DEVELOPMENT OF VALUE ADDED ICE CREAM USING AVOCADO FRUIT.

by

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DECLARATION

I carried out the work described in this thesis at the Ceylon Cold Stores (pvt) Ltd, and at the Faculty of Applied sciences under the supervision of Mr. D.A.M. Arsecularatne. and Mrs. Indira Wickramasinghe. A report on this has not been submitted to any other University for another degree.

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Affectionately Dedicated

To My

Parents & Teachers.

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Abstract

Ice cream is a frozen and flavoured food product containing milk as the main ingredient. These include whole milk, skimmed milk, cream, frozen cream, condensed milk products and milk solids. Freezing a pasteurised mixture of milk, cream, milk solid non-fat, sugar, emulsifier and stabilizers produces ice cream. Other ingredients include flavouring matters and water. Fruits, nuts, candies and syrups are optionally added into ice cream for flavour enrichment. Since it is deficient in proteins, vitamins and mineral salts, it cannot be used as the sole item of food.

In ice cream manufacturing, first the ingredients were weighed and blended together to produce the "ice cream mix". Then the mix was pasteurised. The mix was also homogenized which forms the fat emulsion by breaking down or reducing the size of the fat globules found in milk to less than 1μm. The mix was then aged for at least four hours and usually overnight. After that mix was drawn into a flavour tank where liquid flavours, fruit puree, or colours were added. After the particulates have been added, the ice cream was packaged and was placed into a blast freezer at –30°C to –40°C.

Value added ice creams are more popular among the people, because of the high nutritive value and flavour of the product. The purpose of this study is to develop a puree/sauce of Avocado with an extended shelf life, to introduce into the ice cream as a ripple. As well as an avocado ripple ice cream is new product to the market.

The process involves preserving the avocado pulp in three different treatments. The samples were prepared by adding sugar and water to the fruit pulp and then pasteurised the mix. And the second sample was prepared by adding sugar syrup to the pulp and the third sample was made mixed with powdered sugar. To all three different samples ascorbic acid was used as a preservative. A sensory evaluation was carried out to find out the best sample out of the three. Also microbiological tests were conducted to determine the microbial safety.

From the findings of this study, it can be concluded that avocado pulp can be preserved in the form of puree/sauce by adding sugar and preservatives.

Table of Contents page

Chapter 4

Chapter 5

List of Tables

List of Figure

Chapter 1

1.1 Introduction

Ice cream represents a congealed dairy product produced by freezing a pasteurised mixture of milk, cream, milk solid non-fat, sugars, emulsifier and stabilizers. Products of dairy origin are the main ingredients of ice cream. These include whole milk, skimmed milk, cream, frozen cream, condensed milk products and solid: other ingredients include flavouring matters and water. Fruits, nuts, candies and syrups are optionally added into ice cream for flavour enrichment.

Ice cream is the most popular dessert in the world. Americans get through a staggering 21 litres per person each year. Britain has the third highest consumption of ice cream in Europe at around 8 litres per person per year.

Now a day's ice cream is more popular with fruits. It may be fresh, frozen and canned fruits. Strawberry ice cream ranks third among flavours, being about 8% of total amount of ice cream made. Other fruit flavours are popular in season and are consumed more or less through out the year.

Also there is a big demand for value added ice creams than normal or simple ice cream. E.g. ripple ice cream, fruit and nut etc. The value added ice creams rich in nutritive value and more palatable. Also fruits with ice cream increase the appearance of food and there by it attracts the consumers.

Fruits are recommended to include in balance diet because they contain more vitamins and fibres. As well as fruits may contributes to enhance the flavour and taste of some food items. The ice cream trade is one of the chief markets for fresh, frozen and canned fruits.

Strawberry, Mango, Pineapples are commonly used with ice cream as a form of value addition. These can be used as ripple or slices. Fruit flavours are available as:

extracts prepared from the fruit, artificial compounds, and true extracts fortified artificially.

The avocado is the most nutritive fruit for consumer. It can be used as a value addition for ice creams.

Avocado *(Persea americana)* belongs to the family lauraceae, together with laurel and cinnamon. Three ecological races (sub species) are recognized: Mexican, Guatemalan and West Indian. Avocado originated in Central America and the early Spanish explores recorded its cultivation from Mexico to Peru. It is a popular food in Central America.

The avocado is a very nutritious fruit, containing 3-30% oil similar in composition to olive oil, and much vitamin B. as the sugar content is low, about 1%, it can be recommended as a high-energy food for diabetics.

Also avocado is high in monosaturates. The oil content of avocado is second only to olive among fruits, and sometimes greater. Clinical feeding studies in humans have shown that avocado oil can reduce blood cholesterol.

In Sri Lanka avocado use as a fresh fruit, normally they were ate avocado mixed with sugar. In Brazil, avocado is some time added to ice cream. Filipinos, puree avocados with sugar and milk to make a sweet drink. And some countries avocado eat with lemon or limejuice, salt, and pepper as a salad.

In this research, an attempt is made in avocado puree or sauce with extended shelf life. The purpose of this research is to introduce the avocado sauce into ice cream as a form of ripple. To that, the fruit pulp was mixed with sugar and the preservatives. The sauce must store in deep freezer until it may introduce to ice cream. The product is a nutritive food item to consumers as well as it comes as a new product to the market. Also the product will provide a better way to utilize the loads of avocado during season. Therefore, the wastage during this time can be minimized.

1.2 Objectives:

- Removal of the bitterness of Avocado ripple ice cream and improve acceptable taste and quality of ice cream.
- To develop the product using fruit, which are at the required maturity stage, and applying the appropriate fruit: sugar ratio.

Chapter 2
Literature Review

2.1 What is an ice cream?

In its simplest form ice cream is a mixture of cream, sugar, and flavouring converted into a semi-solid porous frozen mass by mixing in a freezer. (Winton, and Winton, 1999)

Ice cream can be divided into four main categories according to the ingredients used:

- Ice cream made exclusively from milk products.
- Ice cream containing vegetable fat.
- Sherbet ice cream made of fruit juice with added milk fat and milk solid non fat.
- Water ice made of water, sugar and fruit concentrate.

A water ice differs from ice cream in that crushed fruit or fruit
Juice, sweetened with sugar, is frozen without addition of cram or other dairy product. (Bylund, 1995)

2.2 History of ice cream

It is uncertain how long ice cream has been produced, but it probably originates from China. From very old writings it has been learned that the Chinese liked a frozen product made by mixing fruit juices with snow. What we now call water ice. This technique later spread to ancient Greece and Rome, where the wealthy, in particular, were partial to frozen desserts.

After disappearing for several centuries, ice creams in various forms reappeared Italy in the Middle Ages, most probably as a result of Marco polo returning to Italy in 1295 after a 16-17 year stay in China, where he had learned to appreciate a frozen dessert based on milk. From Italy ice cream spread over Europe during the seventeenth century, and long remained a luxury product for the royal courts. (Bylund, 1995)

2.3 Structure Of Ice Cream

Ice cream, a composite of liquid, solid, and gaseous phases, is a dynamic system of temperature-dependent micro and macro surfaces. Crystalline liquid phase equilibrium for water and fat and expansion/contraction and collapse of gas vesicles are directly related to the temperature in the matrix.

