic of cantaloupe sorbet are shown in Table 4.2. For example, correlation analysis revealed that a positive correlation between sweetness and melon flavor ($r = .41$, $p < .01$) which suggested that when the

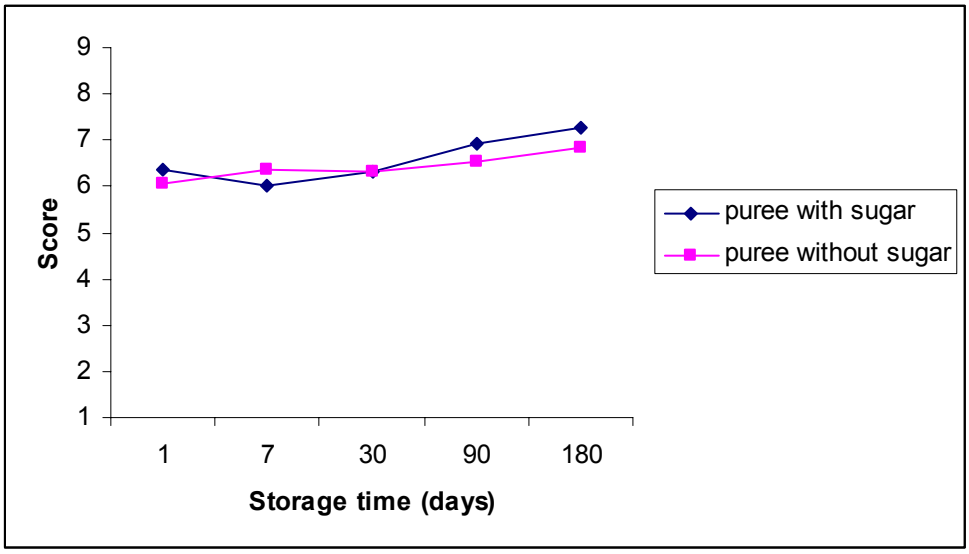

Figure 4.2 Relationship of storage time and panelist evaluated results of color intensity of cantaloupe sorbet.

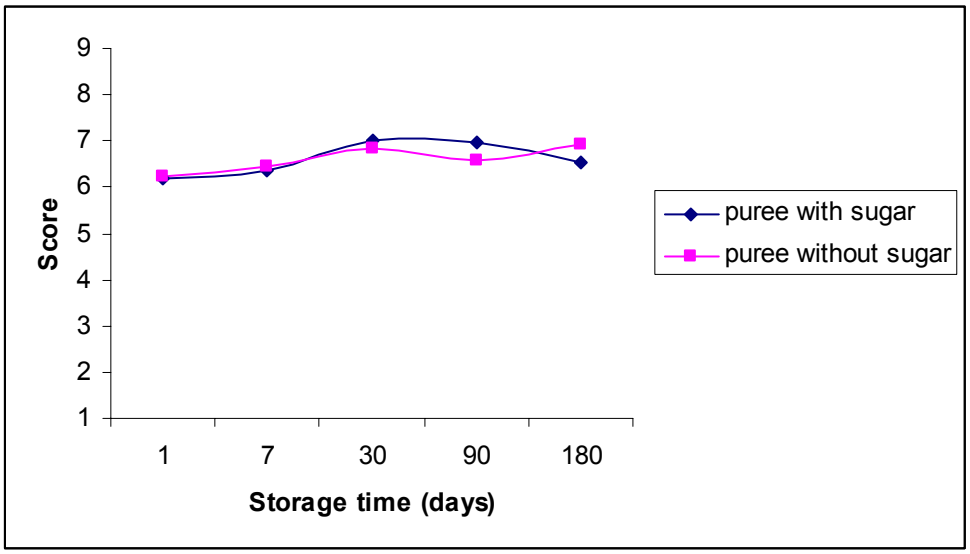

Figure 4.3 Relationship of storage time and panelist evaluated results of overall quality of cantaloupe sorbet.

