Manufacture of Yoghurt ice cream in small scale.

By

M.S.S Kariyawasam.

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Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala Sri Lanka

DECLARATION

The work is described in this thesis was carried out by me at Cathy Rich Memorial Food Processing training Centre under the supervision of Mr C.Edirisinghe and Mr. M.A.J.Wansapala. . A report on this has not been submitted to any other University for another degree.

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M.S.S Kariyawasam.

Date : 04/01/2001

Certified by

....

Date : 01/01/01

Mr C.Edirisinghe,
External Supervisor,
Manager,
Cathy Rich Memorial Food Processing Training centre,
Yodagama,
Embilipitiya.

....

Date : 01/01/2001

Mr.M.A.J.Wansapala,
Internal Supervisor,
Co-ordinator/Food Science and Technology,
Faculty of Applied Sciences,
Sabaragamuwa University of Sri Lanka,
Buttala, Sri Lanka.

**AFFECTIONATELY DEDICATED
TO MY EVERLOVING
PARENTS
BROTHERS AND SISTERS**

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Abstract

Yoghurt-ice cream is a newly developed dairy product, which becomes popular among Europeans and Americans. It is a fermented dairy product. The special features of this product are its high nutritive value with all the benefits of fermentation. It is also consider as good healthy food for people with lactose intolerance. So there is a good demand for yoghurt-ice cream at present.

The main problems of manufacturing of yoghurt-ice cream in Sri Lanka are there is no suitable starter culture and it is not available in the local market. Therefore, there is a possibility of using locally available yoghurt-culture for above purpose. However, the possible problems occur with the yoghurt culture is the high acidity which is undesirable. The aim of this project is to identify the potential problems when use yoghurt culture for the manufacturing yoghurt-ice cream and find solutions for them. The main problem found was the high acidity. Therefore, some treatments were applied to find the desirable time temperature combination for the fermentation. A sensory evaluation and some physiochemical tests were carried out to determine the preference of above treatments.

Based on the result, it concluded yoghurt-ice cream could be manufacture by using locally available yoghurt culture in small-scale industry. Also the results indicate the desirable pH value of yoghurt-ice cream is around 4.76 and suitable time temperature combination for the fermentation is 40^{0}C for 2.5 hours.

Table of content.

List of tables.

List of figures.

Chapter 1.

Introduction.

Milk is a natural, well balance food that is essential to humans and other mammals. Nutritionally it is perfect and natural food. Milk contain almost all the nutrients such as carbohydrates, fat, protein, vitamins and minerals. However, milk can be spoiled readily due to microbial activity. Because of this, people try to preserve it by preparing yoghurt, butter, curd, cream etc. Ice cream is one of a dairy product, which is very popular as a frozen dairy product. Demand for ice cream is very high due to its nutritional value, taste and appearance. However, at present, a value added product called yoghurt-ice cream becomes more popular in Europe and America.

Yoghurt-ice cream is a well-nourished dairy product with new flavour, It is firstly developed at the National Dairy Research Institute, Kernal. It is a combination of two product yoghurt and ice cream. The importance of this product is its nutritive value as a fermented dairy product. The general processing steps of yoghurt-ice cream preparation involve standardizing, pasteurizing, homogenizing, cooling, inoculation, incubation, addition of flavour, cooling, aging, air incorporation and freezing, and hardening.

Some potential problems of manufacturing of yoghurt-ice cream in small scale are lack of suitable starter culture with desired microorganisms and lack of technology that can be adopted in small-scale industry. The normal yoghurt-ice cream starter culture consists of *Streptococcus salivarious* spp. *thermophiilus*, *Lactobacilus delbrukii* spp, *balgaricus*, *Lactobacilus acidophilus and Bifidobacterium*. This kind of starter culture is not available in Sri Lanka. So, it should be imported from countries like New Zealand, which is very expensive. Therefore, in small-scale manufacturing, there is possibility of using this locally available yoghurt culture in preparation of yoghurt-ice cream.

In Sri Lanka, yoghurt is produced by fermenting milk with a 1:1 mixture of *streptococcus thermophillus* and *Lactobacillus balgaricus*, which are the most common bacteria used in the mother culture. *Streptococcus* spp are responsible of flavour and *Lactobacilus* spp are provide acidity to the product.

In yoghurt-ice cream high acidity is not suitable becaus it lower the sens qualties of the f product But when use normal yoghurt culture with same time temperature combination (at 42^{0}C for 4 hours) that use in yoghurt making, it gives high sour taste with large curd particles, because it consist of large number of *Lactobacillus* spp. In this case the incubation time and the inoculation time must be change to reduce number of acid forming microorganisms to get desired acidity and flavour with optimum fermentation.

Objectives of project.

1. To identify the possibility of manufacturing yoghurt-ice cream in small industry.
2. To develop a manufacturing process that can be adopted in small scale.
3. To find suitable time temperature combination for fermentation of ice cream mix by using locally available yoghurt culture.

Chapter 2.

2. Literature review.

2.1. Historical back ground of ice cream.

When ice cream is first found is not known. No reference was yet found on literature. Ice cream probably is evolved from ice beverages and water ices that were popular in Europe. It is come to known that the idea originated in ancient Egypt or Babylon. The evidence of this product reported from ancient Rome. In addition, there is some evidence found from China. The Romans and Chinese used snow and ice brought down from the mountains to prepare frozen delicacies, flavoued with fruit, wine and honey for their Emperors in the first century.

Marco Polo introduces recepies (water ices, sorbet and soerbets) from China. These recepies are known to be used in Asia for thousands of years. Later ice cream becomes popular in France and England through Royal families. Ice cream was probably introduced to United State from Europe. In 1800, the first retail ice cream business was first established in Germantown, Pennsylvania, in U. S. A.

In 1851, Jacob Fusell, in Baltimore, Maryland (U. S, established the first wholesale ice cream industry). They use manually operated tub churns with crushed ice and salt as the freezing medium. Mechanization was first introduced to ice cream industry in 1855. In 1921 first chocolate- coated ice cream bar (I- scream Bar) was manufactured in U. S. A.

The ice cream soda was introduced in 1879 and ice cream corn was manufactured in 1904. After 1920s ice cream become very popular among many countries with the recognization of value of ice cream as an essential food. With the development of storage equipments (refrigerators and low temperature storage units for homes), packing, transportation and product standards ice cream become more popular and widely available to the consumer.
(Arbukle, 1986)

2.2. Definition of ice cream.

According to food, classification ice cream and related foods are generally classified as frozen desserts. According to many writers ice cream, ice milk, sorbets, water ice, frozen custard, frozen confection and mellorone are considered as frozen desserts. Ice cream is a product which may contain a variety of ingredients in addition to milk, cream, non-fat milk solids with sugar, dextrose, corn syrup in dry or liquid form, water and with or with out eggs or egg products, permitted flavours, colours, emulsifiers and stabilizers.

In 1905 the U. S Department of Agriculture defines ice cream as follows: "ice cream is a frozen product made from cream and sugar, with or without a natural flavouring and containing not less than 14 per cent of milk fat. Fruit and nut ice cream must contain not less than 12 per cent of milk fat".

