QUALITY IMPROVEMENT OF READY TO SERVE BANANA FRUIT DRINK

By

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DECLARATION

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TO MY

PARENTS AND TEACHERS

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ABSTRACT

Fruits are important nutritional requirements of human beings, as they contain higher amount of vitamins and minerals, which improve the quality of the diet and maintain good health. Therefore it is necessary to make them available for consumption throughout the year in fresh or processed form.

Ready to Serve fruit drinks, which can be consumed immediately after opening contain higher amount of pulped fruit particles. So the main problem associated in this Ready to serve fruit drinks is cloudy or pulpy appearance. This cloudy or pulpy appearance can be removed by clarification.

Clarification is the process of fruit juice clearing. There are several methods associated in clarification, such as enzymatic clarification, Clarification after heat treatment and using of fining agents.

Clarification of fruit juice by heat treatment enhance the quality, gives better clarified juice, no influence in flavour and taste and reduce the precipitation in fruit drink.

Precipitation is higher in banana RTS drinks than other drinks. Banana juice clarification by heat treatment is the most cheaper and convenient method.

Banana fruit juice is preserved by chemical preservatives like sodium metabisalphate as well as heat treatment. These preservatives are specifically added to prevent the deterioration or decomposition of product.

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CHAPTER 01
INTRODUCTION

1:1 Fruit Processing.

Fruits are one of the important constituents in human diet as they improve the quality of diet by supplying vitamins, carbohydrates, proteins, minerals and fibers. So, it is necessary to make them available for the consumption throughout the year.

Large varieties of fruits are grown in Sri Lanka. Some fruits are grown in limited areas, where the suitable soil and cultivation conditions are found. Seasonal cultivation pattern is common in some fruit crops and, it is a major problem for year round utilization of fruits.

Banana also a seasonal fruit crop and fruits are found abundantly during the season. But the yield of banana is very low during off-season and therefore, it is difficult to buy at reasonable prices. The other problem associated with banana is, higher wastage during the season. As banana a perishable fruit, it is difficult to transport to non-growing areas without or with minimum post harvest losses. So, it is necessary to introduce a proper preservation method for banana to prevent the wastage of fruit during the season and to make them available during off-season.

The art of preservation of food has been known since ancient times. Some of traditional methods still in use are during up in sun, salting and smoking. Based on the latest development in science and technology, foods processing also become an import industry in many countries in the world.

"KC Marketing Services" is a well-established fruit-processing unit situated at Embilipitiya; also conduct some fruit preservation techniques by processing them in to different types of products. Such as RTS drinks, jams, chutneys etc.

Mango, pineapple, wood apple and lime are some fruit varieties, which are used for daily processing. They, developed RTS banana drink at an experimental level, with the aid of enzyme and heat clarification methods. Enzyme clarification method was almost successful, but there were some problems associated with heat clarification method. However, RTS banana drink has not developed yet as a marketable product.

1.2 Objectives of the project:

RTS (ready to serve) banana drink is being tested at experimental levels. But it has several problems associated during processing.

- Enzymatic browning reactions are taken place rapidly after peeling and slicing.
- Higher degree of caramalization is taken place during the heat treatment processing.
- Higher amount of precipitation is occurred after bottling the product.
- The shelf of the product is shorter than the expected.
- The current product is not a palatable and appealing one.

1.2.1. Major objective:

Produce the Ready to serve banana drink with eliminating above problems as far as possible.

1.2.2. Minor objectives:

i. To produce cheep natural RTS banana drink with extended shelf life.
ii. To eliminate or minimize the occurrence of browning reactions and caramalization during processing.
iii. To eliminate or minimize the occurrence of precipitation.
iv. To impart palatable flavour and appearance to the product.

CHAPTER 02
REVIEW OF LITERATURE

2.1. Banana:

Banana represent a one of the most important fruit crop, second only to Grapes in the volume of world production, indicates that banana are the forth largest fruit crop after grapes, citrus and apple. Banana and plantain are starchy berries produced hybrids of *Musa acuminata* and *Musa bulbisiana*.

Banana may be differentiated from plantains on the basis of moisture content, with banana generally averaging 83 percent moisture and plantains 65 percent. Banana may be eaten raw or cooked. Normally banana, which are eaten raw, are referred to as "dessert banana".