Table 4.2 Correlations of the characteristics of cantaloupe sorbet

Characteristics	Color	Sweetness	Flavor	Crystallization	Mouth feel	Overall Quality
Color	----	.197	.393**	.166	-.026	.191
Sweetness		----	.412**	-.033	.359**	.514**
Flavor			----	.222*	.138	.423**
Crystallization				----	-.533**	-.350**
Mouth feel					----	.712**
Overall quality						----

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N = number of samples = 210

score of sweetness increased, the score of melon flavor increased as well. The relationship between overall quality and sweetness, melon flavor, crystallization, and mouth feel (r = .51, r = .42, r = -.35, r = .71, $p < .01$), respectively, indicated that overall quality positively correlated with sweetness, melon flavor, and mouth feel, and was slightly negatively correlated with crystallization. When the score of sweetness, flavor, and mouth feel increased, the overall quality also increased. When the score of crystallization increased, overall quality decreased.

Instrument Evaluation

The pH value, total soluble solids (°Brix), L* value, Hue angle, and Chroma were determined by instrument evaluation (Table 4.3) Treatment and date interaction was determined in the attributes of the L* value and Hue angle value ($p < .05$). As for main effect, during the storage time, the Chroma was decreased ($p < .05$); but, no difference was found between the two treatments. No interaction or main effects were found in the pH value and total soluble solids.

As for the brightness (L*) of cantaloupe sorbet, the results indicated that the L* value of sorbet made from the cantaloupe puree without sugar syrup shifted between 58 and 60. The L* value did not decrease during the storage period. In the sorbet made from the cantaloupe puree with sugar syrup, the L* value was significantly decreased after the first month. These results suggested that the L* value of sorbet made from the cantaloupe puree without sugar syrup did not have a significant change during the six months of storage time. On the other hand, the L* value of the sorbet made from the

Table 4.3 Means and Standard Deviations for the instrument evaluation of two different cantaloupe sorbets in six months

Storage period (days)	Treatment	pH value	°Brix	L* value	Hue angle (°)	Chroma
1	With syrup	5.43±.12	22.10±.41	59.29[a]±.90	77.71[a]±.53	28.88[ab]±1.61
	Without syrup	5.46±.13	22.26±.51	60.35±1.23	78.22±.57	29.87[a]±1.36
7	With syrup	5.31±.08	22.21±.40	57.16[b]±1.58	77.86[a]±.89	28.24[ab]±1.22
	Without syrup	5.37±.09	22.16±.23	58.27±1.46	77.56±.86	28.35[a]±1.67
30	With syrup	5.34±.08	22.94±.53	59.61[*a]±1.33	78.25[a]±1.12	30.29[a]±1.06
	Without syrup	5.33±.19	22.67±.54	61.32±1.30	77.98±.33	29.25[a]±1.36
90	With syrup	5.46±.14	22.20±.33	55.23[*b]±1.29	78.10[a]±1.27	27.58[b]±1.44
	Without syrup	5.33±.19	22.53±.34	59.17±1.66	77.49±.65	28.81[a]±2.07
180	With syrup	5.43±.10	22.56±.50	54.11[*b]±1.90	76.90[*b]±.73	24.80[c]±1.39
	Without syrup	5.44±.12	22.50±.31	59.94±1.56	78.12±.92	25.97[b]±2.24

[*] Means within treatments are different.

[a, b, c, d] Means followed by different letters are different for day.

N = number of samples = 30

cantaloupe puree with sugar syrup decreased significantly after one month of storage (Figure 4.4).

As for the hue angle of cantaloupe sorbet, results indicated that the he angle of the sorbet made from the cantaloupe puree without sugar syrup shifted between 76 to 78. Like the L* value, the he angle did not decrease during the storage period. In the sorbet made from the cantaloupe puree with sugar syrup, however, the he angle was significantly decreased after the third month. Results suggested that the he angle of sorbet made from the cantaloupe puree without sugar syrup did not change significantly during the six months of storage time. However, the he angle of the sorbet made from the cantaloupe puree with sugar syrup decreased significantly after three months of storage time (Figure 4.5). Sliva and Chamul (1991) suggested that the freezing and thawing process may have resulted in the loss of β-carotene in frozen cantaloupe. β-carotene is responsible for the orange color of cantaloupe, which explains the significant decrease of the Hue angle in the sorbet made from frozen puree.

As for croma, results suggested that both sorbets tended to decrease in croma value during the six months of storage time. The value of the sorbet made from the cantaloupe puree without sugar syrup decreased significantly in the third month, while the sorbet made from the cantaloupe puree with sugar syrup decreased significantly after a one-month storage period (Figure 4.6).