But the most broad definition of ice cream is mentioned in the Minnestota State Legislature of 1949 including the specifications of the percentages of ingredients and processing techniques such as freezing and agitation. This definition is as follows:

"ice cream means the clear, pure frozen products and one or more of the following ingredients: eggs, sugar, dextrose, corn syrup in liquid or dry form, and honey, with or without flavouring and colouring, and with or without edible; gelatin or vegetable stabilizer: and in the manufacture of which freezing has been accomplished by agitation of the ingredients. It contain not more than 0.5 per cent by weight of edible gelatin or vegetable stabilizer; not less than 12 per cent by weight of milk fat, and not less than 20 per cent by weight of total milk solids, except when, fruits, nuts, cocoa or chocolate, maple syrup, cakes or confections are used for the purpose of flavouring, then it shall not contain less than 12 per cent by weight of milk fat and not less than 20 per cent by weight milk solids, except for the reduction in milk fat and in total milk solids as is due to the addition of such flavouring, but in no case 16 per cent by weight of total milk solids In no case shall ice cream contain less than 16 per cent by weight of total milk solids. In no case shall any ice cream contain less than 1.6 pounds of total food solids per gallon or less than 4.5 pounds per gallon".
(Ecles *et al*, milk and milk products, 1993)

2.3. Composition of ice cream.

The composition of ice cream depends upon the ingredients used by deferent manufactures. Therefore, there is no definite composition for any type of commercial ice cream. In addition, deferent manufactures in deferent countries use various types of formulas for deferent localities because of this. However, the minimum amounts of different constituents of commercial ice cream are recommended in most countries.

Table 2.1: Composition of good average ice cream.

Fat	12%
MSNF	11%
Sugar	15%
Stabilizer and emulsifier	0.3%
Essence	Trace
Total solids	38.3%

Source: ice cream 1990.

Table 2.2:Ranges in compositions.

Fat	8 -12%
MSNF	8 -15%
Sugar	13 - 20%
Stabilizer and emulsifier	0 – 0.7%
Total solids	36 - 43%

Source: ice cream workshop 1999.

Table 2.3: Composition of ice cream.

Water	87%
Fat	4%
Protein	3%
Carbohydrates (lactose) and minerals	6%
	100%

Source: Ice cream 1990.

Table 2.4: Compositions of premium and average ice cream.

Component	Composition Premium	Average
Milk fat	16%	10.5%
MSNF	9%	11.0%
Sugar	16%	12.5%
Corn syrup solid	-	5.5%
Stabilizer	0.1%	0.3%
Emulsifier	-	0.1%
Total solids	41.1%	39.9%

Source: Food science 1987.

The best ice cream composition for the manufacture to produce is often difficult to establish after consideration is given to legal requirements, quality of product desired, raw materials available, plant procedures, trade demand, competition, and cost, there is a choice of product of minimum, average, or high milk solid composition.

In ice cream the percentage of milkfat varies more than any other constituent does. The milk fat contain may vary from 8 – 24%, depending upon such factors as state or city requirements, grade, price and competition. As the fat content of ice cream is increased, the milk solid non-fat must decreased so as to avoid "sandiness" (i.e., the crystallization of milk sugar or lactose in the finished ice cream).

The composition that avoid sandiness and permit recognition of particular local preferences as sugar content, fat content etc., of commercial ice cream and related products. These local preferences and quality of ingredients, as well as the technique of manufacture, are fully as important as the composition in determining the best ice cream for that locality.

Some of the characteristics that merit considerations are cost, handling properties (including mix viscosity, freezing point and whipping rate of the mix), flavor, body and texture, food value, colour and general palatability of the finished product. In developing, the formulation to fulfill the needs of any particular situation, numerous factors must be considered. These include the personal preference of company management or customer demand for flavour, body and texture, and colour characteristics of the finished products, smooth, chewy to heavy, or corser texture; higher over run or more cooling body and texture characteristics; or increase milk to intensify colour in various products. Other factors might include meeting composition standards; the nature of the competition; type of manufacturing operation; source, availability, and cost of dairy and nondairy ingredients; volume of operation; and desired quality of ingredients.

Although the methods of processing and freezing influence the characteristics of the mix and finished product, the effects if constituents supplied by the ingredients is also important. Therefore, the role of each constituents (fat, MSNF, sweeteners, stabilizer, egg solids, optional ingredients, flavour and colours) is important in contributing to the characteristics of the ice cream.

(Arbukle, W. S. Ice cream, 1986)

Table 2.5: Approximate composition (%) of commercial ice cream and relater products.

Product	Milkfat	MSNF	Sugar	Stabilizer and emulsifiers	Approximate
Economic ice cream	10.0 12.0	10.0 – 11.0 9.0 – 10.0	15.0 13.0 – 16.0	0.3 0.2 – 0.4	35.0 – 37.0
Trade brand ice cream	12.0 14.0	11.0 8.0 – 9.0	15.0 13.0 – 16.0	0.30 0.2 – 0.4	37.5 – 39.0
Deluxe ice cream (premium- super premium)	16.0 18.0 - 20.0 20.0	7.0 – 8.0 6.0 – 7.5 5.0 – 6.0	13.0 – 16.0 16.0 – 17.0 14.0 – 17.0	0.2 – 0.4 0.0 – 0.2 0.0 – 0.2	40.0 – 41.0 42.0 – 45.0 46.0
Ice milk	3.0 4.0 5.0 6.0	14.0 12.0 11.5 11.5	14.0 13.5 13.0 13.0	0.4 0.4 0.4 0.35	31.4 29.0 – 30.0
Sherbet	1.0 – 3.0	1.0 – 3.0	26.0 – 35.0	0.4 – 0.5	28.0 – 36.0
Ice	–	–	26.0 – 35.0	0.4 – 0.5	26.0 – 35.0
Mellorine	6.0 – 10.0	2.7 (Protein)	14.0 – 17.0	0.4	36.0 – 38.0
Frozen yogurt	3.25 – 6.0 0.5 – 2.0	8.25 – 13.0 8.25 – 13.0 8.25 – 14.0	15.0 – 17.0 15.0 – 17.0 15.0 – 17.0	0.5 0.6 0.6	30.0 - 33.0 29.0 – 32.0 28.0 – 31.0
Dietary frozen dessert	< 0.5 < 2	Not less than 7% TMS	11.0 – 13.0 or more	0.5	18.0 – 20.0

Source; Milk and its properties 1993

2.4. Role of the constituents.

2.4.1. Milk.

Since milk is the source of the dairy products used as ice cream ingredients, it is important to have an understanding of its composition and properties.

Milk is composed of water, milkfat, and MSNF. The TS content of milk includes all the constituents of milk except water. The MSNF constituents are those found in skim include, lactose, protein, and minerals. These solids are also referred to as skim milk solids, and serum solids (SS).

The composition of milk is influenced by numerous factors. For example, the MSNF content varies with the fat content of milk. A 0.4% change in MSNF for each 1% change in fat may be used in general way to determine the MSNF content of milk at the various fat levels.

Milk is produce in the mammary gland from constituents supply through the blood. Some constituents may pass through the mammary system and in to the milk by filtration, but most of them are secreted or produced by the mammary gland. As a result, certain of the constituents of milk, including milkfat, casein, and lactose, are found in major amounts only in milk.

(Arbukle and Creemers, 1954)

Milk is a structurally complex physiochemical system. The approximate composition of milk is as follows:

Table 2.6: Approximate composition of milk.

Constituents	Mean %	Normal variation %
Water	87.1	82.10 - 89.44
Fat	3.9	2.60 - 8.37
Protein	3.3	2.44 - 6.48
Lactose (milk sugar)	5.0	2.41 - 6.11
Ash (mineral)	0.7	0.56 - 0.97
MSNF	9.0	7.20 - 11 90
TS	12.9	10.56 - 17.90

Source: milk and its properties 1993.

Table 2.7: Physical properties of milk.