Ice cream is both an emulsion and foam. The milk fat exists in tiny globules that have been formed by the homogeniser. There are many proteins, which act as emulsifiers and give the fat emulsion its needed stability. The emulsifiers are added to ice cream to actually reduce the stability of this fat emulsion by replacing proteins on the fat surface. When the mix is subjected to the whipping action of the barrel freezer, the fat emulsion begins to partially break down and the fat globules begin to flocculate or destabilize. This partially coalesced fat stabilizes the air bubbles, which are being beaten into the mix. (Kilara, 1996)

2.4 Composition Of Ice Cream

The chemical composition of ice cream differs mainly with regard to the fat content, and three grades of ice cream can usually be found in most market areas.

I. One grade just meets the minimum fat content, often has an overrun that approaches the maximum allowed by law and usually contains relatively inexpensive flavour ingredients.

II. At the other extreme are the so called premium ice creams that are high in fat, low in overrun, and usually contain natural flavours.

III. A third grade of ice cream, designed as a compromise between the minimum products, is the type that has dominated the market for many years.

IV. Newer developments have introduced a fourth grade referenced to as super premium ice cream that are characterized by higher fat contents and lower overruns than premium varieties

Table 2.1 Representative formulae fore ice creams of different grades.

Constituents	Grade Of Ice Cream				
	Economy	Regular	Premium		Super premium
		%	1	2	
Milk fat	10.10	10.10	12.00	14.00	16.00
Skim	7.50	9.00	10.00	10.50	9.50
Whey	2.50	2.00	1.50	_	_
Sucrose	4.50	7.60	12.00	12.00	15.50
Corn syrup	9.0	6.00	5.00	4.00	_
High fructose	4.50	2.60	_	_	_
Stabilizer	0.05	0.15	0.13	0.12	0.12
Emulsifier	0.30	0.25	0.15	0.10	_
Total solids	35.55	37.70	40.78	41.22	41.22

Source: ice cream course (Germantown) 1996

Since ice cream is manufactured with widely differing analytical composition and is flavoured with a variety of substances, the average chemical composition can only be approximated practically all the fat, protein, and minerals are contributed by milk solids. Lactose, sucrose, corn sweeteners and to a small extent stabilizers account for the carbohydrate content of ice cream. (Kilara, 1996)

2.5 Ice cream Ingredients, Functions and Sources:

2.5.1 Milk Fat: -

Lipid constitutes 10-18% of mix weight and is the most important factor that affects quality. When choosing a formula, an ice cream manufacture first selects a fat level and then proportions the other components to blend with it.

Milk fat Imparts richness, body or substance, and helps ensure a smooth textured ice cream. Perhaps the most easily recognizable difference between law-fat and high-fat ice cream is the sensation coldness; law-fat ice cream feels colder in the mouth. Milk fat contributes to a subtle flavour quality. It is a good carrier and synergist for added flavour compounds and it promotes the desirable tactile qualities. Most ice cream manufacturers favour the use of fresh cream as the principal of fat. Flavour problems are minimized and fresh cream has handling advantages not possessed by stored fat products, which must be thawed or comminute before added to the blending vat. Frozen cream, plastic cream and butter are frequently used as a partial replacement for fluid cream when the latter is in short supply.

Over 98% of milk fat by weight consists of triglycerides involving some 100 different fatty acids. Consequently, the crystallization behaviour of milk fat is intricate. Large differences in melting point of the component triglycerides result in a wide melting rang. Milk fat is liquid above 40.C and usually completely solidified below –40°C. There for in the manufacture of ice cream, the fat exists as mixture of crystallization affect several physical properties including susceptibility of fat globules to aggregation, coalescence, or dispersion. (Kilara, 1996)

2.5.2 Milk Solids Non Fat: -

The non-fat milk solids are also referred to as serum solids. Besides contributing to flavour, body, and texture, they are essential to the formation and maintenance of small stable air cells. The amount used depends upon the fat content; higher fat lower serum solids. Excessive amounts may give rise to sandiness, or affect taste by imparting "saltines". The amount of serum solids is also influenced by the length of

time ice cream is held in cabinets. Concentrated skim and whole milk and non-fat dry milk are the most important sources of serum solids supplementing those derived from cream. Whey solids can be used as a partial substitute for skim milk solids.

Serum solids contain lactose proteins, and ash or minerals. As a share of the mix weight, protein will seldom be less than 3% or more than 4.5%. Whey can be used in ice cream, but legal restrictions make it a very minor contributor to the properties including availability of whey protein concentrates and albumin fractions from whey this situation could change to offer product development opportunities. Milk proteins, more particularly casein micelles, coat the surface of fat globules during homogenisation and are, therefore, the primary emulsion stabilizing agent in ice cream mix.

Lactose and ash are considered to be incidentally present and have very little functional advantage. Emulsification and foaming are surface-active properties of proteins and are related to protein film formation. Surface-active compounds adsorbed at the surface or interface of liquids at relatively low concentrations as low as 0.02ppm for casein. (Kilara, 1996)

2.5.3 Sugars and sweeteners: -

The sweeteners of ice cream are contributed by sucrose, corn sweeteners, and to a slight degree by lactose. Since components in true solution determine the freezing point, the concentration of sugars prevents ice cream from being frozen solid even at very low temperatures. Sugars can therefore be viewed as antifreeze components. Were it not for the sugars, ice cream would freeze hard at a comparatively high temperature and the product would be entirely lacking in desirable body and texture characteristics. (Kilara, 1996)

2.5.4 Stabilizers: -

The primary reason for using a stabilizer in ice cream is to aid in the maintenance of smooth texture by preventing large ice crystal formation during handling by the manufacture, dealer, and consumer between manufacture and consumption. Compared to ice cream that does not contain a stabilizer, properly stabilized ice cream will have a heavier body, will not taste as cold, and will melt more slowly and to a creamier consistency.

In many food applications stabilizes are used as thickening, suspending and emulsifying agents. Their function in ice cream is primarily to control the ice crystal size. All stabilizers increase the viscosity of the unfrozen portion, which restricts molecular migration to crystal nuclei, there by limiting crystal size. The ability to hold relatively large amounts of water is also offered as an explanation for the maintenance of smooth texture.

The most commonly used hydrocolloids are sodium carboxymethyl cellulose (CMC), locust bean gum, sodium alginate, propylene glycol alginate, carrageenan, and guar gum. Gums occasionally used for special purposes include gelatin, tragacanth, and Arabic.

Commercial ice cream stabilizers are usually blends of two or more basic ingredients. CMC, locust bean gum, and guar gum stabilizers alone or in combination, almost always are blended with a small amount of carrageenan, a sulphated galactose polymer. Carrageenan complexes with milk protein and when present in mix at a concentration of approximately 0.018% effectively inhibits the serum separation or wheying off encountered when the above-mentioned gums are used alone. Stabilizers differ in respect to their effect on mix viscosity, ease of dispersion in mix, body and texture, and melting characteristics of ice cream. The particular stabilizer chosen for use will depend on a combination of factors involving price, the type of processing used in making the mix, and body and texture qualities desired in the finished product. (Kilara, 1996)

2.5.5 Emulsifiers: -

Any substance that is capable of aiding the formation of a stable mixture of two otherwise immiscible substances (e.g. fat and water) is called an emulsifier; any substance that helps to maintain an emulsion when it has been formed is called a stabilizer. Most emulsifiers are called surface or surface-active agents. Emulsifiers are especially desirable when extrusion techniques are used for forming speciality items such as sandwiches, slices, and factory filled cones. Emulsifiers stiffen ice cream by a process involving agglomeration of tat globules. They favour a smooth texture since both ice crystal and air cell size is reduced. Emulsifiers may improve the whipping properties, particularly if stored fats are used and the mix is frozen in a batch or soft serve freezer. Since overrun and texture problems are rarely encountered in the air metered commercial ice cream manufacture, the stiffening ability is the most important factor to be considered when selecting an emulsifier.