Banana being primarily carbohydrates (22.2-31.2%) are low in fats, cholesterol and sodium. Potassium levels are high.(400mg/100g pulp). Banana also a good source of ascorbic acid. During ripening, the starch component is gradually converted to simple sugars (fructose, sucrose, and glucose), while the moisture content of the pulp increases. The time of conversion to simple sugars can also be used to differentiate plantains/cooking bananas (later conversion) from banana that are eaten raw (earlier conversion). (Kinneth F Kiple and Kriemheld, 2000)

2.2. General uses of banana:

2.2.1. Leaves:

Where banana are locally grown, the non-fruit parts of the plant are employed for a variety of purposes. Fresh banana leaves serve as wrapping material for steamed or cooked foods and also a disposable meal platter. Fresh leaves are used medicinally for the treatment of a variety of disorders, including headaches, menstrual cramps, and urinary track infections. Young unfolded leaves are employed as tropical remedies for chest ailments, and the stem juice is used to treat gonorrhea.

Juice from fresh banana leaves occasionally serves as a light brown dye or stain. Because of their 30 to 40 percent tannin content. Dried leaves may be woven as house screens or be a source of fibrous strings for simple weaving or short-term structure

construction. Dried leaves may also be employed to absorb salt water to transport distant locations, where they are burned to produce a salty ash seasoning of vegetable cumes.

2.2.2. Fruits:

Of growing importance is the use of banana plants and fruits in livestock feed. It is very important dessert of human. Dried banana peels are used to blacken leather, and dried green plantains, ground fine and roasted, have reportedly served as a substrate for coffee. (Kinneth F Kiple and Kriemhild, 2000)

2.3. Economic importance of banana:

The secondary centers of banana distribution in Africa, Central America and the Caribbean have become the greatest consumers and exporters of bananas. Estimates of the total banana production of the world range from 20 to 30 million tons per year entering international trade. Africa is the largest producer of bananas; withy some sources saying that half of the world's bananas are produced there. But most African bananas are consumed locally, although some are exported to Europe. Ecuador (the world's largest banana exporter), Colombia, Jamaica and Panama all exports bananas to the United States and Europe, whereas the Philippines and Thaiwan export bananas to other Asian countries particularly Japan. (Kinneth F Kiple and Kriemhild, 2000)

Table 2.1: Composition of raw banana (100g of edible portion).

Water (%)	74.3
Energy (Kcal)	92.0
Proteins (g)	1.0
Lipid (g)	0.5
Carbohydrate (g)	23.4
Calcium (mg)	6.0
Phosphorus (mg)	20.0
Iron (mg)	0.3
Vit.A value (I.U)	81.0
Thiamin (mg)	0.05
Rhiboflavin (mg)	0.1
Niacin (mg)	0.54
Ascorbic acid (mg)	9.1
Crude fibre (g)	0.5
Total dietary fibre (g)	1.6

(Source: U.S.D.A. Agricultural Hand Book, Revised 1982)

Table 2.2: Chemical composition of pulps of some ripe banana varieties grown in India.

Type	Edible Matter(%)	Moisture (%)	Protein (%)	Redu. Sugar(%)	Non red. Sugar(%)	Starch (%
Lalvelchi	85.1	74.7	1.0	15.2	2.7	1.4
Poovan	77.7	73.8	1.1	19.8	0.2	4.3
Basrai	69.9	75.1	1.1	9.2	8.8	1.8
Vamankeli	71.7	78.5	1.0	10.0	5.0	4.6
Harichal	75.3	75.5	0.9	10.9	7.5	0.9
Mutheli	81.8	71.2	1.0	9.6	8.4	2.3
Rastheli	84.0	71.3	1.7	15.5	3.4	7.0
Safed Velchi	86.5	65.9	0.9	13.5	9.1	4.5
Ney Poovan	91.8	65.9	1.0	23.6	4.1	4.3
Lal Kel	75.3	72.7	0.8	5.4	13.3	3.2
Chendaddali	79.2	75.0	1.5	7.1	13.8	1.7
Rajeli	72.7	64.6	1.1	14.0	7.1	6.9
Nandran	78.8	64.1	0.4	23.9	2.5	8.2
Bankel	74.7	80.0	---	4.1	6.7	---
Monthem	77.7	71.6	1.0	15.2	3.7	7.1

(Source. U S D A Agricultural Hand Book, Revised 1982)

2.4. The process technology of making fruit drinks.

The production of fruit beverages in commercial scale was practically unknown till about 1930, however it has gradually become an important industry due to their nutritious value. Natural fruit drinks have become more popular and at present achieved a very large market in our country than synthetic drinks.

Fruit beverages are easily digestible, highly refreshing, quenching thirst, appetizing and nutritionally superior to many synthetic and aerated drinks.