Property	Value
Acidity (%)	0.16 ± 0.02
PH	6.6 ± 0.2
Surface tension (dynes)	55.3
Specific gravity	1.032 ± 0.004
Freezing point (^{0}C)	-0.55
Boiling point (^{0}C)	100.17
Specific heat at	
0^0C	0.920
15^0C	0.938
40^0C	0.93
Coefficient of expansion at	
10^0C	0.9975
15.6^0C	0.9985
21.1^0C	1.0000
Viscosity (cP)	1.6314
Electrical conductivity (mbo)	$45 - 48 \times 10^{-4}$

Source: Ice cream 1987.

2.4.2. Milkfat.

Milkfat is an ingredient of major importance in ice cream. The use of the correct percentages is vitally essential not only to balance the mix properly, but also to satisfy legal standards. Studies tent to show consistently that the fat particles concentrated towards the surface of the air cell during the freezing process in ice cream. This perhaps counts, in part, for milkfat imparting in rich characteristic to the flavour (Creamers and Arbuckle, 1954). Milk fat does lower the freezing point. It tends to retard the rate of whipping. High fat content may limit the consumption, will have a high caloric value, and will increase the cost. The fat content of commercial ice cream is usually 10 – 12% the best source of milk fat is fresh cream. (King, 1950) Other sources are frozen cream, plastic cream, butter, butter oil and condensed milk blend. Milkfat is associate with small amount of phospholipids of which lecithin is one of the most important in contributining to its properties. Milkfat contribute a subtile flavour quality, is good carrier and synergist for added flavour compounds, and promotes desirable tactual qualities (Doan and Keeney, 1965). It is characteristic noted that account for superior flavour qualities of frozen dairy foods made from fresh milkfat compared with those made from vegetable fat(Doan and Keeney, 1965).

2.4.3. Milk solid non fat (MSNF).

MSNF is the solid of skim milk, and consist of protein (36.7%), milk sugar (lactose; 55.5%), and minerals (7.4%). It is high in food value, is expensive and while not adding much to the flavour of ice cream, does enhance its palatability. The lactose added largely to the sweet taste largely produce by added sugar, and the minerals tend to have a slightly salty taste, which rounds out the flavour of the finished product.

The protein in the MSNF help to make the ice cream more impact and smooth, and thus tend to prevent the weak body and coarse texture. Therefore as much MSNF as can be added is desirable except that excess of milk solid non-fat in a salty, overcooked, or condensed milk flavour. MSNF increase viscosity and resistance to melting, but also lower the freezing point. Variation over the usual range of concentration have no pronounced effect on whipping ability, but variations in the quality of the MSNF do have an important influence on it.

MSNF varied inversely with fat content in order to maintain mix balance and to ensure good body texture and storage properties. However, one problem that occurs is that the high concentration of lactose, which may crystallize under certain conditions, can cause sandiness in texture. Because of the many factors that may effect lactose crystallization, it is difficult to give a statistically certain limit to the percentage of MSNF that should be used in an ice cream mix. However, as rile of thumb, the MSNF should be no more than 15.6 – 18.5% of the total solids in the mix, depending on whether the turnover will be slow or rapid. (Keeney, 1958)

2.4.4. Emulsifiers.

Emulsifiers are used in manufacture of ice cream:

1. To produce a finished product with smoother texture and stiffer body.
2. To reduce the whipping time.
3. To give the mix a uniform whipping quality.

The use of emulsifiers results in air cells are smaller and more evenly distributed throughout the internal structure of the ice cream. While egg yolk solids may produce similar results, there effect is not so pronounced.

The emulsifying ingredients commonly used in ice cream industry are mono- and diglycerieds of fat forming fatty acids. One or the other, or both, may be used in a mix. The total amount of emulsifier may not exceed 0.2%. The use of two polyoxyethyline type emulsifiers-sorbitan tristearate and polysorbate-has was authorized as safe in food in frozen dairy foods, but only up to 0.1% limit. The excessive use of emulsifiers may result in slow melting, and body and textural defects.

2.4.5. Stabilizers.

Stabilizers are used to prevent the formation of objectionable large ice crystals in ice cream and are used in such small amounts as to have a negligible influence on food value and flavour. There are of two general types:

1. Gelatin stabilizer which come from animal source (such as calfskin, pork skin, and bones), and which supply certain desirable amino acids.
2. Vegetable stabilizer such as sodium alginate, carrageenan, agar-agar, CMC (sodium carboxymethilcellulose), and gums such as tragacanth, karaya, and oat gum.

All stabilizers have higher water holding capacity, which is effective in smoothing the texture and giving body to the finished product. Thus, there effect on flavour is indirect. They increase viscosity, have no effect on the freezing point, and with a few exceptions tend to limit whipping ability. Their most important function is to prevent coarsing of texture under temperature fluctuations in retail cabinets.

The amount of stabilizer to use varies with its properties, with the solid content of the mix, with the type of processing equipment, and with other factors. The amount use may be in range 0 – 0.5%, but generally is from 0.2% to 0.3%.

Stabilizers extensively used in frozen dairy foods include sodium and propylene glycol alginates, CMC, guar gum, locust beam gum, carrageenan (Irish moss extract), gelatin, and pectin. The alginate has an immediate stabilizing effect upon addition to mix. CMC produces a chewy characteristic in the finished product. Gelatin process a thin mixes and requires and aging period. Pectin is used in combination with the gums as sherbet or stabilizer.

The uses of stabilizers are as follows:

1. Improves smoothness of the body
2. Aid in preventing ice crystal formation in storage.
3. Gives uniformity of product.
4. Gives desired resistance to melting.
5. Improve handling properties.

The problems that comes from using excessive amounts of stabilizers:

1. Undesirable melting characteristics
2. Soggy or heavy body

Commercial stabilizer products are usually blends of the various stabilizing materials in the proportions necessary to give the desired characteristics in the frozen product.
(Arbukle, 1986)

2.4.6. Total solids (TS).

TS replace water in the mix, thereby increasing the nutritive value and viscosity, and improving the body and texture of the ice cream. This is especially true when the increase in TS is due to added dextrin (prosugers), sweet cream buttermilk solids, or eggs. Egg yolk solids, like sweet cream, butter milk solids, improve the whipping ability and shorten the freezing time. Increase the percentage of TS decrease the percentage of frozen water and frequently permits a higher overrun while maintaining the minimum of 1.6lb of food solids per gallon of ice cream. During the hot weather one disadvantage is that the increase in calorie content associated with TS somewhat reduce the cooling effect of the ice cream. A heavy soggy product results when the TS content is too high, i.e., above 40-42%. (King, 1950)

2.4.7. Water and air.

Water and air are important constituents of ice cream, but can easily be overlooked. Water is continues phase, which is present as a liquid, a solid, or as a mixture of the two physical states. The air is dispersed through the water-fat emulsion, which is composed of liquid water, ice crystals and solidify fat globules. The interface between the water and air is stabilizing by a thin film of unfrozen material. The interface of the fat are covered by a layer of fat emulsify agents.

Water in the ice cream mix comes from fluid dairy products, or from added water. The water from milk, having passed through mammary gland, may be expected to be clean. The water from the other sources must come from a supply where purification is assured.

In the manufacture of ice cream, the overrun or increase in volume of ice cream over the volume of mix used is due to the incorporation of air. The amount of air in ice cream is important because it influences quality, is involved in meeting legal standards, and influences profit. Maintaining a uniform amount of air is important in quality and product control.