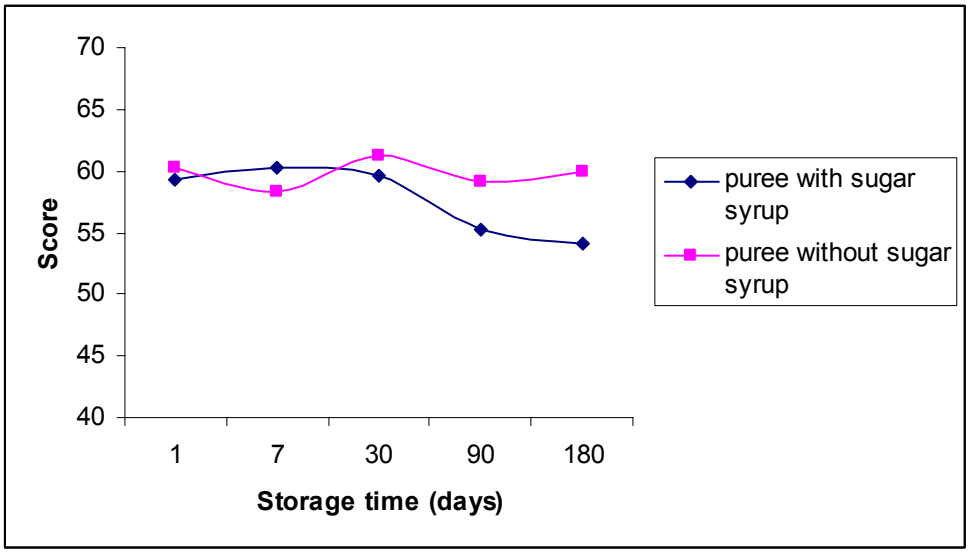

Figure 4.4 Relationship of storage time and instrumental results of the L* value of cantaloupe sorbet.

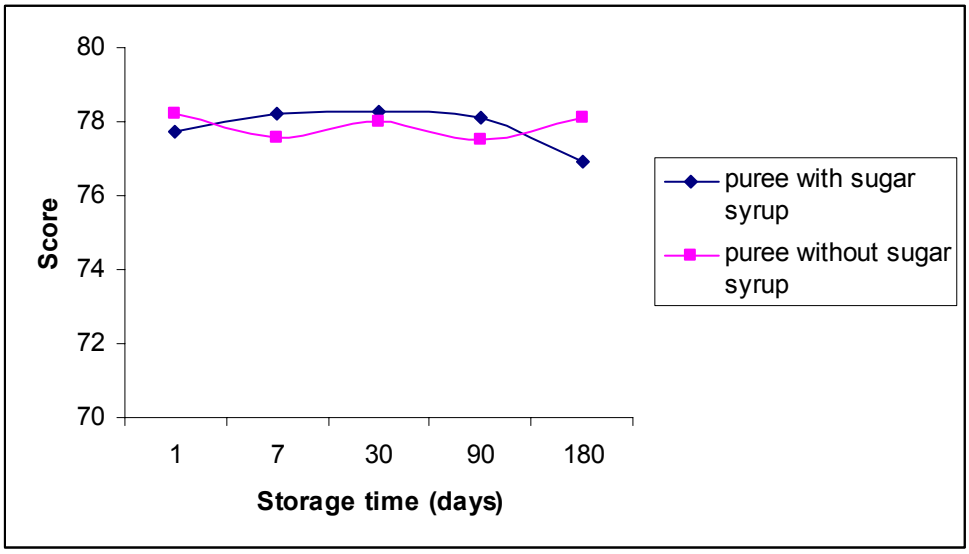

Figure 4.5 Relationship of storage time and instrumental results of the hue angle of cantaloupe sorbet.