2.4.1. Unfermented juice or pure fruit juice.

This is the natural juice processed out of the fruit, and remains practically unaltered in its composition during preparation and preservation. (Nimal,1997)

2.4.2. Fruit juice beverage.

This is a fruit juice, which is considerably altered in composition before consumption. It may be diluted before it is served as a drink. (Nimal,1997)

2.4.3. Fermented fruit beverage.

This is a fruit juice, which has undergone alcoholic fermentation by yeast. The product contains varying amount of alcohol. Grape wine, Apple ciders, Berry wines etc are typical examples of this kind of beverages. (Nimal,1997)

2.4.4. Fruit juice squash.

This consists essentially of strained of juice containing moderate quantities of fruit pulp to which cane sugar is added for sweetening.

e.g. Orange squash, Lemon squash, Pineapple squash. (Nimal,1997)

2.4.5. Fruit juice cordial.

This is a sparkling, clear sweetened fruit juice from which all the pulp and other suspended materials have been completely eliminated.

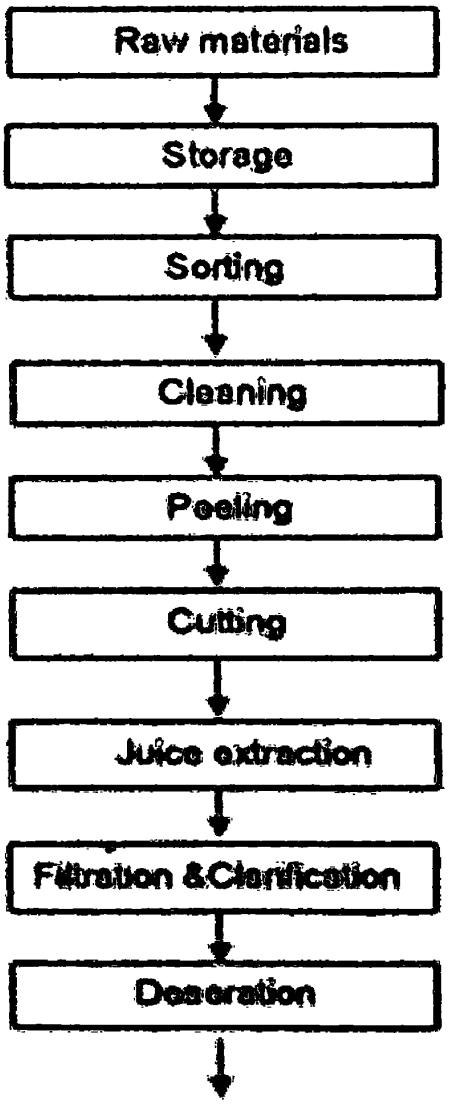
e.g. Sherbets of sandal, orange, almond, rose, etc.

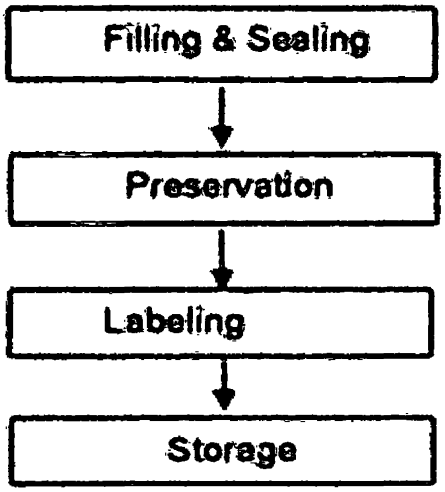
It contains at least 25 percent juice and 30 percent acid and 350 ppm of SO_2. (Srivastawa and Sanjeev Kumar, 1994).

2.4.6. Fruit juice concentrates.

This is a fruit juice, which has been concentrated by the removal of water either by heat or by freezing. Carbonated beverages and others products are made from this. They contain pure juice with at least 32 percent total soluble solids. (Srivastawa and Sanjeev Kumar, 1994).

2.5. Unit operations of fruit juice processing.





(Source: Industrial Development Board, 1995)

Figure 2.1: Common unit operations of Fruit Drink making.

2.5.1. Raw materials.

Raw materials are of primary importance. Some fresh fruits may be quite good for consumption as it is or cooked, but some are not suitable for fruit juice preparation. The variety and maturity of the fruit and locality of cultivation influence the flavour and keeping quality of its juice. The price of raw materials is one of the main factors, which affects the cost of finished product. In Sri Lanka, there is a wide fluctuation in availability of fruits due to the maturation of different fruit crops in different seasons.

2.5.2. Storage.

During storage, fruits are ripened. They continue some biological processes that were predominated before harvesting. They respire. So use oxygen and release carbon dioxide and generate heat.