Both monogycerides and polysorbate esters are approved for use in ice cream. Monoglycerides are most often obtained from a mono and diglyceride mixture also containing small proportions of triglycerides and traces of saponification products. The monoglyceride content of commercially available products may very from 40-98% and since the emulsifiers are usually derived from hydrogenated vegetable and animal fats, palmitic and stearic acid esters predominate. The effectiveness of such an emulsifier depends on the percentage of monoglycerides and on the particular fatty acids percent. There is an inverse relationship between carbon chain length of the fatty acid and the stiffness produced in ice cream; capric acid lauric acid monoesters are more effective in this respect than glyceryl monopalmatate or monostearate. Monoglycerides containing unsaturated fatty acids impart more stiffness than saturated monoglycerides.

Polysorbate emulsifiers provided for in federal standards are the polyethylene derivatives of sorbbitan tristerarae and sorbitan monovleate. These emulsifiers are more hydrophilic than the monoglycerides and are used at much lower levels, since they are especially effective in imparting stiffness to ice cream as it leaves the freezer. (Kilara, 1996)

2.6 Sri Lanka Standards for Ice Cream.

Definition for ice cream according to Sri Lanka Standard.

Ice Cream:

A frozen sweetened product made from a heat-treated mix consisting of edible fat and milk solids with or without other ingredients and permitted additives.

The product is intended for storage, sale and consumption in the frozen state. (SLS 223:1998)

2.6.1 Categories of ice cream according to SLS: -

- Simple Ice Cream:

A sweetened product made from a mix consisting of edible fat and milk solids with colour, flavour, emulsifier and stabilizer.

- Complex ice cream:

Simple ice cream with any one or more of the optional ingredients
(Fruits and fruit products, Nuts, free from damages, rancidity, moulds, insect and rodent infections.)
Food ingredients, intended to impart flavour, taste or texture.
e.g. cocoa, chocolate, coffee, ginger, honey, treacle etc.

- Novelties:

Single serve packs of either simple or complex ice cream with an outer edible coating such as chocolates, nuts, biscuits, etc. (SLS 223:1998)

2.6.2 Ingredients:

All ingredients used in the preparation of ice cream shall be clean and sound and fit for human consumption. Perishable ingredients not in immediate use shall be stored hygienically under refrigeration. (SLS 223:1998)

2.6.3 Requirements:

General requirements:

- Ice cream shall be manufactured, packed, stored and distributed under the hygienic conditions.
- Ice cream shall be stored at a temperature bellow –18°C. products other than frozen desserts shall not be stored together with ice cream.

Pasteurisation requirements:

- Milk ingredients used in the ice cream shall be pasteurised or subjected to an equivalent heat treatment.
- The whole mix of ice cream excluding flavours, colours, fruits and nuts shall have undergone heat treatment and shall satisfy the phosphates test. No ingredients other than fruit, fruit pulp, fruit juice, nuts, colouring matter and flavouring agents shall be added after heat treatment.

2.6.4 Heat treatment:

Ice cream mixture shall be subjected to any of the heat treatment given bellow.

The mixture shall be kept at a temperature not less than

a) 66°C for at least 30 minutes.
b) 71°C for at least 10 minutes.
c) 79°C for at least 15 seconds.
d) 149°C for at least 2 seconds.

After heat treatment the temperature of the mixture shall be reduced to 7°C or below within 90 minutes. The mixture shall be kept at that temperature until the freezing process begins.

2.6.5 Finished product requirements:

- Ice cream shall have a pleasant odour and flavour. It shall be smooth in texture and of uniform consistency.
- Ice cream shall be free from contamination or any objectionable matter. It shall also be free from ice crystals, lactose crystals or butter granules. (SLS 223:1998)

2.7 MANUFACTURE OF ICE CREAM:

The liquid ingredients are heated in the mixing vat to about 110°F, and then the sugar is added, together with the other dry ingredients. Some ingredients, such as sodium alginate, used as a stabilizer, require a higher temperature for dispersion in the mix, so they are added after the mixture has reached about 160°F. (Lampert, 1987)

2.7.1 Pasteurisation: -

Pasteurisation is an important step in the manufacture of ice cream. As the fat and sugar present give some protection to bacteria in the mix, it is necessary to pasteurise at a higher temperature than is needed for milk. In a batch pasteurise, a temperature of at least 155°F is held for 30 minutes. HTST pasteurisation is widely used, employing plate heaters, tubular heaters, or vacuum pasteurises. HTST pasteurisation is done at a temperature of at least 175°F for 25 seconds. Recent work has shown that UHT, ultra-high temperature pasteurisation, has a beneficial effect upon the flavour, stability, and texture of ice cream. (Lampert, 1987)

2.7.2 Homogenisation: -

After pasteurisation, the mix is homogenized at a temperature between 160 and 200F. This is an essential step because it prevents churning of the mix in the freezer, reduces the time needed to age the mix, affects its viscosity and improves the body and texture of the ice cream. A pressure of about 2500 pounds is used with a two-stage homogeniser; about 2500 pounds on the first stage and 500 pounds on the second for mix containing up to 14% of fat. For mixes containing over 14% of fat, pressures of 1500 to 1800 pounds, respectively, are used. After homogenisation, the mix is cooled to 30-40°F and held in storage at about 34F until it is to be frozen. (Lampert, 1987)

2.7.3 Aging The Mix: -

At what time it was a common practice to hold or age the homogenized mix at a temperature of 32 to 40F for four to twenty-four hours in order to permit clumping of the fat globules and to increase the viscosity of the mix. This procedure allows the mix to freeze more quickly and gives the ice cream a better body and texture. It is of value when a fat content of 15% or more and when little consideration is given to the other milk constituents. The modern method of using a stabilizer, emulsifier, and a mix of high milk solids non-fat content has made a long aging period unnecessary. The mix may be held for a few hours, or go to the freezer directly from the homogeniser. (Lampert, 1987)

2.7.4 Continuous Freezing: -

The continuous freezer has two functions:

- To whip a controlled amount of air into the mix.
- To freeze the water content in the mix to a large number of small ice crystals.

Commercial ice cream freezers are of either the batch or the continuous type. In the batch freezer, direct expansion of ammonia gas or frozen refrigerant is used as the freezing medium. With in the cylinder, a dasher fitted with scraper blades turns about 200 revolutions a minute and removes the frozen cream from the sides of the freezing cylinder. In seven to eight minutes the mix is frozen to the required consistency at 21 to 23°F.