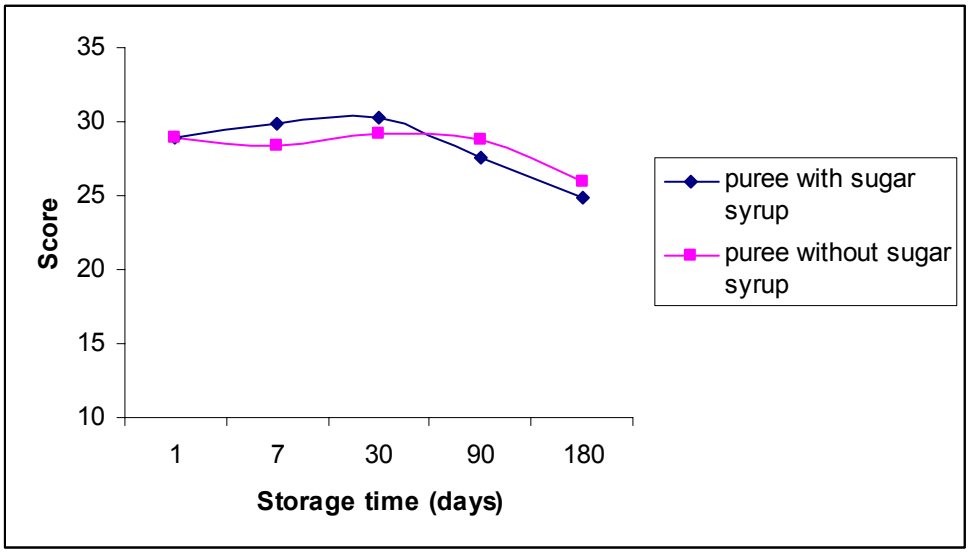

Figure 4.6 Relationship of storage time and instrumental results of the chroma of cantaloupe sorbet.

Correlation between Instruments and Panelists

Correlation analysis was employed in order to determine the relationship between the instrument and panelists evaluation. Results (Table 4.3) suggested that the total soluble solids were positively correlated with the characteristic of sweetness score from the panelists ($r = .34$, $p < .01$), which indicated when the total soluble solids value increased, since sweetness score from the panelists increased as well. In addition, the L* value, Hue angle, and Chroma were negatively correlated with the color score from panelists results ($r = -.41$, $r = -.26$, $r = -.42$, $p < .01$), respectively. These results indicated that when the L* value, hue angle, and chroma increased, the color score from the panelists decreased. No other significant correlation differences between the instrument results and the panelist results, were indicated

References

Anonymous (1998). Researchers forecast healthy future for retail fresh-cut sales. *Fresh-cut, 6*, 14-15.

Ayhan, Z., & Chism, G. W. (1998). The shelf-life of minimally processed fresh cut melons. *Journal of Food Quality, 21*, 29-40.

Beaulieu, J. C., Ingram, D. A., Lea, J. M., & Bett-Garber, K. L. (2004). Effect of harvest maturity on the sensory characteristics of fresh-cut cantaloupe. *Journal of Food Science, 69*, S250-S258.

Bett-Garber, K. L., Beaulieu, J. C., & Ingram, D. A. (2002). Effect of storage on sensory properties of fresh-cut cantaloupe varieties. *Journal of Food Quality*, *26*, 323-335.

Galeb, A. D. S. (1994). *Use of ion-exchange and direct osmotic concentration technologies for processing cantaloupe juice* (Doctoral dissertation, Oregon State University, 1994). *Dissertation Abstracts International*, 54, 09B.

Galeb, A. D. S., Wrolstad, R. E., & McDaniel, R. (2002). Composition and quality of clarified cantaloupe juice concentration. *Journal of Food Processing Preservation, 26*, 39-56.

Guven, M., & Karaca, O. B. (2002). The effects of varying sugar content and fruit concentration on the physical properties of vanilla and fruit ice-cream-type frozen yogurts. *International Journal of Dairy Technology*, *55*(1), 27-31.

Geoffrey, K. (1991). *Design & Analysis: A researcher's handbook* (3rd ed.). New Jersey: Prentice-Hall.

Hong, G. P., & Nip, W. K. (1990). Functional properties of precooked Taro flour in sorbet. *Food Chemistry, 36,* 261-270.

Moskowitz, H. (2001). Learning from the competition through category appraisal: one practitioner's keys to faster and more efficient product development. *Food Service Technology, 1*, 103-118.

Mutton, L. L., Cullis, B. R., & Blakeney, A. B. (1981). The objective definition of eating quality in rockmelons (*Cucumis melo*). *Journal of the Science of Food and Agriculture, 32,* 385-391.

O'Connor-Shaw, R. E., Roberts, R., Ford, A. L., & Nottingham, S. M. (1994). Shelf life of minimally processed honeydew, kiwifruit, papaya, pineapple, and cantaloupe. *Journal of Food Sciences*, *59*(6), 1202-1206, 1215.