Changes are taken place in cell wall composition and structure, which results softening of fruits. Colour is become yellow or orange due to demasking of carotene, xanthophylls like pigments by chlorophyll. Acid content is decreased and sugar content increased with time. Volatile compounds are produced and give the fruits their typical aroma and flavour.

During storage, especially higher temperatures and humidity should be eliminated.

So, storage areas should be well ventilated to reduce the heat generation

Specially in the case of banana, fruits should be well ripening to reduce the pectic substances. So, storage is very important in banana industry.

2.5.3. Cleaning.

Cleaning is an important unit operation in which contaminating materials are removed. It is important to remove pesticide spray residues and dust also. Washing is used commonly for cleaning purposes. Commercially washing with water must be accompanied with brushing, rubbing and forcing water. Other methods of washing are, spray washing and steam washing. (IDB publications)

2.5.4. Peeling and cutting.

The objective of peeling is to remove the outer layer of fruits. As the fruit flesh contain higher amount of polyphenolic compounds, it tends to browning reactions due to oxidation of polyphenolic compounds just after peeling. So it is necessary to treat with antioxidative agents just after peeling.

Peeling may be performed in various ways. These are hand peeling, steam peeling, mechanical peeling, lye peeling etc. But in the case of banana processing, normally use hand-peeling method. Cutting of fruits is done after peeling, to obtain small pieces of fruits, which is facilitated the extraction of juice.

2.5.5. Juice extraction.

Generally juice is extracted from fresh fruit by crushing and pressing them. Screw type juice extractors, basket presses or fruit pulpers are mostly used.

The method of extraction differs from fruit to fruit according to their structure and composition. Before pressing most fruits are crushed to facilitate the extraction. Some fruits require heat processing for breaking up the juice containing tissues. Finally, the juice is strained through a thick cloth or a sieve to remove seeds. All equipments used in the preparation of fruit juices and squashes should be rust proof and acid proof. Copper and iron vessels should be strictly avoided as these metals react with fruit and cause blackening of the product. Machines and equipments made of aluminium, stainless steel, etc can be used. During extraction, juices should not be unnecessarily

exposed to air as it will spoil the Colour, taste and aroma and also reduce the vitamin content. (Srivastana and Sanjeev Kumar, 1994)

2.5.6. Filtration and clarification.

Fruit juices always contain varying amount of suspended matter consisting of broken fruit tissues, seed, skin, gums, pectic substances and protein in colloidal suspension. Seed, pieces of pulp and skin that adversely affect the quality of juice, are removed by straining through a thick cloth or sieve. Removal of all suspended matter improves the appearance but often results in disappearance of fruit characters and flavours. The present is to let fruit juice and beverages retain a cloudy or pulpy appearance to some extent. (Gupta, 1993)

Complete removal of all suspended matters from juice is known as clarification. It is closely related to the quality, appearance and flavour of the juice. The following clarification methods are used.

i. Enzyme clarification:

Various kinds of enzymes such as proteolytic, pectin decomposing, hydrolytic, starch-liquefying enzymes, etc...are sometimes using to remove pectin, protein and starch from juices. In the trade, these enzyme preparations are sold under different brand names, such as Pectinol, Filtragol, Ido, Pectasine, etc. Each class of enzymes has a different type of action on the colloids present in the juice. The process of clarification differs according to the particular enzyme used. (Manoranjan Kalia, Sangeetha Sood, 2000)

ii. Chemical finings:

The bulk of suspended matter, specially in the case of apple juice, consists of protein and pectin like substances. The colloidal substances carry on them electrical charge, generally negative, and are precipitated when this charge is neutralized by the addition of positive charged colloids. Gelatin and casein act partly in this manner, and partly by forming insoluble precipitates with the constituents of the juice. For instance, casein combines with the acids and

gelatin with the tannins of the juice. On allowing the treated juice to settle, the precipitates formed carry down with them other suspended particles also. (Manoranjan Kalia and Sangeetha Sood, 2000)

iii. Clarification by freezing.