Studies have been conducted on gases other than air in ice cream. Researchers have developed a method of injecting in to the mix during the freezing process liquid nitrogen (N_2) at atmospheric pressure and at a temperature well below that of milk. (Arbukle, 1986)

2.5. Nutritional value of ice cream.

Although ice cream is known as a frozen dessert, it is a healthy and nutritious food. It provides all the nutrients such as carbohydrates, proteins, fat minerals and vitamins. The nutritional value depends on the composition of the deferent ingredients.

Table 2.8: Composition of Plain Ice cream (per 100-g Edible Portion)

Constituent	Good Average Ice cream.
Water%	61.7
Food energy%	96.7
Protein%	4.1
Fat%	12.7
Total Carbohydrates%	20.7
Weight per 100-cal portion (g)	50.8

Source: Ice cream plant and manufacture 1988.

2.5.1. Carbohydrates.

The most abundant nutrient found in ice cream is carbohydrates. Carbohydrates are the main source in energy and heat in the body. The main carbohydrates found in the ice cream are sugar. In the manufacture of ice cream, several types of sugars are use as sweeteners, which may be from either beet or cane. Sucrose is the most commonly used sugar in ice cream, which is a disaccharide, consists of both glucose and fructose. Also lactose, which is only found naturally in milk present in ice cream. Lactose is very important in human body to maintain the intestine microflora (Lactobacillus *acidophilus*) to control acidic condition in intestine, assimilation of calcium and utilization of phosphorus. Some other sugars may come in to ice cream with additional ingredients such as fruits According to many writers the carbohydrates, percentage in good average ice cream is 20.7% (per 100g edible portion). (Arbukle, 1986)

2.5.2. Protein.

Proteins are essential to human body as building material of protoplasm and cells. Ice cream is rich of all the milk proteins. The most significant importance about milk protein is it contains all the essential amino acids such as tryptophan and lysine. The protein content of good average ice cream is 4.1% (per 100g edible portion).

2.5.3. Fat.

Fat is consisting of glycerol and fatty acids, fatty acids may be found as either saturated or unsaturated form. Fat may come to ice cream with deferent ingredients, especially with milk, cream or vegetable base oils. Milk fat consists mainly of trygleceried of fatty acids. Milk fat contains around sixty fatty acids. It also contains non-saponifiable fractions and other compounds such as lecithin, tocopherol and cholesterol.

Fat are insoluble in water and soluble in ethyl or other solvents use to extract them. Determination by extraction method for milk fat has been well standardized.

The fatty acids are released from glycerol on saponification and the early determination, before 1955. Now it is replaced by GLC method.

Cholesterol may be determined by colorimetric or precipitation method.

Table 2.9: Selected fatty acids and cholesterol in ice cream (per 100g edible portion).

Item	Total (g)	Fatty acids			Cholesterol (mg)
		Total unsaturated (g)	Unsaturated oleic (g)	Linoleic (g)	
Ice cream	12.5	7.0	4.0	Trace	45.0
Ice ream	2.4	1.0	1.0	Trace	0 0

Source: Ice cream 1986.

2.6. Technology / manufacturing process.

Ice cream manufacturing is consisting of essential major steps mentioned as follows.

1. Selection of the ingredients.
2. Calculating the mix.
3. Preparation of the ice cream mix.
4. Blending.
5. Pasteurization.
6. Homogenization.
7. Aging the mix.
8. Freezing.
9. Hardening.

2.6.1. Selection of ingredients.

The various ingredients normally used are water, milk fat, milk solid non-fat, sugar (sucrose), stabilizers and emulsifiers. These ingredients may found in either liquid form or solid form. The quantity and quality of the ingredients should be fulfilling the regiments of national or international standards.

These ingredients are used to give different physical and chemical properties to the ice cream; such are resistance to melting, smoothness, ice crystal formation, chewness, taste etc.

2.6.2. Calculating the mix.

The calculation should be done after the composition of the ice cream mix to be used has been decided. When calculating the mix following facts should be, consider.

1. In order to retain the flavour of consumers a satisfactory uniform quality should be consider.
2. Reduce the additional cost that causes the profit of the manufacture

2.6.3 Blending.

The dry ingredients including skimmed powder, sweeteners, stabilizers and emulsifiers etc are added, while the liquid is tasted, at temperature below 50°C. To avoid the lumpiness the solid materials should be mixed thoroughly with sugar and added to the liquid ingredients. If gelatin is the stabilizer, it is best added after it is thoroughly mixed with an equal volume of sugar below the liquid ingredients reach temperature of 50°C. If use sodium alginate as stabilizer it should not be mixed until the temperature of the mix has reached at least 65 - 68°C.

2.6.4 Pasteurization.

The object of pasteurization is to destroy all the pathogenic and most of the souring bacteria may present in milk. In industrial level pasteurization is a practice in pasteurization vats. As rule, the viscous fluids are placed in vat first, followed by the less viscous fluids. Sugar and gelatin are added at last. In vats, the mixture is heated to a temperature of 68.3 - 73.9 °C (155 - 165 °F), and held from 25 to 30 minutes (in HTST). In ultra high temperature of pasteurization (UHT) the mix is held at a temperature of 135°C for specific time 40 seconds.

In addition, there is another pasteurization method called high heat short time (HHST) at temperature of 79.44°C (175°F) at 25 seconds and 100°C (212°F) for 0.01 seconds. Today the most popular method is continuous HTST using plate heat exchange, because the processes benefit for;

1. Improve process control.
2. Less stabilizer requirement.
3. Saving of time and space.
4. Increase capacity.

2.6.5 Homogenization.

The main purpose of homogenization is to reduce the size of the fat globules to at least four microns in diameter with vast majority being smaller than two microns. In homogenization the pasteurized ice cream mix is pumps to a small chamber from which it is homogenization the pasteurized ice cream mix is pumps to a small chamber from which it is forced out under considerable pressure, through a small needle valve. The temperature at homogenization may range from 45.5^{0}C to 75^{0}C and pressure range from 1500 to 3000 psi. Homogenization gives smooth and velvet texture, improve whipping ability, diminishes the danger of churning during freezing and increase viscosity. In single stage homogenize the pressure is 2000 to 2500 lb and in double stage homogenize in first stage 2500 - 3000 lb and in second stage 500 lb. Ice cream made from homogenized mix appears slightly richer in fat. Immediately after homogenization, the mixed is cooled temperature of 4.44^{0}C (40^{0}F) or lower. The usual homogenization temperature is 62.78^0 - 76.67^{0}C (145^{0}F - 170^{0}F) because at low temperature 48.89^0 – 54.44^{0}C (120 - 130 ^{0}F) homogenization increase the formation of clumps of fat globules, increase viscosity and freezing time.

2.6.6. Aging the mix.

It impossible to achieve a good viscosity only by practicing homogenization. Both homogenization and aging processes are essential for it. Aging results in a mix taking on an increased viscosity, glossy and smooth appearance. In this process, aging time is very important because adequate time improves the freezing characteristics and overrun. Preferable time for aging varies between 4 to 24 hours. If hold the mix in aging tanks more than five days is likely to cause some deterioration. In both flavour and quality. In commercial condition with sophisticated machinery (homogenizes and freezers) 3 to 4 aging is quite enough. However, with high fat mixes with low-pressure homogenization 24 hours of aging is needed. Aging temperature is also a critical value, if it exceeded more than 4 44^{0}C (40^{0}F) some bacteria may tend to grow on it. There is no advantage of aging the mix in very low temperature such as –2.22 to –1.11^{0}C (28 - 30^{0}F), there is more danger that the first of the mixer enter the mixer might freeze fast to the cold walls of the freezer and tend to damage the dasher. Therefore the preferable temperature for aging is around 2.22^{0}C (36^{0}F) or a little below. The effect of the aging is as follows.