The continuous ice cream freezer operates much like the batch freezer, but differs in that a continuous flow of mix and air are pumped through the freezing unit under controlled conditions. (Lampert, 1987)

2.7.5 Overrun: -

Air is a necessary ingredient of ice cream, because without it the mix would freeze to a hard or soggy mass. The increase in volume affected by whipping air into the mix

during the freezing process is known as overrun. The usual overrun for packaged ice cream is about 80%; for soft ice cream it is from 40 to 80%. The usual range for bulk ice cream is from 80 to 100%, but it may reach 150%. Thus, one gallon of mix makes about two gallons of finished ice cream; and conversely, two gallons of ice cream melt down to about one gallon of liquid.

An ice cream with an excessive amount of air lacks body and melts too rapidly in the mouth. The beater or dasher is allowed to revolve in order to incorporate the air in the ice cream. Whipping should be completed in two or three minutes in order to prevent the ice cream from melting through lack of refrigeration. In the continuous freezer, whipping is accomplished automatically while the mix passed through the freezer.

The formula for the calculation of overrun is:

$$\% \text{ Overrun} = \frac{\text{Gallons of ice cream} - \text{Gallon of mix}}{\text{Gallons of mix}} * 100$$

When weight is used, the formula become:

$$\% \text{ Overrun} = \frac{\text{weight of mix (lbs)} - \text{weight of ice creams}}{\text{Weight of ice cream (lbs)}} * 100$$

2.7.6 Hardening: -

It is necessary to continue freezing the semi-fluid product drawn from the freezer, without further agitation, until it is firm. The quicker it is done, the better the body of ice cream. In modern practice, the ice cream is packaged as it comes from the freezer. The packages are placed in a room held at –20 to – 50°F, or conveyed through a tunnel wherein a blast of high- velocity, equally cold air quickly cools the product, during hardening some 20 to 50% of the water remaining in the ice cream is frozen. (Lampert, 1987)

2.8 Composition of ice cream

The composition of ice cream may vary considerably, especially in its content of fat and milk-solid-non-fat.

Table 2.2 Percentage composition of ice cream:

	Maximum	Minimum	Usual Range
Fat	20	08	9-14
Milk-Solid-Non-Fat	14	06	9-11
Sugar	18	12	14-16
Stabilizer	1.0	0.0	0.25-0.50

Source: Modern dairy products 1987

The quality of an ice cream depends largely upon its total solids and fat content. Cost is a controlling factor in the fat content. An average analysis of commercial ice cream of good quality is as follows.

Table 2.3 Commercial ice cream (vanilla):

Protein	4.6%
Fat	11.5%
Lactose	5.0%
Sucrose and Dextrose	15.0%
Ash	0.9%

Source: Modern dairy products 1987

Included in the mineral constituents of the ash, are 0.12% of calcium, 0.17% potassium, 0.08% phosphorus; and 0.07% sodium. (Lampert, 1987)

2.9 Nutritive value of ice cream

Ice cream is an excellent food and a concentrated source of energy, but because of its large amounts of fat and carbohydrate it is an unbalanced food if made the principal part of a diet. Experiments on animals have shown that ice cream of average composition does not supply sufficient protein, mineral salts, or vitamins to maintain normal growth. The addition of more dry milk solids-non-fat to the mix corrects this defect to a considerable degree.

It generally is agreed that ice cream is easily digested, especially be cause the homogenisation and heat treatment of the mix favours the formation of a soft curd in the stomach. The flavour has a psychological effect and stimulates the flow of the digestive juice. The widespread use of ice cream in hospitals demonstrates the value placed upon it as a palatable, digestible, and nutritive food.

Ice cream of average compositions furnishes about 1100 calories a quart or about 200 calories a serving. If it is assumed that the average overrun of ice cream is 100%, the calorific value of the frozen product is one-half that of the liquid mix from which it is made.

Ice milk with a content of 4.5% fat and 33% total solids, furnishes about 155 calories per100g. A sherbet of average composition would also furnish about 150 calories. (Lampert, 1987)

2.10 Fruits in ice creams:

In ice cream manufacturing fruits or fruit flavours are commonly use. Fruit flavours are available as:

1. Extracts prepared from the fruit.
2. Artificial compounds.
3. True extracts fortified artificially.

These flavours supplement the fruits in cases where it is necessary to avoid excessive amounts of fruit, but they are quite generally inferior to the flavour obtained from the fruit it self and do not supply the desired fruit pulp.

A special mix need not be used for fruit ice cream unless the basic mix contains more than 16% sugar content a 3: 1 fruit pack should be used. If the mix contains 15% sugar or less, the 2: 1pack is usually preferred.

Since fruit ice cream contains a higher percentage of sugar than plain ice cream it should be drawn from the freezer at about 1°F colder. A drawing temperature of 23°F. For the batch freezer or 20°F. For the continuous freezer is satisfactory under most conditions.

Fresh fruit and fresh frozen fruits are most desirable flavouring materials. The aged fruit-sugar mixture used at the rate of 15 to 20% produces good results with many fruits. The fruit sugar ratio may vary from 2 parts fruit to 1 part sugar to as high as 9 parts fruit to 1 part sugar. Fruits may be used whole, sliced, crushed, diced, pureed or as juice.

For processing of fruit ice creams or ripple ice cream we can use Apple, Apricot, Banana, Blackberry, Blueberry, cherry, pineapple, Strawberry and Avocado like fruits. Out of these fruits Avocado is a special fruit, because it is an only fruit having high amount of fat content. (Frandsen, and Arbuckle, 1961)

2.11 AVOCADO

2.11.1 General Introduction to Avocados

The Avocado is one of the most nutritive among fruits. It is regarded as the most important contribution of the New World to the human diet.

The avocado (Persea americana Mill.) is a evergreen tree which is native to Mesoamerica. Its natural range covers environmental conditions from the central highlands of Mexico where frosts occur to the rain forests of northwest Columbia. The trees are evergreen and may reach heights of up to 20m.the trees shallow rooted and have poor water uptake and hydrolic conductance. Although the trees produce an abundance of floweres, usually less than 0.1% of the flowers set fruit and most of these fruit abscise within 6 weeks from full bloom. Vegetative growth is cyclical with pronounced growth flushes. There may be one to six shoot flushes per year. Axillary branching may be proleptic, that is, a shoot develops only after a period of dormancy as a resting bud or sylleptic, where shoot growth occurs simultaneously with the parent axis with no dormant phase. In avocados, it is quite easy to discern between these two types of axillary branching. (http://ucavo.urc.edu/)

In Sri Lanka it is cultivated mainly in the wet zone. The leaves are pointed and the fruit pear-shaped, neither sweet nor juicy, 10-15 cm long, with a single stone. The edible pulp is greenish yellow. Avocados have a high fat content (17%) and are rich in protein. Several varieties have been introduced to Sri Lanka, including the popular 'Grottfried': the green fruits turn purple as they ripen, whereas in 'pollok' they remain green. Ripe fruits appear from June to September. Avocados are usually eaten as fruit in Sri Lanka, sweetened with sugar or treacle. In the west however, they are popular ingredient in salads. (Jayaindra, and Fernado, 1997)

Common names: Avocado
Alligator pear (English)
Aguacate
Palta (Spanish)