Colloidal suspensions, when subjected to freezing, are readily precipitated on thawing. Apple juice, particularly, responds very well to this treatment. Freshly extracted grape juice, besides containing the usual suspension of pulp, skin, etc., also carries varying quantities of cream of tartar of potassium hydrogen tartar. When the juice is bottled in usual way, the cream of tartar goes on precipitating gradually in the form of fine crystals. The presence of these crystals in the juice is rather objectionable. In order to stop this slow precipitation, the bulk o the juice is subjected to refrigeration for several months to complete the precipitation. The clear juice is then bottled. Grape wines also behave like grape juice and are, therefore treated similarly. (Manoranjan Kalia and Sangeetha Sood, 2000)

iv. Clarification by heating:

It is a well-known fact that colloidal material in fruit juices usually coagulates, when the juices is heated, and settle down rapidly. To get good results, the juice is heated to about 82 C for a minute or less, and then cooled down rapidly. The heating is affected in flash heaters to avoid oxidation by air and to minimize the loss of flavouring materials. After flash heating and cooling, the juice is mixed with the filter aid and passed through the filter press. One great advantage of this method is that it also removes from the juice those substances, which would otherwise be precipitated during pasteurization of the juice. (Manoranjan Kalia, Sangeetha Sood, 2000)

v. Settling.

The juice is stored in a carboy or barrel, after adding chemical preservatives to ensure that it does not undergo fermentation. e.g. lime juice is stored for a 5 to 6 months for settling with the addition of 700ppm sulpher dioxide. Colloidal pectins, gums, proteins, settle down and juice is siphoned off for further treatment. However, the process is very slow. (Srivastana and Sanjeev Kumar, 1994)

vi. Filtration.

Filtration is necessary to remove completely all fine and colloidal suspension. In this process, the juice after straining is forced through a filtering medium, which may be cotton pulp, wood pulp, woven fibre, cloth etc. The colloidal suspension tends to clog the filter, hence filter aid is used to reduce clogging. (Srivastana and Sanjeev Kumar, 1994)

2.5.7. Deaeration.

Fruit juices contain some air. Most of which is present on the surface of the juice and some is dissolved in it. Most of the air is removed by subjecting the fresh juice to a high vacuum. This process is called deaeration, and the equipment used for the purpose is called a deaerator. Being a very expensive method, it is used only in developed countries (Gupta, 1993)

2.5.8. Preservation of fruit juice.

Freshly extracted juices are highly attractive in appearance and posses' good taste and aroma, but deteriorate rapidly if kept for some time. This is on account of some reasons, such as,

i. Fermentation caused by moulds and yeast.

ii. Enzymes present in the product may affect the colour and flavour adversely.

iii. Chemicals present in the pulp or juice may react with one another and spoil its taste and aroma.

iv. Air coming in contact with the product may react with the glycosidal materials present in it and render the product bitter.

v. Trace of metal from the equipment may get into the product and spoil its taste and aroma.

(Frazier and Westhoff, 1978)

So, following principles are involved in the preservation of foods.

(A). Prevention or delay of microbial decomposition.

(a). By keeping out microorganisms. (Asepsis)

(b). By removal of microorganisms. (Fitration)

(c). By hindering the growth and activity of microbes using chemicals or antibiotics.

(d). By killing the microorganisms using heat or radiation.

(B). Prevention or delay of self-decomposition of food.

(a). By destruction or inactivation of enzymes.

(b). By prevention or delay of chemical reactions.

(C). Prevention of damage by insects, animals and mechanical causes.

(a). By proper pre and post harvest practices.

(b). By proper field sanitary practices.

(c). By minimizing compression, vibration and impact damages during transportation.

The general used preservation methods are;

(1). Preservation with heat treatment.

(2). Preservation with additives (chemicals).

(3). Preservation by freezing.

(4). Preservation with carbon dioxide.

(1). Preservation with heat treatment.

Coagulation of protein and inactivation of their metabolic enzymes by the application of heat lead to the destruction of microorganisms present in foods. Further heating can also inactivate the enzymes present in foods. So, heating of food to higher temperatures is used as a good preservation method.

There are two high temperature treatment methods.

1.1.) Pasteurization (Temperature below 100^0C).

1.2.) Sterilization (Temperature 100^0C or above).

1.1). Pasteurization:

Pasteurization is common in preservation of fruit juices, ready to serve (RTS) and nectar. During pasteurization the product is heated at boiling temperatures or slightly below for sufficient length of time to kill the spoilage microorganisms.

Pasteurization does not kill all microorganisms present in the juice. Some spores and spore forming bacteria (*Bacillus subtilis* and *Bacillus mesentericas*) can survive and multiply later. These organisms are highly sensitive to acid and therefore cannot grow in acid fruit juices.

Mould spores are destroyed by heating at 79^0C for 5 to 10minutes.Moulds require oxygen for their growth. Removal of air from juice by filling the container completely or deaerating the juice under vacuum or replacing the air with CO_2 facilitates the destruction of moulds even at low temperatures. Yeast and acid tolerant bacteria are readily killed if the juice is heated for a few minutes at about 66^0C.

Table 2.3: Thermal death time for bacteria.