1. The portion of the mix may change slightly.
2. The fat is solidifying.
3. If gelatin is used as a stabilizer, it swells and combines with water.
4. Viscosity is increase largely due to above-mentioned changes.

2.6.7 Freezing.

In this heat is rapidly withdrawn from the ice cream mix, thus freezing a part of the water into ice crystals. In addition, air is incorporated in to mixture by beating or agitating air-freezing mixture. Freezing is accomplished by circulating cold brine, ammonia or other preferable gas. There are generally two types of ice cream freezers. They are:

1. Batch type freezers.
2. Continuous type freezers.

First ice cream in the mixture is freezing to a semisolid consistency and then air is incorporated in to it by moving dashes. With equipped scrapers in the side of the semi solid mixture until desirable swell, or overrun is obtained. Therefore the volume of ice cream becomes larger than the mixture. Ice cream mixture enters the freezer at 4.4^{0}C (40^{0}F) and drops rapidly to a temperature of -4.4^{0}C (20^{0}F) to -5.5 (22^{0}F). The freezing is discontinued when desirable overrun is obtained and ice cream mix develops rather firm body.

2.6.8. Packing.

Ice cream is put in to containers when ice cream is drawn from the freezer. It gives the desired form and size for the convenient handling during the hardening, storage, shipping and market processing. Packing can be divided in to two types.

1. Bulk packing.
2. Packing for direct retail sale.

2.6.9. Hardening.

This is the final step in the manufacturing, when it is drawn from the freezer, it has the semi-fluid consistency and it is not stiff enough to hold its shape In industrial level hardening is carried out at hardening rooms or in a hardening tunnel In specially designed hardening tunnels cold air is b[illegible]wing on packages of incoming ice cream Determining the t[illegible] needed to drop the tempe[illegible]ure to 0°F at the c[illegible]ter of the ice cre[illegible] mat[illegible] the time [illegible] hardening. The preferable temperature is -26.1^{0}C (-15^{0}F) for hardening rooms the temperature range in between -23.33 to -28.89 ^{0}C (-10 to 120^{0}F) or lower.

A fast hardening is better than slow hardening to reduce the formation of small ice crystals. The factors affecting the hardening time (Tracy and McCown 1934) are as follows.

1. Air circulation.
2. Size and shape of pack.
3. Temperature of the air.
4. Section of the room.
5. Temperature of ice cream drawn from the freezer.
6. Composition of mix.
7. Percentage overrun.

2.7. Yoghurt.

Yoghurt is the fermented milk product obtained from cow or buffalo milk or a mixture there of by the agency of microorganisms *Streptococcus thermophilus* and *Lactobacillus balgaricus*. The milk is standardized to 10.5 to 11.5% solids, heated to about 90^{0}C (30 – 60 minutes), and then cooled (40 – 45^{0}C). An incubation temperature of 42^{0}C for yoghurt manufacture, so that symbiotic growth and the proper ration of the organisms are maintained (Dutta *et al*, 1972). The innoculum is a mixed culture of *Strepococcus thermophilus* and *Lactobacilus balgaricus* in 1:1 ratio. The combination of these two organisms in the needed to obtain the desired flavour and acid in the product

2.8. Yoghurt-ice cream.

This product is a combination of both yoghurt and ice cream. Whole milk, skim milk cane sugar, stabilizer and cream or butter are use as main ingredients. The mix is inoculated with 2% starter culture consisting of *Streptococcus salivarius* spp, *thermophilus, lactobacillus delbruekii* spp, *bulgaricus*, and *L Acidophilus* and *Bifidobacterium bifidum* After incubation at 37^{0}C for 12 hours, the mix is kept at 4^{0}C overnight for aging This is then broken and selected flavours such as strawberry, orange, pineapple, chocolate, mango or dry fruits and their respective colours are added and the mix is frozen in ice cream freezer to give 60% overrun. It is stored at -10^0 to -20^0C until use.

Table 2.10: Standards of yoghurt-ice cream.

Fat	4 – 6%
Milk solid non fat	9 – 11%
Total solids	30 – 36%

Source: ice cream seminar 2000.

2.9. Fermentation.

In food, industry microorganisms are used in many ways. Microorganisms are widely used for fermentation purpose. Desired alterations of food by microorganisms are referred to as fermentation. By definition, fermentation is the anaerobic break down of an organic substance by an enzyme system, in which the final hydrogen acceptor is an organic compound.

2.9.1. Lactic acid bacteria.

The organisms referred to as lactic acid bacteria include certain species in genera *Streptococcus*, *pediococus*, *leuconostoc* and *lactobacillus*. The first two genera are homofermentative, the *leuconostoc* are heterofermentative and the *lactobacilli* include both homofermentative and heterofermentative types. The homofermenters convert carbohydrates primarily to lactic acid, while the heterofermenters produce lactic acid and substances such as acetic acid, ethyl alcohol and carbon dioxide. This means that the homofermenters use primarily one metabolic pathway, whereas the homofermenters use more than one pathway.

The lactic acid bacteria usually grow in sequence in a food product. Generally the *leuconostoc* or *streptococcai* begin in the fermentation and are followed by pedicoccai and *lactobacilli*

The production of lactic acid from sugar is used in vegetable, fruit and dairy product fermentation. The organisms normally present in or on the foods can be utilized. However there are cultures available for used in control fermentation. These starter cultures are preferred in the fermentation of milk. Although there are many similarities in the lactic acid fermentation, due to the various substrates, there are some differences.

2.9.2. Fermentation of dairy products.

The production of lactic acid from lactose in milk is important in the manufacture of fermented dairy products. The main lactic acid formers. are the homofermentating *Streptococcai*, *S. lactis* and *S. cremoris*. Strains of the organisms vary in the rate of acid production. In addition, the rate is influence by the temperature, pH, antibiotics, bacteriophages, stimulants, inhibitory compounds, milk composition, available nutrients, and the condition of the culture, strain compatibility and strain dominance.

Yoghurt fermentation is an interesting example of an interaction between two organisms in which there is mutual growth stimulation. *S. salivarios thermophilus* initiate the fermentation producing carbon dioxide and formic acid, lowering the pH and stimulating the growth of *L delbreukii* spp *balgaricus*. *L. delbreukii* spp *balgaricus* produce small peptides and amino acids via protinase activity that in turn stimulate the growth of *S. salivarios thermophilus*. This interaction produces faster growth of the two organisms (and therefore a faster fermentation), more lactic acid and more flavour compounds than if the organisms are grown separately.

The final product has a pH of 3.7 – 4.3, a lactic acid content of 0.8 – 1.8%, 20 – 40 ppm acetaldehyde (the main flavouring constituent) plus low concentration of diacetiyl and acetic acid which also contribute to the final flavour.

Recently, a deferent type of yoghurt has been produce that uses a mixture of *L acidophilus* and *Bifidobacterium bifidum* (AB yoghurt) or *L. acidophilus* and B. *bifidum* and S *salivarios spp thermophilus* (ABT yoghurt) as the starter culture. These 'bio' or therapeuratic yoghurts are said to have health promoting properties Manufacture of this type of yoghurt involves direct vat inoculation with the starter followed by incubation at 37°C for about 16 hours giving a final product with pH of 4.2 – 4.4 and milder creamier flavour

2.9.3. Benefits of fermentation.

Fermented foods are extremely voluble addition to the human diet for a whole verity reasons:

1. Increase in verity.
2. Use as ingredients.
3. Improvements in nutritional quality.
4. Preservation.
5. Health benefits.
6. Improve digestibility.
7. Detoxification of raw materials.