Botanical name: *Persea Americana*

2.11.2 Origin and Distribution

Avocado originated in Central America and the early Spanish explorers recorded its cultivation from Mexico to Peru, but not in the West Indies at that time. It was introduced into Jamaica in about 1650 and to southern Spain in 1601. It was reported in Zanzibar in 1892. Avocado was first recorded in Florida in 1833 and in California in 1865. In India, it may have been introduced in the south and west coast of India about 50 to 75 years ago from Ceylon. Avocado is now grown in most of the tropical and subtropical countries. (Bose, and Mitra, 1991)

2.11.3 Species and Races

2.11.3.1 SPECIES

The avocado (*Persea americana*) belongs to the family Lauraceae that has about 47 genera and 1900 species including two other species of economic importance, viz., *Cinnamomum zeylanicum* (cinnamom) and *C. camphor* (camphor). (Bose, and Mitra, 1991)

2.11.3.2 RACES

In avocado, though the following three ecological races (subspecies) have been recognised, it is the natural inter-racial hybrids of these races that are of horticultural and commercial importance now. (Bose, and Mitra, 1991)

MEXICAN RACE

It is characterised by small fruits weighing less than 250g and ripening 6-8 months after flowering. Fruit have thin, smooth skin with a large seed fitting loosely in the central cavity and its oil content is up to 30%, the highest of all the three races, amongst the three races, this is the most resistant to cold temperature.

GUATEMALAN RACE

This race is native to the highlands of Central America. Fruits are fairly large, weighing up to 600g and borne on long stalks. The fruit ripen 9 to 12 months after flowering. Their skin is thick and brittle and often warty. Its seeds, held tightly in the cavity of the fruit, are small. The oil content ranges between 8 and 15%.

WEST INDIAN RACE

This group with medium-sized fruit is native to the lowlands of Central America. The fruit skin is smooth but leathery and glossy. Fruits are borne on long stalks and require up to 9 months for ripening from the date of flowering. Its seeds are large, fitting loosely in the cavity. The oil content of the fruit is low, ranging between 3 and 10%. This race is the least resistant of the three to cold temperatures. (Bose, and Mitra, 1991)

2.12 AVOCADO FRUIT.

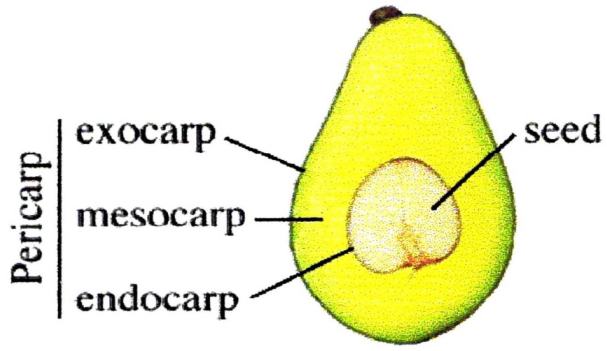

Figure 2.1: Cross section of the Avocado

Avocado fruit is a single- seeded berry. A fruit is the matured ovary of a flower. Basically, it consists of the ovary wall, or pericarp, which encloses one or more seeds. The pericarp is differentiated into three layers of tissues: the outer layer is exocarp, which commonly is called the skin or rind. The middle layer is mesocarp, which, generally, makes up the bulk of the pericarp. The inner layer is endocarp, which, in some fruits is tough, leathery, or hard, in other fruits is soft or fleshy.

All fruits may be classified into two broad categories: dry, and fleshy. The avocado falls into the latter category.

There are two main classes of fleshy fruits: drupes and berries. Drupes are characterized by having a fleshy mesocarp but a tough-leathery or bony endocarp. They are said to have "stones" or "pits" rather than seeds (example: peaches). Also, a drupe usually has only a single seed. Berries, to the contrary, are characterized by having a fleshy endocarp, as well as mesocarp, and may have more than one seed.

An avocado fruit is cut longitudinally, as above that the exocarp is the skin or rind. It may be very thin as in Mexican race avocados or thick and almost woody as in some of the large Guatemalan race fruits. The mesocarp is fleshy and makes up the bulk of the pericarp. The endocarp is thin, often not well differentiated from the mesocarp, and sometimes imperceptible. In some soft ripe avocados, it may adhere to the outer seed coat when the seed coat when the seed is removed from the fruit, giving the seed a sort of frosty appearance ((http://ucavo.urc.edu/)

2.12.1 Fruit colours: -

The avocado comes in a variety of colours, some of which are depicted here. As the avocado matures, the colour will often change in a way characteristic of that variety. Other varieties remain the same colour when immature or mature. Below are some typical colours found in avocados. (http://ucavo.urc.edu/)

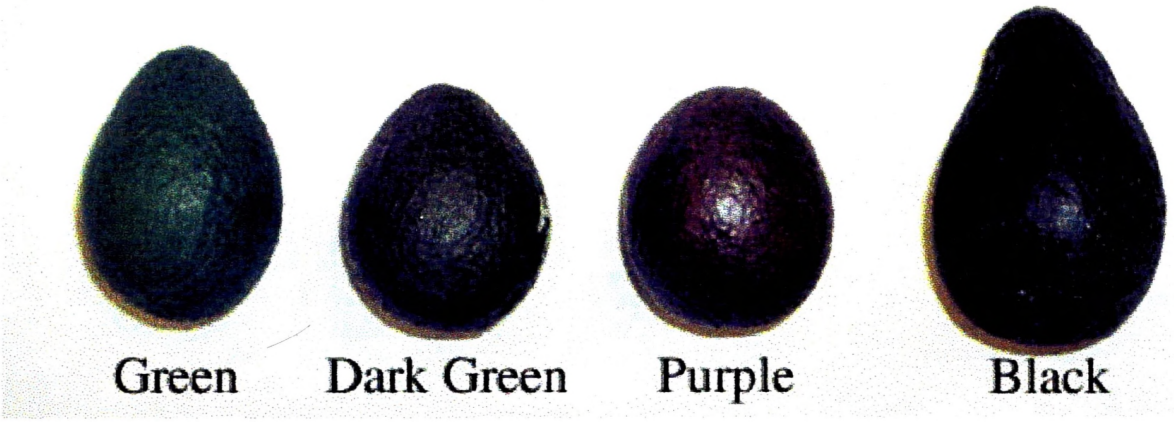

Figure 2.2: Different colours of the Avocado fruit

2.13 THE COMPOSITION OF FRUIT

The main constituent of any succulent fruit is water, which makes up from about 78 to 88% of the total weight; other volatile constituents, such as essential oils, esters, etc... are usually relatively negligible in quantity, although important from the point of view of flavour and aroma. The non volatile constituents include sugars, fruit acids, pectin and gums, woody fibre and cellulose, nitrogenous substances, mineral salts and, in a few cases, starch. Colouring maters, tannins and allied substances, and substances important in nutrition and medicine like ascorbic acid and alkaloids, may also be present in small quantities.