Name of the bacteria	Time (minutes)	Temperature (^{0}C)
Salmonella typhosa	4.3	60
Staphylococcus aureus	18.8	60
Escherichia coli	20-30	57.3
Streptococcus thermophillus	15	70.77
Lactobacillus bulgaricus	30	71

(Source: Srivastava and Sanjeev Kumar, 1994)

Enzymes also require air (oxygen) at normal temperature for their action and it can be destroyed at moderate temperatures by removing air from the juice. Pectic enzymes, which cause changes in flavour and also bring about clotting of particles in the juice can be destroyed by heating the juice for about 4 minutes at 85^{0}Cor for one minute at 88^{0}C.

Usually juice, RTS and nectar are pasteurized at about 85^{0}C for 25 to 30 minutes according to the nature of the juice and the size of the container.

Acid fruit juice requires a lower temperature and less time for pasteurization than the less acid once. Juice can be pasteurized in two ways.

(i). By heating it at low temperature for a long time.

(ii). By heating at high temperature for a short time only.

According to above time temperature combinations, there are three methods of pasteurization.

(a). Bottle or holding pasteurization.

This method is commonly used for the preservation of fruit juice at home. The extracted juice is strained or clarified and filled in bottles, leaving sufficient head space for the expansion of the juice during heating. The bottles are then sealed air tightly and pasteurized.

(b). Overflow method.

Juice is heated to a temperature about 2.5°C higher than the pasteurization temperature, and then filled in hot sterilized bottles up to the brim, taking care that during filling and sealing the temperature of the juice does not fall below the pasteurization temperature. The sealed bottles are pasteurized at a temperature2.5°C lower than the filling and sealing temperature and then cooled.

(c). Flash pasteurization.

The juice is heated rapidly to a temperature of about 5.5°C higher than the pasteurization temperature and kept at this temperature for a minute. The method has been developed specially for the canning of natural orange juice. But can also be used for grape and apple juice.

1.2). Sterilization.

By this method all microorganisms are completely destroyed due to high temperature. The time and temperature necessary for sterilization vary with the type of food. Fruit products should be heated at 100°C for 30 minutes so that the spore forming bacteria, which are sensitive to high acidity, may be completely killed. Before using, empty bottles should also be sterilized for about 30 minutes by placing them in boiling water. Temperature about 100°C can only be obtained by using steam pressure sterilizers such as pressure cooker and autoclaves.(Frazier and Westhoff, 1978)

(2). Preservation with additives (chemicals).

Using chemical preservatives also controls microbial spoilage of fruit products. The inhibitory action of preservatives is due to their interfering the mechanism of cell division, permeability of cell membrane and activity of enzymes.

Pasteurized squashes, cordials and crushes have a cooked flavour. After the container is opened, they ferment and spoil within a short period, particularly in tropical climate. To avoid this, it is necessary to use chemical preservatives.

Chemically preserved squashes and crushes can be kept for fairly a long time even after opening the seal of the bottle. But it is essential that the use of chemical should be properly controlled, as their indiscriminate use is likely to be harmful.

The preservatives used should not be injurious to health and should be non-irritant. It should be easy to detect and estimate.

The three important chemical preservatives permitted in many countries are;

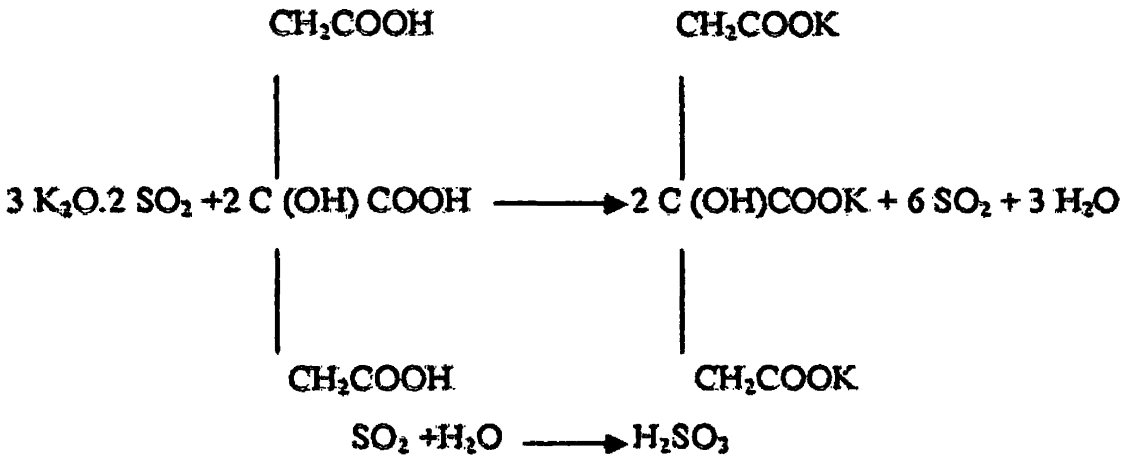
2.1). Sulphur dioxide.
2.2). Benzoic acid.
2.3). Citric acid.