(Garbutt, J. Essentials of food microbiology, 1997)

2.9.3.1 Improvement in nutritional quality.

L. acidophilus and *Bifidobacterium bifidum* cultures are capable of controlling intestinal disorders, production of digestive enzymes, relief from constipation, reducing the carcinogenic activity, controlling blood cholesterol level, production of vitamins such as B_1, B_6, B_{12} and folic acid and anti microbial activity against pathogenic micro-organisms such as enteropathogenic *Escherichie coli*, *Salmonella* spp and *Staphylococcus aureus*. (Srilakshmi, Food science, 1997)

Chapter 3.

3. Material and method.

3.1. Material

All the raw materials used for the research work were locally available materials. Dried whole milk powder (fat minimum of 26%) and skim milk was used as the milk sauce and cream (fat 60%) and butter (fat 81.4%) were used as sauces of fat except whole milk. In addition, other ingredients such as water, sugar, stabilizer (IC107 and gelatin) and egg yolk, stature culture, colours and flavours were used.

As equipments an ice cream machine, incubator, thermometers, utensils, electrical beater, freezer, electric balance, gas burner and plastic yoghurt cups (as packing materials for storage of final product) were used.

3.2. Method.

3.2.1 Preliminary studies to determine the desirable incubation time and temperature.

As the taste effect, the final quality of the product the incubation time is very important because the taste depend on the incubation time and the temperature. Prolong incubation increases the acidity of the product also increase the sour taste of the ice cream. At high acidity, the taste becomes undesirable. Because of that, preliminary studies were done to determine the desirable incubation time and the temperature.

For this determination of incubation, temperature and time were tested. The samples were kept in incubator with deferent temperatures ranging from 40^{0} to 44^{0} C, and best temperature was found. The suitable time was determined by fermenting the ice cream mix at pre determines suitable temperature by changing the time from 1 hr to 5.5 hr. Then pH of the samples was recorded. A sensory evaluation was carried out to determine the desirable taste of the product.

3.2.2. Preparation of youghurt-ice cream.

For the preparation of youghurt ice cream, some steps of both youghurt making procedures and ice cream making procedures were followed, after standardizing the mix according to the standard of youghurt - ice cream. Pasteurization of milk, homogenization of milk, addition of ingredients of, cooling to desirable inoculation temperature, inoculation and incubation were taken from youghurt making procedure. Aging, freezing and air incorporation and hardening were taken from ice cream making procedure. The process flow chart is as follows.

Standardization

↓

Pasteurization.

↓

Homogenization.

↓

Cooling.

↓

Inoculation.

↓

Incubation.

↓

Stirr and break the curd.

↓

Addition of flavors.

↓

Cooling.

↓

Aging

↓

Air incorporation and freezing

↓

Hardening

Figure 3.1 Flow diagram of manufacture of youghurt ice cream

3.2.3. Standardization of mix.

The youghurt - ice cream was prepaid by whole milk powder. Normal fat content of available milk powder is minimum of 26%, but the fat content of normal cow milk is 3.7%. Therefore using mass balance method identified the amount of milk powder to be dissolving and amount of water to be use. The calculation is as follows.

Mass balance method.

Data.

Fat content of milk powder	- 26% (minimum).
Fat content of milk (after addition of water)	- 3.7%.
Fat content of water	- 0%
Amount of water (in grams)	- Y.
Amount of milk powder to be add (in grams)	- X.
Weight of milk (in grams)	- 1,000

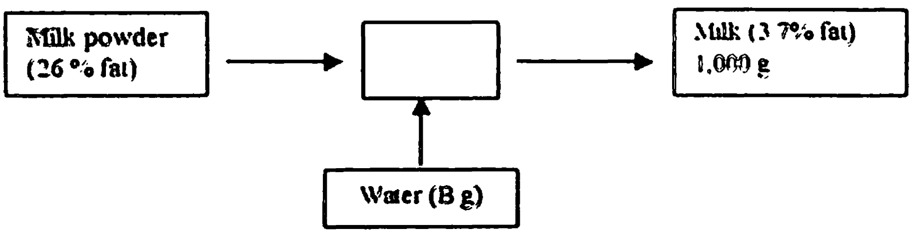

Figure 3 2 Mass balance for milk reconstitution

Calculation.

Mass balance for above system (assuming the weight of material that enters the system equal to the weight of material that leaves the system)

Weight of milk powder + weight of water = weight of milk

$$A + B = 1{,}000 \qquad (1)$$

Mass balance for fat

Fat content of milk powder + fat content of water = fat content of milk.

(26/100) x A	+	(0/100) x B	= (3.7/100) x 1,000
0.26A	+	0.0B	= 37 ______________ (2)
0.26A	+	0.0	= 37
A			= 37/0.26
A			= 142.3g.
Amount of milk powder to be added			= 142.3g

Using A = 142.3 to equation (1)

142.3	+	B	= 1,000.
B			= 1,000 - 142.3
B			= 857 7
Water to be added			= 857.7g

Calculating the fat content of cream.

The cream needed for the production of youghurt - ice cream was separated from the milk (3 7% fat) by using a cream separator, that gives total skim milk (0 1% fat) According to the observations when add one liter of milk to the separator, only 60ml of cream was provided. All the calculations were done according to above observations

Data.

Number of liters inserted to the separator	- 10
Number of liters of cream result	- 0 6
Fat content of total skim milk	- 0 1%
Fat content of cream	- A%

Calculation.

If the material inserted to the separator is equal to the material that leave the separator

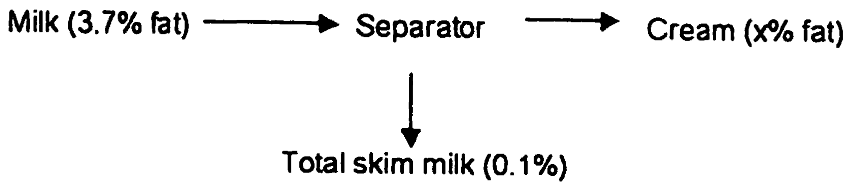

Figure 3.3: mass balance for cream separator.

Mass balance to the system:

Weight of milk	= Weight of cream + Weight of total skim milk.
Parts of fat in milk	= parts of fat in cream + parts of fat in total skim milk.
3.7×10	$= A \times 0.6 + 0.1 \times 9.4$
37	$= (0.6)A + 0.94$
$(0.6)A$	$= 37 - 0.94$
$(0.6)A$	$= 36.06$
A	$= 36.06 / 0.6$
A	$= 60.1$

Therefore the fat percent in cream = 60.1%

Step 1.

List of available ingredients and desired constituents were listed.

Table 3.1: list of available ingredients and constituents

Available ingredients		Desired mix composition		
Ingredient	Constituent (%)	Constituent	Proportion (%)	Weight (g)
Stabilizer	TS (90%)	Fat	6.0	60.0
Sugar	Sugar (100%)	MSNF	11.0	110.0
Milk	Fat (3.7%) MSNF (8.3 %)	Sugar	15.0	150.0
Butter	Fat (81.4%) MSNF (1%)	Stabilizer	0.5	5.0
Skim milk	Fat (0.1%) MSNF (26%)			

Step 2.

Table 3.2: Completed Proof sheet

A proof sheet was prepared and informations were entered.