In most fruits the natural sugars, sucrose, glucose and fructose, constitute the greater part of the total soluble solids. The principle fruit acids are citric, malic and tartaric; others, which may be present in small quantities, are succinic, lactic and oxalic. (Morris, 1951)

CHEMICAL COMPOSITION OF AVOCADO FRUIT (per 100g of edible portion)

Table 2.4 General compositions of Avocado fruit

Energy value cal.	250.00
Protein (g)	1.70
Fat (g)	26.40
Total Carbohydrate (g)	5.10
Crude fibre (g)	1.80

Source: Fruits tropical and sub tropical 1991

Table 2.5 Minerals (mg) in Avocado fruit:

Calcium	10.00
Chlorine	11.00
Copper	0.45
Iron	0.60
Magnesium	35.00
Manganese	4.21
Phosphorous	38.00
Potassium	368.00
Sodium	3.00
Sulphur	28.50

Source: Fruits tropical and sub tropical 1991

Table 2.6 Vitamins (mg) in Avocado fruit:

Vitamin A as Carotene	0.17
Ascorbic acid	16.00
Niacin	1.10
Riboflavin	0.13
Thiamin	0.06

Source: Fruit tropical and sub tropical 1991

The pulp has a buttery consistency, looks very much like cow's butter and bland in taste with a nutty flavour. It does not have any offensive odour or smell; in fact, it has a pleasant aroma of the interior shell of a tender coconut. After attempting once or twice, people normally get used to the taste and start relishing it. The pulp may be preserved by freezing, and is used as a sandwich filling or spread, and in ice creams and milk shakes. The fruit has a very high fat content and may cause a slight indigestion if consumed too much, though the fat by it self, unlike animal fat, is harmless. As the sugar content is low it can be recommended as a high-energy food for diabetics. Avocado oil, which is similar in composition to olive oil, is widely used for the preparation of cosmetics. (Bose, and Mitra, 1991)

2.14 Uses:

Compared to other fruits, Avocados are highly nutritious, a good source of potassium and a moderate source of source of vitamin A. Avocado fruit do not contain cholesterol, and Florida varieties have less total fat than California varieties.

Cooking impairs flavour and appearance of avocados, but many satisfactory frozen products can be prepared. The most popular ways of serving the Avocado are in salads, as appetizers, dips. (http://edis,if as,ufl,edu/)

Chapter 3

Material and Methodology

3.1 Materials: -

3.1.1 Materials for sample preparation: -

1. Fresh avocado
2. Sugar
3. Water
4. Plastic Containers
5. Thermometer
6. Electronic balance
7. Measuring cylinders
8. Electronic blender

3.1.2 Materials for sensory evaluation: -

1. Four different samples
2. Ballet paper (Appendix I)

3.1.3 Materials for microbiological test: -

Apparatus: -

1. Electronic balance.
2. Sprit lamp
3. Incubator
4. Sterile laboratory glassware
5. Colony counter

Reagents: -

1. Ringer solution
2. Nutrient agar
3. Yeast extract agar
4. Antibiotic

3.2 Methodology.

3.2.1 Method of sample preparation: -

Fresh avocado were obtained from the local market in bulk. Damaged and spoiled ones were removed and the avocados were washed thoroughly in cold water to remove dirt, dust and insects if any.

Avocado fruits were cut lengthwise around the seed, then twisted the halves were in opposite directions to separate. A spoon was slipped between the seed and the fruit and worked the seed was out. Then the spoon was used between the skin and fruit to scooped the fruit away from the skin. Flesh was blended using a electronic blender to get a pulp.

3.2.1.1 First treatment: -

The fruit pulp, sugar and water were measured, according to the developed recipe. The ratio of mixture was 200g of pulp/ 180g of sugar/ 120g of water. The raw material and ingredients were mixed thoroughly and the paste or sauce was transferred to a saucepan and pasteurised at 70C for 10 minutes. Then the sauce was cooled using water bath and transferred to the plastic containers.

After that 150mg (300ppm) of ascorbic acid was added to the puree. And the sauce was transferred to the deep freezer.

3.2.1.2 Second treatment: -

180g of sugar and 130g of water mixed in saucepan and dissolved thoroughly. And then the mixture was boiled slowly to obtain sugar syrup. According to the developed recipe 200g of pulp and prepared sugar syrup were mixed thoroughly. After that 150mg (300ppm) of Ascorbic acid was added to the sauce and mixed slowly. Then the sauce was added with ice cream or transferred to the deep freezer.

3.2.1.3 Third treatment: -

The 200g of flesh were weighed using electronic balance. After that 180g of sugar were weighed and added to the flesh. Then the flesh and sugar were blended thoroughly. The sauce was transferred to the containers and 114mg (300ppm) of Ascorbic acid was added to the sauce. Then the sauce was added to the ice cream or the pulp was stored in deep freezer..

3.2.2 Method of sensory evaluation: -

First 3 samples of avocado sauce were mixed with vanilla flavoured ice cream, which obtained before hardening as a ripple respectively. Then the samples were labelled and transferred to the deep freer for hardening.
Then the 4 identical cups were labelled with 3 digit random numbers. Two tablespoons of three different samples and reference sample were put in to labelled cups respectively.

A hedonic test was conducted to determine the four samples of avocado ripple ice cream, using a five-point category scale. A group of 30 untrained panellists were selected and the testing method and the procedure was explained. Four samples were presented in four identical containers to the panellists. The samples containers were coded with three digit random numbers.

356- Sample which was prepared by the first method.

475- Sample which was prepared by the second method.

802- Sample which was prepared by third method.

572- Reference sample.

Four different samples were simultaneously presented to each panellist with a ballet paper. And the panellists were instructed to taste the samples and evaluate the degree of liking. By checking a category scale that ranged from like extremely to dislike extremely.

For data analysis, the category was converted to numeric scores ranging from 1 to 5 where 5 represented like extremely and 1 represented dislike extremely. The numerical scores of four samples were tabulated and analysed by Kruskal- Wallis test. (Appendix ii)

3.2.3 Method of microbiological tests: -

3.2.3.1 preparation of the media: -

Yeast extract agar:
Suspended 23g in 1 litre of distilled water. Bring to the boil to dissolve completely sterilize by autoclaving at 121° C for 15 minutes.

Nutrient agar:
Suspended 28g in 1 litre of distilled water. Bring to the boil to dissolve completely. Sterilize by autoclaving at 121°C for 15 minutes.

3.2.3.2 Preparation of the dilutions:

First dilution: 10g of sample was weighted and added to the 90ml of ringer solution. And the mixture was mixed thoroughly.

Second dilution: the 10ml of first dilution was measured to the sterile pipette and added to the 90ml of ringer solution. Then the mixture was mixed thoroughly.

3.2.3.3 pour plate techniques for total plate count: -

1ml of first dilution was aseptically introduced into sterilized plates and approximately 15- 20 ml of nutrient agar was poured. The temperature of agar was 45°C. Then the lid was closed and shaken gently for even distribution of media in petri dish. After that it was kept in few minutes at a room temperature for solidify the nutrient agar.

The solidified plates were placed upside down in the incubator and temperature was set at 30- 35°C, and incubated for 48 hours.

Colonies appearing in the media were counted by using the colony counter and the results were recorded.

The same procedure was repeated for second dilution. (Gunasekaran, 1995)

3.2.3.4 pore plate techniques for yeast and mould: -

1ml of sample was aseptically introduced into sterilized plate and approximately 15-20ml of yeast extract agar with antibiotic was poured. (50ml of yeast extract agar was prepared by adding 1ml of antibiotic) The temperature of yeast extract agar was 45°C. Then the lid was closed and shaken gently for even distribution of media in petri dish. After that it was kept in few minutes at a room temperature for solidify the yeast extract agar.