2.1). Sulphur dioxide:

Is widely used in the preservation of juice, pulp, nectar, squash, crush, cordial and other products. It has good preservation action against bacteria and moulds and inhibits enzymatic activities also. In addition it acts as and antioxidant and bleaching agent. These properties help in the retention of ascorbic acid, carotene and other oxidizable components present in food. It also retards the development of non-enzymatic browning or discolouration of the product. It is generally used in the form of its salts such as sulphites, bisulphites and metabisulphites.

Potassium metabisulphite ($K_2O.2SO_2$ $K_2S_2O_5$) is commonly used as a stable source of sulphur dioxide. Being a solid, it is easier to use than liquid or gaseous sulpher dioxide. It is fairly stable in neutral or alkaline media, but decomposed by weak acids like carbonic, citric, tartaric and malic acids. When added to fruit juice, it reacts with the acid in the juice, forming the potassium salt and sulpher dioxide, which is liberated and forms sulphrous acid with the water in juice.

The reactions involved are as follows.



Sulphur dioxide has a better preservative action than sodium benzoate against bacteria and moulds. It also retards the development of yeast in juice, but cannot arrest their multiplication, once their number has reached a high value.

It is well known that fruit juice with high acidity does not undergo fermentation readily. The preservative action of the fruit acid is due to its hydrogen ion concentration. The pH for the growth of mould ranges from 1.5 to 8.5. That of yeasts from 2.5 to 8.0 and of bacteria from 4.0 to 7.5. As fruit beverages like citrus squashes and cordials have generally a p^H of 2.5 to 3.5 the growth of mould and yeasts in them cannot be prevent by acidity alone. Bacteria, however, cannot grow. The pH is, therefore, of great importance in the preservation of fruit product and by regulating it, one or more kinds of microorganism in the beverage can be eliminated.

Table 2.4: The concentration of sulphur dioxide required preventing the growth of microorganisms at different p^H levels.

pH	Organisms and sulphur dioxide concentrations. (ppm)			
	Saccharomyces Ellipsoideus. (Yeast)	Mucor	Penicilium	Mixed bacteria
2.5	200	200	300	100
3.5	800	600	600	300
7.0	Above 5000	Above 5000	Above5000	Above1000

(Source: Srivastana and Sanjeev Kumar, 1994)

The toxicity of sulphur dioxide increases at high temperatures. Hence its effect depends on the acidity, pH, temperature and substances present in fruit juice.

The advantages of using sulpher dioxide are;

- It has a better preservative action than sodium benzoate against bacterial fermentation.
- It helps to retain the colour of the beverage for a long time than sodium benzoate.
- Being highly soluble in juices and squashes, it ensure better mixing and hence their preservation.
- Being a gas, it helps to preserve the surface layer of fruit juices.
- Any excess of sulpher dioxide present can be removed by heating up to 71°C, passing air through the juice or by subjecting the juice to vacuum.

This may causes some loss of flavouring materials due to volatilization, which can be compensated by adding flavours.

Major limitations of using sulphur dioxide are;

- It cannot be used in the case of some naturally coloured juices like those of pomegranates, strawberry, coloured grape etc, on account of its bleaching action.
- It cannot also be used for juices which are to be packed in tin containers, because it is not only corroded the tin surface, but also forms hydrogen sulphide which has an undesirable odour and forms black compounds by reacting with tin surface. (Srivastana and Sanjeev Kumar, 1994)
- If use higher dose of sulphur dioxide it may causes irritations and cough to the consumer.

2.2). Benzoic acid.

It is partially soluble only in water. Sodium benzoate is used and one part of sodium benzoate is soluble in 1.8 part of water at ordinary temperatures, whereas only0.37 part of benzoic acid is soluble in 100 part of water. Sodium benzoate is thus nearly 170 times as soluble as benzoic acid. Pure sodium benzoate is tasteless and odourless.

The antibacterial effect of benzoic acid is increased in the presence of carbon dioxide and acid. Eg.*Bacillus subtillis* cannot survive in benzoic acid solution in the presence of carbon dioxide. Benzoic acid is more effective against yeast than against moulds. It does not stop lactic acid and acetic acid fermentation.