Park, O. (2004). *Quality and customer acceptability of frozen cantaloupe*. (Master's thesis, Texas Tech University, 2004).

Peet, M. (2002). Muskmelon – Harvest and post-harvest. Retrieved June 14, 2003, from Crop Profiles – Muskmelon web site: www.cals.ncsu.edu/sustainable/peet/profiles/muskharv.htnl

Portela, S. I., & Cantwell, M. I. (2001). Cutting bland sharpness affects appearance and other quality attributes of fresh-cut cantaloupe melon. *Journal of Food Science*, *66*, 1265-1270.

Rosenfeld, H., & Nes, A. (2000). Prediction of sensory quality of strawberry jam by means of sensory quality attributes of fresh fruit. *Journal of the Science of Food and Agriculture, 80,* 1895-1902.

Shih, Y., Hoover, L. C., Thompson, L. D. & Boyce, J. B. (2005). *Sensory evaluation and value analysis of cantaloupe sorbet.* Unpublished manuscript.

Simandjuntak, V., Barrett, D. M., & Wrolstad, R. E. (1996). Cultivar and frozen storage effects on muskmelon (*Cucumis melo*) colour, texture and cell wall polysaccharide composition. *Journal of the Science of Food and Agriculture, 71*, 291-296.

Stogo, M. (1990). *Frozen desserts – A complete retailer's guide*. New York: Van Nostrand Reinhold

Stogo, M. (1998). *Ice cream and frozen desserts – A commercial guide to production and marketing.* New York: John Wiley & Sons, Inc.

Suslow, T. V., Cantwell, M., & Mitchell, J. (2002). Cantaloupe – Recommendations for maintaining postharvest quality. Retrieved June 16, 2003, from Cantaloupe Produce Facts web site: http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/cantaloupe.html

Texas Department of Agriculture (2004). Cantaloupe season. Retrieved November 11, 2004, from Texas Department of Agriculture web site: http://www.agr.state.tx.us/education/tips/com_cantaloupe.htm.

United States Department of Agriculture (2003). An economic assessment of cantaloupe executive summary. Retrieved October 14, 2003, from USDA web site: www.rma.usda.gov/pilots/feasible/txt/cantaloupe.txt

Vance Research Service and Market Facts, Inc. (1990). *Fresh Trends 90': A profile of the fresh produce consumer*. Reports 1,4.

Wagner, A. B., Dainello, F. J., & Parson, J. M. (2001). Harvesting and handling. Retrieved June 14, 2002, from Texas A&M University, extension, veghandbook web site: http://aggie-horticulture.tamu.edu/extension/veghandbook/chapter10/chapter10.html.

Yamaguchi, M., Hughes, D. L., Yabumoto, K., & Jennings, W. G. (1977). Quality of cantaloupe muskmelons: variability and attributes. *Scientia Horticulturae*, *7*, 59-70.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Conclusions

A thorough understanding of customers' needs and desires is vital to successful operation of today's foodservice organizations. Successful management mindset must include recognition that customers are much more aware of health and weight issues, and therefore tend to prefer light, fresh, and healthy food. Fitting wonderfully into this concept is the cantaloupe, which is tasty, flavorful, nutritious, and low calorie. Consumption of cantaloupes has increased steadily in the United States since the 1980s, accompanied by increasing interest in various forms of this versatile food item. The demand for new forms of cantaloupe products has grown by leaps and bounds and the need to meet customer demands now challenges everyone in the foodservice industry. The need to meet this challenge has provided the impetus for this study, the goal of which is to develop an appropriate frozen dessert item for restaurants by using a high-speed freezing method, and to conduct a value analysis study to initiate development of procedures for cost reduction.

Findings of the Study

Three objectives were included in the study. The first was to determine the appropriate thickening agent for cantaloupe sorbet. Trained panelists results suggested that cantaloupe sorbet without any thickening agent developed significantly brighter

color, more sweetness, and lower overall quality ratings than the sorbets containing thickening agents. On the other hand, the sorbet with thickening agents (guar, xanthan, and mixed gum) resulted in a relatively pale orange color intensity, less sweetness, and better overall quality rating than the sorbet without any thickening agents. The cantaloupe sorbet with xanthan gum and mixed gum received the same scores for all characteristics, but xanthan was utilized because it received the highest score overall. The instrument evaluation results also indicated that cantaloupe sorbet with xanthan gum and mixed gum, received the same results from all instrumental analyses.