The solidified plates were placed upside down in the sterilized table in room temperature for 72 hours.

Colonies appearing in the media were counted by using the colony counter and the results were recorded. (Gunasekaran, 1995)

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Results of the sensory evaluation (Appendix ii)

4.1.1 Results of the taste

Table 4.1 Analysis results of sensory evaluation on taste

Sample	Average rank
1	67.6
2	61.5
3	74.1
4	38.8

P = 0.000

According to the table No: 4.1 the p value for the test is less than 0.05. This implies that a significant difference exists among the four samples at 5% significant level. When average rank value is considered number 3 sample has the highest rank value. So the sample no 3 can be considered the best when considering the taste.

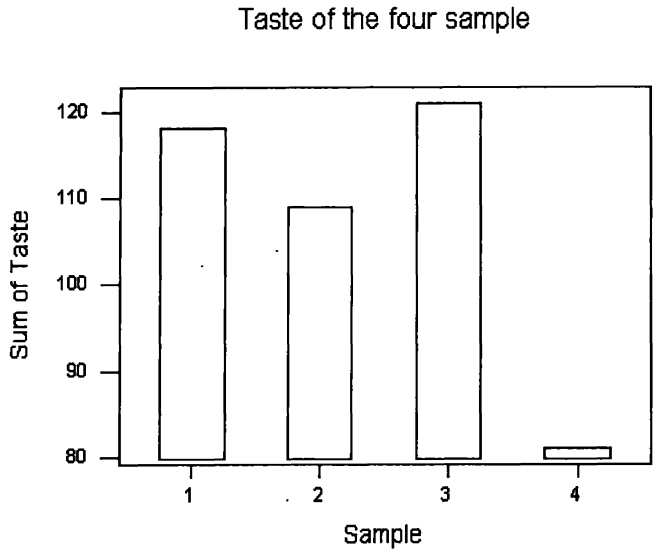

Figure 4.1: Sum of taste of the four samples

According to the figure no. 4.1 this graph illustrate that third sample has highest value of sum when considering the taste. These results illustrate that sample no 3 as the best.

4.1.2 Result of the smell

Table 4.2 Analysis results of sensory evaluation on smell

Sample	Average rank
1	61.6
2	64.4
3	68.4
4	47.6

P = 0.072

According to table no 4.2 the p value for the test is greater than 0.05. This implies that a no significant difference between the four samples at 5% significant level. When rank values are considered, number 3 sample has highest rank value. So the sample no 3 can be considered the best when considering the smell.

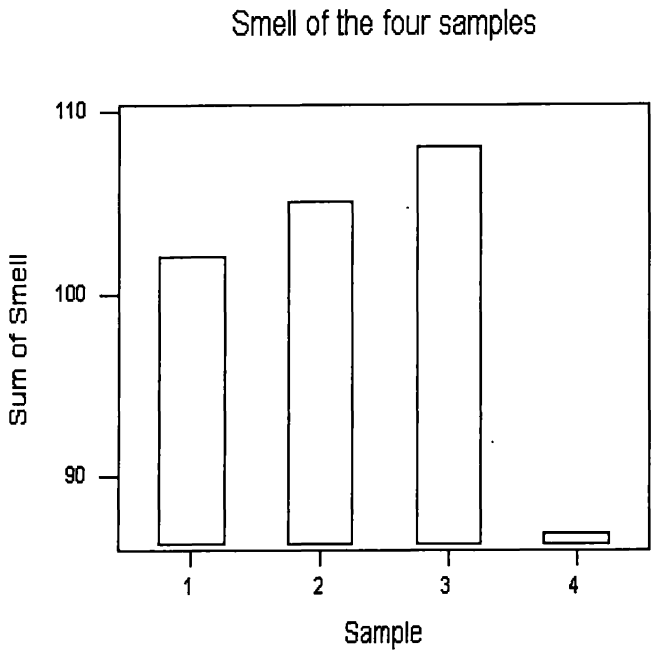

Figure 4.2: Sum of smell of the four samples

According to the figure no. 4.2 this graph illustrate that third sample has highest value of sum when considering the taste. These results illustrate that sample no 3 as the best.

4.1.3 Results of the colour

Table 4.3 Analysis results of sensory evaluation on colour

Sample	Average rank
1	68.6
2	63.2
3	55.1
4	55.1

P = 0.316

According to table 4.3 the p value for the test is greater than 0.05. This implies that no significant difference between four samples at 5% significant level. According to ranks values number 1 sample has highest rank value. So the sample no 1 can be considered the best when considering the colour.

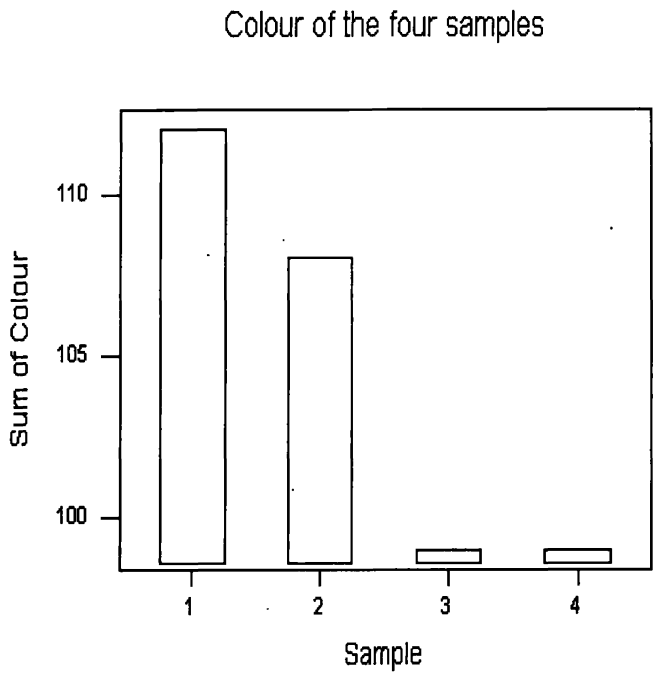

Figure 4.3: Sum of colour of the four samples

According to the figure no. 4.3 this graph illustrate that first sample has highest value of sum when considering the taste. These results illustrate that sample no 1 as the best.

4.1.4 Results of texture

Table 4.4 Analysis results of sensory evaluation on texture.

Sample	Average rank
1	59.3
2	62.7
3	65.1
4	54.9

P = 0.653

According to table 4.4 the p value for the test is greater than 0.05. This implies that no significant difference between four samples. According to average rank value number 3 sample has high rank. So the sample no 3 can be considered the best when considering the colour.