Ingredients	Ingredient Weight (g)	Calculated constituents				
		Fat (g)	MSNF (g)	Sugar (g)	Stabilizer (g)	Total solids (g)
Stabilizer	5.56				5.00	5.00
Sugar	150.00			150.00		150.00
Skim milk	231.77		60.26			60.26
Butter	48.42	39.41	0.48			39.89
Whole milk	564.25	20.88	46.83			67.71
Total	1000	60.29	107.57	150.00	5.00	322.86
Calculated %		6.029	10.757	15.00	0.50	32.286
Check with						
Desired wt	1000	60.00	108.00	150.00	5.00	323.00
Desired %		6.00	10.80	15.00	0.50	32.30

Step 3.

Here there was only one source of stabilizer available and it contained 90% TS, the balance being water. Therefore 90% of number of stabilizer needed must equal 5g, the desired amount of stabilizer in the mix, and so = 5 x (100 / 90)

The amount of stabilizer needed = 5.56g

This figure is entered in the weight column of the proof sheet

The 5.56g of stabilizer product supplies 5.0g of dry stabilizer, which also count as 5.0g TS. Enter these figures in the stabilizer and TS columns, respectively

In addition, cane sugar is the only source of, and so 150g are needed

Step 4.

To find the amount of condensed skim milk needed, serum point method was used and following formula was applied.

$$\text{Condensed skim milk Powder needed} = \frac{(\text{serum solids needed}) - (\text{serum of mix X } 0.09)}{(\text{serum solids/g of cond. milk}) - (\text{serum/g of cond. milk X } 0.09)}$$

(0.09 represent percentage of total solids in 1g of skim milk)

The figures that needed for formula are obtained as follows:

From step 1 the amount of MSNF needed is 110g. To obtained amount of serum of the mix, first find the sum of the fat (60g, from step 1), the stabilizer (5.56g, from step 3), and sugar (150g, from step 3)

The sum of weights of sugar, stabilizer and fat = 60.0 + 5.56 + 150

= 215.56g

Then subtract this from desired total weight of mix, 1000g

The amount of serum of mix = 1000 – 215.56

=784.44g

The amount of MSNF of 1g of condensed skim milk by multiplying the 1g by 26% which gives 0 26.

Then these figures were substituted in above formula to calculate amount of condensed skim milk needed

$$\text{Condensed skim milk needed} = \frac{110 - (784.44 \text{ X } 0.09)}{0\ 26 - 0\ 09}$$

$$= \frac{110 - 70\ 5996}{0\ 17}$$

$$= \frac{39\ 4004}{0\ 17}$$

$$= 231\ 77g$$

This figure is entered in the weight column of the proof sheet. Also, enter in their respective columns the amount of MSNF and TS supplied by the 231 77g condensed skim milk. These valves were obtained by multiplying the 231.77 by the respective percentages of MSNF and TS.

231 77 X 26% MSNF = 60.26g MSNF.
231 77 X 26% TS = 60.26g TS.

Step 5.

The amount of butter needed is calculated with the aid of following formula, using the following figures:
From step 1, the amount of fat needed is 110 00g. To calculate the amount of milk and butter needed. First, find the sum of stabilizer (5.56g, from step 3), the condensed skim milk (231.77g, from step 4), and the sugar (150.00g, from step 3).

$$\text{Amount of butter needed} = \frac{\text{(fat needed)} - \text{(milk and butter needed X proportion of fat milk)}}{\text{(fat per pound of butter)} - \text{(fat per pound of milk)}}$$

The sum of weights of sugar, stabilizer and skim milk = 150.00 + 5.56 + 231.77
= 387 33g

When subtract this from the desired total weight of the mix can get the amount of milk and butter needed.
Amount of milk and butter needed = 1000 – 387 33
= 612.67g.

The fat is obtained in 1g of 81 4% butter by multiplying the 1g by 0.4, which gives 0 4g, and the amount of fat in 1g of 3 7% milk by multiplying the 1g by 0.037, which gives 0 037g
Then substitute these figures in above formula

$$\text{Amount of butter needed} = \frac{60\ 00 - (612\ 67 \times 0\ 037)}{0\ 814 - 0\ 037}$$

$$= \frac{60\ 00 - 22\ 67}{0\ 78}$$

$$= \frac{37\ 33}{0\ 78}$$

= 48.42g.

This figure is entered in the weight column of the proof sheet. Also, enter their respective columns the amount of fat, MSNF, and TS contained in the 48.42g of butter. These values are obtained by multiplying the 48.42g by respective percentages of fat, MSNF, and TS:

48 42g X 81.4% = 39.41g fat.
48.42g X 1% = 0.4842g MSNF.

And adding:

39.41g + 0.4842g = 39.89g TS

Step 6.

The amount of milk needed is computed by subtracting the amount of butter (48 42g, from step 5) from the amount of milk and butter needed (612 67, from step 5)

Amount of whole milk needed = 612.67 – 48.42
= 564.25g.

This is entering in the weight column. Then calculate the amount of fat, MSNF, and TS contained in the whole milk by multiplying 564.25g by the respective percentages

564 25 X 3 7% = 20.88g fat
564 25 X 8 3% = 46 83g MSNF.
And adding
20 88 + 46 83 = 67 71g TS

3.2.4. Sensory evaluation of yogurt-ice cream.

A sensory evaluation was carried out to determine [illegible]table time and the temperature for the fermentation of ice cream mix, because these [illegible]actors has great effect on the final quality of yogurt-ice cream

The aim of the first sensory evaluation was to determine the suitable temperature for the fermentation. This was evaluated by measuring the preference for colour, aroma, mouth feel, appearance and taste using Hedonic analysis technique.

The second sensory evaluation was done to determine the suitable period for the fermentation at pre-decided temperature (the temperature that selected from first sensory evaluation) measure the preference for colour, aroma, mouth feel, appearance and taste using Hedonic analysis technique

A sensory panel with 10 trained members was participated for the sensory evaluation. All the panelists were assigned to separate booths. A glass of water and cream cracker biscuits were provided for all the panelists. The glass of water was supplied to rinse the mouth before and in between tasting the samples, biscuits were supplied to be taken in between tasting to prevent the carrying over effect. In addition, a score cards were provided to each panelists and requested to score the samples according to their preference, by putting the numbers. A score card is shown in appendix 1.

All the test data were analyzed by SAS statistical computer software by using analysis of variance method (ANOVA) and least significant method (LSD) for Turkey test (Snedecor 1956) at 5% level.

The samples were labeled as follows:

To determine suitable temperature for fermentation with desirable flavour.

Table 3.3: List of samples of 1st sensory evaluation.

Time (in hours)	Temperature. (^0C)				
	40	41	42	43	44
4	912	834	756	678	590

To determine suitable time at 40^0C for fermentation.

Table 3.4: List samples of 2nd sensory evaluation

Temperature	Time (in hours)						
	1.0	1.75	2.5	3.25	4.0	4.75	5.5
40^0C	135	246	357	468	579	680	791

3.2.5. Determination of pH.

The pH valves of samples were obtained by using a pH meter (Hanna).

3.2.6. Determination of total soluble solids (Brix).

The brix valves of the youghurt-ice cream were obtained using hand refractometer

Chapter 4.

4. Results and discussion.

4.1. Sensory evaluation.

According to the sensory evaluation, samples were evaluated by Hedonic test method for overall acceptability. The results of the first sensorv evaluation are shown in appendix 2. In this test the degree of likening for products were measured to determine the suitable temperature for the fermentation of ice cream mix. The datum was statistically analyzed by analysis of variance (ANOVA). According to the results the deference between the samples are significant at 5% level. The F values were taken from the F table shown in appendix 3.