The second study was to determine a cost reduction method (for a restaurant) which would offer cantaloupe sorbet as a dessert or a palate cleanser, at the same time, to apply value analysis techniques to the product. *Trained panel session results* suggested that the sorbet made from non-frozen sources of cantaloupe (fresh and chilled chunks) were significantly paler than sorbets from frozen sources (frozen chunks and frozen puree) ($p < .05$). The sorbet made from fresh cantaloupe or frozen puree received similar scores in all characteristics. Results indicated that except for the color intensity, sorbet made from frozen puree had qualities similar to sorbet prepared from the fresh cantaloupe product. Instrumental analysis results were the same as trained panel results. *Consumer panel session results* revealed that consumers preferred the color intensity of sorbet made from non-frozen sources of cantaloupe over frozen sources ($p < .05$). Sorbet made from frozen chunks received the lowest score in all characteristics. Except for color intensity of the sorbet, the product of frozen puree received the same degree of likeness for the rest of attributes from the customers as the sorbet made from fresh cantaloupe. As for the

overall quality, in a linear regression equation, 81% of variance could be predicted by the four characteristics, which are flavor, mouth feel, sweetness and crystallization. *Value analysis results* indicated that it took around 40 minutes to make the sorbet from 1.5-pounds of fresh cantaloupe but took only 30 minutes to make the sorbet from 1.5 pounds of frozen cantaloupe puree. As for labor costs, the difference in making these two sorbets was $0.90. Additionally, the sorbet made from frozen cantaloupe puree had less waste than product of fresh cantaloupe.

The propose of the third study was to determine a convenient method for production of cantaloupe sorbet from purees with and without sugar syrup along with investigation into effects of the shelf life of cantaloupe puree. Trained panel session results suggested that there was no significant difference between treatments (cantaloupe puree with and without sugar syrup), but a significant difference was found in the six months storage periods. As for the color intensity, the results revealed that after a one-month storage period, the color of cantaloupe sorbet became brighter. As for the overall quality, both cantaloupe sorbets received the highest score after one-month of storage. In the sorbet made from puree with sugar syrup, overall quality decreased while the sorbet made from puree without sugar syrup increased in the sixth month. Instrumental analysis results revealed that in the sorbet made from puree with syrup, the L* value, Hue angle, and Chroma tended to decrease after one month of storage. In the sorbet made from puree without syrup, the L* value and Hue angle had a waved curve during the six months storage period while the Chroma decreased after one month of storage.

Implications

The first study revealed that sorbet containing 0.05% of xanthan gum attained the highest overall quality. The caloric availability test listed the digestibility of xanthan gum is zero (Milani, 1993). Xanthan gum is used in the manufacture of diet products because the human body cannot digest it (Sikora, Juszczak, & Sady, 2003). These findings strongly supported that xanthan gum is an appropriate thickening agent for producing cantaloupe sorbet.

The second study revealed that, based on results of the trained and consumer panel session, sorbet made from frozen puree attained characteristics and degree of likeness similar to sorbet made from fresh cantaloupe. Frozen puree, moreover, proved an excellent choice for production of the sorbet. Based on value analysis results, the sorbet made from frozen puree had the lowest labor cost and less waste than that made from fresh cantaloupe. Obviously, use of frozen puree could reduce preparation time which in turn would lower labor costs and waste because frozen cantaloupe puree would not need pre-preparation by employees.

The third study revealed no difference in characteristics of sorbet made from cantaloupe puree with and without sugar syrup, but length of the storage period did influence color intensity. The longer the storage time, the darker the color. During the U.S. cantaloupe off-season, imported cantaloupe is dominant in the market at present. History has shown that the imported cantaloupes have been associated with foodborne illness; safety of imported cantaloupe is, therefore, questionable. It is extremely

important to determine shelf life of frozen cantaloupe puree because it can ensure a year-round supply.