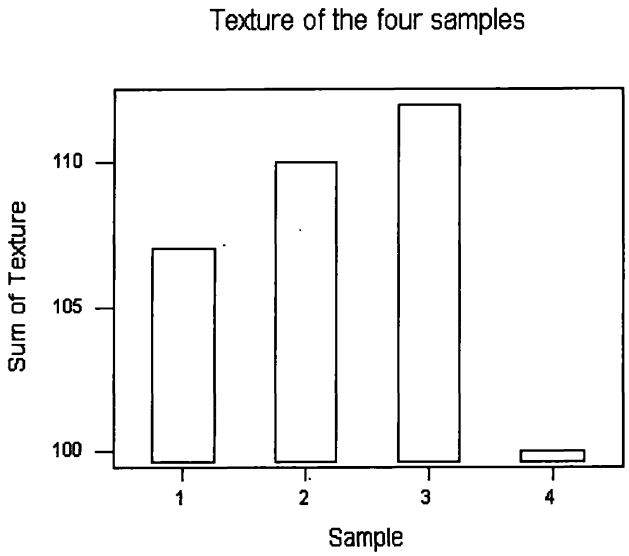

Figure 4.3: Sum of colour of the four samples

According to the figure no. 4.4 this graph illustrate that third sample has highest value of sum when considering the texture. These results illustrate that sample no 3 as the best.

4.1.5 Results of the overall acceptability

Table 4.5 Analysis results of sensory evaluation on overall acceptability.

Sample	Average rank
1	67.2
2	63.6
3	74.5
4	36.6

P = 0.000

According to table 4.5 the p value for the test is less than 0.05. This implies that a significant difference exists among the samples. According to average ran value number 3 has highest rank. So the sample no 3 can be considered the best when considering the colour.

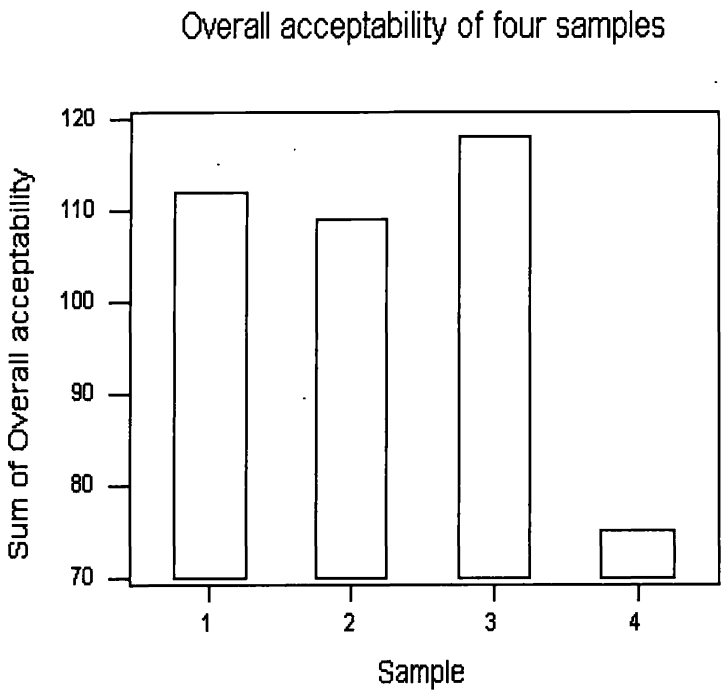

Figure 4.5: Sum of overall acceptability of the four samples

According to the figure no. 4.5 this graph illustrate that third sample has highest value of sum when considering the overall acceptability. These results illustrate that sample no 3 as the best.

4.2 Results of the microbiological test

Table 4.6:Results of total plate count test

Sample	First dilution	Second dilution
1	1070/g	1700/g
2	Uncountable	6200/g
3	1620/g	3400/g

According to table 4.2.1 the results shows that the sample no.2 has high amount of counts. This sample is not pasteurized and also it contains high amount of water.

4.7: Results of the yeast and moulds

Sample	First dilution
1	380/g
2	390/g
3	550/g

According to table 4.2.2 no.2 and 3 samples have high number of counts. Reasons for high count may be the samples were not heat-treated.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study was focused on the development of value added ice cream using Avocado. Through out this research, an attempt was taken to development of a puree form avocado with extended shelf life. According to the results, it can be concluded that adding sugar and preservatives can preserve avocado pulp. The results obtained in the sensory evaluation revealed that the best sample is number 3,i.e. the sample that was prepared by adding powdered sugar and preservatives.

5.2 Suggestions.

This method can be used to preserve avocado pulp to introduce into ice cream as value addition. The product will provide a high nutritive value than normal ice creams and it is also a new product to the market.

5.3 Recommendation for the further studies

In this research, two samples are prepared but heat treatment was not given. Because avocado can't heat treat, as it develops bitter taste and impairs flavour and appearance of Avocado. But in these samples microbial counts are high. If a strong preservative is used instead of ascorbic acid, can obtain a puree that is safer microbiologically. Further studies should be done with other preservatives.

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http://edis,ifas,ufl,edu/

http://ucavo.urc.edu/

(University of California, Department of Agriculture & Natural Resources.)

Appendix I

Name: .....

Date: .....

Please taste each samples in order listed bellow. Rank the samples for the following attributes using the category scale given bellow.

Attribute	Code 356	475	802	572
Taste	.....	.....	.....	.....
Smell	.....	.....	.....	.....
Color	.....	.....	.....	.....
Texture	.....	.....	.....	.....
Overall acceptability	.....	.....	.....	.....

Category scale:

1- Dislike extremely
2- Dislike slightly
3- Neither like nor dislike
4- Like slightly
5- Like extremely

Comments -.....
.....
.....
.....

Appendix ii

Kruskal-Wallis Test

Kruskal-Wallis Test on Taste

Sample	N	Median	Ave Rank	Z
1	30	4.000	67.6	1.29
2	30	4.000	61.5	0.17
3	30	4.000	74.1	2.48
4	30	3.000	38.8	-3.94
Overall	120		60.5	

H = 17.53 DF = 3 P = 0.001
H = 19.21 DF = 3 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test

Kruskal-Wallis Test on Smell

Sample	N	Median	Ave Rank	Z
1	30	3.000	61.6	0.20
2	30	3.000	64.4	0.72
3	30	4.000	68.4	1.44
4	30	3.000	47.6	-2.35
Overall	120		60.5	

H = 6.11 DF = 3 P = 0.106
H = 6.99 DF = 3 P = 0.072 (adjusted for ties)

Kruskal-Wallis Test

Kruskal-Wallis Test on Colour

Sample	N	Median	Ave Rank	Z
1	30	4.000	68.6	1.47
2	30	4.000	63.2	0.48
3	30	4.000	55.1	-0.98
4	30	4.000	55.1	-0.98
Overall	120		60.5	

H = 3.22 DF = 3 P = 0.359
H = 3.54 DF = 3 P = 0.316 (adjusted for ties)

Kruskal-Wallis Test

Kruskal-Wallis Test on Texture

Sample	N	Median	Ave Rank	Z
1	30	4.000	59.3	-0.22
2	30	4.000	62.7	0.39
3	30	4.000	65.1	0.84
4	30	3.500	54.9	-1.01
Overall	120		60.5	

H = 1.45 DF = 3 P = 0.694
H = 1.63 DF = 3 P = 0.653 (adjusted for ties)

Kruskal-Wallis Test

Kruskal-Wallis Test on Overall

Sample	N	Median	Ave Rank	Z
1	30	4.000	67.2	1.22
2	30	4.000	63.6	0.57
3	30	4.000	74.5	2.55
4	30	2.000	36.6	-4.35
Overall	120		60.5	

H = 20.42 DF = 3 P = 0.000
H = 22.22 DF = 3 P = 0.000 (adjusted for ties)

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