Table 4.1: Summary of LSD for first sensory evaluation.

Sample	Mean	T grouping
912	4.750	A
834	2.000	B
765	1.875	B
678	1.375	C
590	1.125	C

To determine the deference between the samples Turkey test was done to get the least significant deference. The Turkey test indicates sample 912 is more preferable than the other samples, and sample 834 and 765 are preferable than the sample 678 and 590. Results of sensory evaluation to determine the suitable temperature for fermentation, shown that temperature of 40^{0}C is more suitable for the fermentation of ice cream mix.

According to the results of second sensory evaluation, to determine the more suitable period, it indicates that there is a significant deference between the samples at 40^{0}C. The results of second sensory evaluation are shown in appendix 2.

Table 4.2: Summary of LSD for second sensory evaluation.

Sample	Mean	T grouping
357	4.625	A
246	3.250	B
135	2.625	C
468	2.000	D
579	1.250	E
680	1.000	E
791	1.000	E

The samples with long fermentation time (more than 2 hours and 30 minutes) were rated poor in the sensory evaluation as they give undesirable sour taste. Therefore, 2 hours and 30 minutes of fermentation time is more suitable to produce yoghurt ice cream with desirable taste and desirable fermentation.

4.2 pH test.

pH of the final products was measured and they were tabulated as follows

Table 4.3: pH values of samples

Sample name	pH value
135	5.15
246	5.05
357	4.76
468	4.56
579	4.41
680	4.21
791	4.10

Fermentation with high temperature and time the pH of the all samples were reduced. But the pH of the sample that was rated high in sensory evaluation (sample 357) was at 4.7 pH. Therefore, the desirable average pH of the final product is 4.76 pH.

Chapter 5.

5. Conclusions and recommendations

5.1. Conclusion.

1 Yoghurt ice-cream can be prepared by using locally available yoghurt starter culture in small-scale.

2 The temperature at 40°C for 2 hours and 30 minutes is the suitable time temperature combination for the fermentation of ice cream mix

3 The desirable pH level of yoghurt-ice cream is 4 76

5.2. Recommendations.

The composition of the yoghurt-ice cream should be analyzed to measure the levels of fat, protein and sugar after the fermentation.

A microbial test must be carried out to identify microorganism present in both yoghurt culture and yoghurt-ice cream

A sensory evaluation should be carried out to evaluate the finally selected product with similar product in the market

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Appendix: 1.

Questionnaire for Hedonic test.

Product: Yoghurt-ice cream.

Name:................................ **Date**........................

Please score these samples for preference. Score the sample you like best as first and the you like least as fifth.

Taste the samples in the following order: 912 834 756 678 590

Sample no

	....	....	....	....	....
Overall acceptability					

Comments:

Appendix: 2.

Data of sensory evaluation.

Table 2.1: sensory score for overall acceptability (1st sensory evaluation).

Judges	Sample No				
	912	834	756	678	590
1	5	2	2	2	2
2	5	2	2	1	1
3	4	2	2	1	1
4	4	2	2	2	1
5	5	2	1	1	1
6	5	2	2	1	1
7	5	2	2	1	1
8	5	2	2	2	1

Table 2.2:Analysis of Variance Procedure for overall acceptability.

Dependent Variable: SCORE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	69.22500000	6.29318182	46.99	0.0001
Error	28	3.75000000	0.13392857		
Corrected Total	39	72.97500000			

Analysis of Variance Procedure

Dependent Variable: SCORE

Source	DF	ANOVA SS	Mean Square	F Value	Pr > F
JUDGES	7	1 37500000	0 19642857	1 47	0 2195
SAMPLES	4	67 85000000	16.96250000	126 65	0 0001

Table 2.3: results of LSD for 1st sensory evaluation.

Means with the same letter are not significantly different

T Grouping	Mean	N	SAMPLES
A	4.750	8	912
B	2.000	8	834
B			
B	1.875	8	756
C	1.375	8	678
C			
C	1.125	8	590

Table 2.4: sensory score for overall acceptability (2nd sensory evaluation).

Judges	Sample no						
	135	246	357	468	579	680	791
1	4	4	5	2	1	1	1
2	3	4	4	1	1	1	1
3	3	4	5	3	1	1	1
4	3	4	5	2	2	1	1
5	2	3	5	2	1	1	1
6	2	2	4	1	1	1	1
7	2	3	4	1	1	1	1
8	2	2	5	4	2	1	1

Table 2.5:Analysis of Variance Procedure for overall acceptability.

Dependent Variable: SCORE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	93.39285714	7.18406593	19 97	0.0001
Error	42	15.10714286	0.35969388		
Corrected Total	55	108.50000000			

Analysis of Variance Procedure

Dependent Variable SCORE

Source	DF	ANOVA SS	Mean Square	F Value	Pr > F
JUDGES	7	5 64285714	0 80612245	2 24	0 0496
SAMPLES	6	87 75000000	14 62500000	40 66	0 0001

Table 2.6: results of LSD for 2nd sensory evaluation.

Means with the same letter are not significantly different

T Grouping	Mean	N	SAMPLES
A	4.625	8	357
B	3.250	8	246
C	2.625	8	135
D	2.000	8	468
E	1.250	8	579
E			
E	1.000	8	680
E			
E	1.000	8	791

Appendices 3.

F-table.

n_1 – Degree of freedom for numerator

n_2 – Degree of freedom for denominator

$n_2 \backslash n_1$	1	2	3	4	5	6	8	12	24	A
1	161.4	199.5	215.7	224.6	230.2	234.0	238.9	243.9	249.0	254.3
2	18.51	19.00	19.16	19.25	19.30	19.33	19.37	19.41	19.45	19.50
3	10.13	9.55	9.28	9.12	8.01	8.94	8.84	8.74	8.64	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.04	5.91	5.77	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.82	4.68	4.53	4.36
6	5.99	5.14	4.76	4.53	4.39	4.28	4.15	4.00	3.84	3.67
7	5.69	4.74	4.35	4.12	3.97	3.87	3.73	3.57	3.41	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.44	3.28	3.12	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.23	3.07	2.90	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.07	2.91	2.74	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	2.95	2.79	2.61	2.40
12	4.75	3.88	3.49	3.26	3.11	3.00	2.85	2.69	2.50	2.30
13	4.67	3.80	3.41	3.18	3.02	2.92	2.77	2.60	2.42	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.70	2.53	2.35	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.64	2.48	2.29	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.59	2.42	2.24	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.55	2.38	2.19	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.51	2.34	2.15	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.48	2.31	2.11	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.54	2.28	2.08	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.42	2.25	2.05	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.40	2.23	2.03	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.38	2.20	2.00	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.36	2.18	1.98	1.73
25	4.24	3.38	2.99	2.76	2.60	2.49	2.34	2.16	1.96	1.71
26	4.22	3.37	2.98	2.74	2.59	2.47	2.32	2.15	1.95	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.30	2.13	1.93	1.67
28	4.20	3.34	2.95	2.71	2.56	2.44	2.29	2.12	1.91	1.65
29	4.18	3.33	2.93	2.70	2.54	2.43	2.28	2.10	1.90	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.27	2.09	1.89	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.18	2.00	1.79	1.51
60	4.00	3.15	2.76	2.52	2.37	2.25	2.10	1.92	1.70	1.39
120	3.92	3.07	2.68	2.45	2.39	2.17	2.02	1.83	1.61	1.25
a	3.84	2.99	2.60	2.37	2.21	2.09	1.94	1.75	1.52	1.00

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