Recommendations

Cantaloupe is mainly consumed as fresh fruit during the peak-growing season due to its unique flavor and attractive color. Because cantaloupe is a perishable product and only available between June and November, it has been subjected to further processing into different forms in order to serve customers year round, such as frozen melon balls, melon punches, and fruit soups. Cantaloupe ice cream and sorbet are other ways to utilize cantaloupe. These uses can increase the value of cantaloupe as well. A value-added food product means value of the raw product has increased through the addition of ingredients or processes which make them more attractive to the consumer. In the supermarket, size 12 melon (12 melons/18.8 kg carton) are cost an average of $2.00 during the peak season. However, a bag of mixed frozen fruit (1/4 of which is cantaloupe balls) costs $5.00; a pint of cantaloupe-flavored ice cream (Blue Bell) costs an average of $3.00. The value-added method is a good way to not only increase the value of cantaloupe but also to meet the customers' desire to enjoy cantaloupe in the off-season.

Therefore, in the future, product development should be conducted on the cantaloupe fruit in order to increase the usage of the cantaloupe melon. For instance, cantaloupe puree can be used as a sauce in main courses in a restaurant or as an ingredient in baked foods, such as cake or cookie. Adding value to a food product can

encourage independent producers to process their raw product into marketable goods, thus increasing farm income.

In addition to new product development, follow-up studies associated with cantaloupe sorbet should be conducted. After the pilot study of the customers' acceptance of cantaloupe sorbet, it is necessary to establish a larger scale study in order to obtain reliable data. Next, a commercial production formula should be determined for mass production, followed by marketing research in order to determine a strategy for promotion of the new products.

References

Milani, F. X. (1993). Modification and pilot production of induced complex formation between Xanthan gum and whey proteins at reduced pH value (Doctoral dissertation, University of Wisconsin-Madison, 1993). *Dissertation Abstracts International*, 54, 07B.

Sikora, M., Juszczak, L., & Sady, M. (2003). Hydrocolloids in forming properties of cocoa syrups. *International Journal of Food Properties*, *6*, 215-228.

APPENDIX A

CANTALOUPE SORBET – TRAINED PANEL EVALUATION SHEET FOR THE THICKENING AGENT

Cantaloupe Sorbet – Trained Panel Evaluation Sheet

Experiment One Date: _____ Section: _____ Name: _____

Instructions:

- Familiarize yourself with the quality attributes listed on the next page before tasting the sample.
- Evaluate each sample independently.
- Visually evaluate the sample and record the **Color Intensity** scores.
- Taste the sample orally and record the eating quality attribute scores.

Sample Number	Color Intensity	Sweetness	Melon Flavor Intensity	Mouth Feel	Crystallization	Viscosity	Overall quality

Color intensity	
9	Extremely bright
8	Very bright
7	Bright
6	Slightly bright
5	Neither bright or pale
4	Slight pale
3	Pale
2	Very pale
1	Extremely pale

Sweetness	
9	Extremely sweet
8	Very sweet
7	Sweet
6	Slightly sweet
5	Neither sweet or mild
4	Mild
3	Very mild
2	Detectable sweetness
1	Cannot detect sweetness

Melon flavor intensity	
9	Extremely strong melon flavor
8	Very Strong melon flavor
7	Strong melon flavor
6	Melon flavor
5	Slight melon flavor
4	Mild melon flavor
3	Very mild melon flavor
2	Detectable melon flavor
1	No melon flavor

Mouth Feel	
9	Extremely smooth
8	Very smooth
7	Smooth
6	Slightly smooth
5	Nether smooth or grainy
4	Slightly grainy
3	Grainy
2	Very grainy
1	Extremely grainy

Crystallization	
9	Extremely much crystallization
8	Very much crystallization
7	Much crystallization
6	Crystallization
5	Little crystallization
4	Slight crystallization
3	Very slight crystallization
2	Detectable crystallization
1	No crystallization

Viscosity	
9	Extremely hard to separate
8	Very hard to separate
7	Hard to separate
6	Not easy to separate
5	Slight easy to separate
4	Separately
3	Easy to separate
2	Very easy to separate
1	Extremely easy to separate

Overall quality	
9	Extremely good
8	Very good
7	Good
6	Slightly good
5	Neither good or poor
4	Slightly poor
3	Poor
2	Very poor
1	Extremely poor

APPENDIX B

CANTALOUPE SORBET – TRAINED PANEL EVALUATION SHEET FOR THE FOUR MARKET FORMS AND SHELF LIFE STUDY

Cantaloupe Sorbet – Trained Panel Evaluation Sheet

Experiment Three & Four Date: _____ Section: _____ Name: _____

Instructions:

- Familiarize yourself with the quality attributes listed on the next page before tasting the sample.
- Evaluate each sample independently.
- Visually evaluate the sample and record the **Color Intensity** scores.
- Taste the sample orally and record the eating quality attribute scores.

Sample Number	Color Intensity	Sweetness	Melon Flavor Intensity	Mouth Feel	Crystallization	Overall quality

Color intensity	
9	Extremely bright
8	Very bright
7	Bright
6	Slightly bright
5	Neither bright or pale
4	Slight pale
3	Pale
2	Very pale
1	Extremely pale

Sweetness	
9	Extremely sweet
8	Very sweet
7	Sweet
6	Slightly sweet
5	Neither sweet or mild
4	Mild
3	Very mild
2	Detectable sweetness
1	Cannot detect sweetness

Melon flavor intensity	
9	Extremely strong melon flavor
8	Very Strong melon flavor
7	Strong melon flavor
6	Melon flavor
5	Slight melon flavor
4	Mild melon flavor
3	Very mild melon flavor
2	Detectable melon flavor
1	No melon flavor

Mouth Feel	
9	Extremely smooth
8	Very smooth
7	Smooth
6	Slightly smooth
5	Nether smooth or grainy
4	Slightly grainy
3	Grainy
2	Very grainy
1	Extremely grainy

Crystallization	
9	Extremely much crystallization
8	Very much crystallization
7	Much crystallization
6	Crystallization
5	Little crystallization
4	Slight crystallization
3	Very slight crystallization
2	Detectable crystallization
1	No crystallization

Overall quality	
9	Extremely good
8	Very good
7	Good
6	Slightly good
5	Neither good or poor
4	Slightly poor
3	Poor
2	Very poor
1	Extremely poor

APPENDIX C

CANTALOUPE SORBET – CONSUMER PANEL EVALUATION SHEET

Cantaloupe Sorbet – Consumer Panel Evaluation Sheet

Sample number: _____ Panelist name: _____

Cantaloupe sorbet quality characteristics:
Directions: Please taste the sample and indicate the degree to which you like or dislike the sample by placing a check (✓) in the blank for each characteristic. Please state the reason that you like/dislike the sorbet in the blank provided.

	(1) Dislike extremely				**Neither like or dislike**				**(9) Like extremely**
Color	□	□	□	□	□	□	□	□	□
Sweetness	□	□	□	□	□	□	□	□	□
Flavor	□	□	□	□	□	□	□	□	□
Crystallization	□	□	□	□	□	□	□	□	□
Mouth-feel	□	□	□	□	□	□	□	□	□
Overall acceptability	□	□	□	□	□	□	□	□	□

Comments:_____

_____

Market-related questions:

Directions: Please answer the questions by placing a check (✓) in the appropriate blank.

1. If you were to order this product in a restaurant, what would you be willing to pay?

_____ 1) $1.00~$1.99 _____ 3) $3.00~$3.99

_____ 2) $2.00~$2.99 _____ 4) other _____

2. Select the response the most closely reflects your likely action.

Based on overall quality and not price:

_____ I would eat this food every opportunity I had.

_____ I would eat this food very often.

_____ I would eat this food frequently.

_____ I like this food and would eat it now and then.

_____ I would eat this food if available but would not go out of my way.

_____ I don't like it but would eat it on an occasion.

_____ I would hardly ever eat this.

_____ I would eat this if there were no other choices.

_____ I would eat this only if forced to.

Date: _____

Demographic profile:

Directions: Provide the information requested by placing a check (✓) in the appropriate blank.

1. What is you gender?

_____ 1) Female _____ 2) Male

2. What is your age?

_____ 1) under 21 _____ 4) 41~50

_____ 2) 21~30 _____ 5) 51~60

_____ 3) 31~40 _____ 6) over 60

3. What is your ethnic origin?

_____ 1) African-American _____ 4) Hispanic

_____ 2) American Indian or Alaskan Native _____ 5) White

_____ 3) Asian or Pacific Islander _____ 6) Other, specify _____

4. What is your annual household income?

_____ 1) under $25,000 _____ 3) $50,000 - $74,999

_____ 2) $25,000 - $49,999 _____ 4) over $74,999