The quantity of benzoic acid required depends on the nature of the product to be preserved, particularly its acidity. In the case of juices having a p^H of 3.5 to 4.0, which is the range of a majority of fruit juices. Addition of 0.06 to 0.10 percent of sodium benzoate has been found to be sufficient. In the case of low acid fruit juices such as grape juice at least 0.3 percent is necessary. The action of benzoic acid is reduced considerably at Ph 5.0. Sodium benzoate in excess of 0.1 percent may produce a disagreeable burning taste. In the long run benzoic acid may darken the product.

The preservative should never be added in solid form, but should be dissolved in a small quantity of juice or water, and the solution is added to the bulk of the product. If this care is not taken, the solids may settle undissolved at the bottom of the container with the result that fermentation may start easily.

2.3). Citric acid.

Citric acid is odourless and may be obtained as colourless crystals or as a white powder, which has a strongly acid taste. It is used in conjunction with appropriate flavour impart a fruitful character.

2.5.9. Filling and Sealing.

Bottles are thoroughly washed with hot water and dried. Before filling bottles are washed with diluted sodium metabisulphate solution, and then filled leaving 1.5 to 2.5 cm headspace. Then bottles are sealed either with crown corks or with caps.

2.6. Other Ingredients used in fruit juice processing.

i. Sugar.
ii. Food colours.
iii. Flavours.
iv. Stabilizers and thickeners.

2.6.1. Sugar.

All juices are sweetened by adding sugar, except those of grape and apple. Sugar also act as a preservative for the flavour and colour and prolongs the keeping quality.

Various sweetening agents have been used as substitutes for cane sugar (sucrose). Substances have been synthesized which are 10 to 3000 times as sweet as sucrose. Non-nutritive sweeteners are mainly used in the manufacture of low colouring soft drinks.

The first synthetic sweetening agent was saccharine. Which is 300 times sweeter than sucrose and is detectable in 10 ppm of water. It has a bitter and unpleasant taste. Because of its toxic effects on chronic use, its consumption has been restricted to 15 mg per kg of body weight. (1g per day for a 52 kg person).

2.6.2. Food colours.

The acceptance of a fruit depends to a large extent upon its attractive colour. The characteristic colour of raw fruit is due to the pigments due to the pigments naturally present in it. Some times artificial colour is added during the preparation and processing fruit to make them more attractive. Various colours are used in the preparation of fruit and fruit products.

In the selection of dyes, it is desirable to choose those, which have high solubility in order to obtain a concentrated solution of a particular colour.

Colours are generally available in the form of powder or ready to use solution. Although colours are added to the attractiveness of the fruit products, it is better to avoid their use as far as possible and educate the consumer to use products not containing colourants. Colours can often be used to cover defects in the natural products.

2.6.3. Flavours.

The substances mainly responsible for the aroma of food products are volatile compounds. These may be aliphatic esters, aldehydes or ketones and are present in fruit and other natural foods in very low concentrations.
Flavouring materials can be classified as,

i. Substances isolated from naturally occurring materials. (Euginol and Citrate)
ii. Those occurring naturally such as lemon oil and sweet orange oil.
iii. Substances prepared synthetically, but which also occur in natural materials.(Vanillin, Cinamaldehyde and Diacetyl)

iv. Synthetic substances which do not occur to any significant extent in natural flavouring materials. (Amyloacetate, Ethylphenyl) (Srivastawa and Sanjeev Kumar, 1994)

2.6.4.Stabilizers and thickeners.

These substances help to improve the texture of foods, inhibit crystallization of sugar and formation of ice stabilized emulsions and foams. They combine with water to form gels and make the food viscus. (Gum Arabic, agar-agar, Alginic acid, Carboxymethyl cellulose (CMC), Gelatin, Pectin, Amylose)

CHAPTER 03

MATERIALS AND METHODS

3.1. Equipments and machineries required for the manufacturing process.

- Fruit bins.
- Stainless steel knives.
- Stainless steel spoons.
- Stainless steel pans.
- Weighing scale.
- Pulper.
- Thermometer.
- Heat source- water bath.
- Stain less steel sieving equipment.
- Measuring cylinders.(1 or 2 liter).
- Glass tube.
- Refractometer.
- Burette.
- Flat bottom flask.
- Glass bottles.
- Funnels and jugs.
- Bottle sealer.

3.2. Ingredients and chemical reagents required for the process.

- Water.
- Sugar.
- Salt.
- Food colours (egg yellow).
- Sodium meta bisulphate (SMS, 0.1%solution).
- Citric acid.
- 0.1M NaOH Solution.
- Phenolphthalein indicator.

3.3. Manufacturing process.

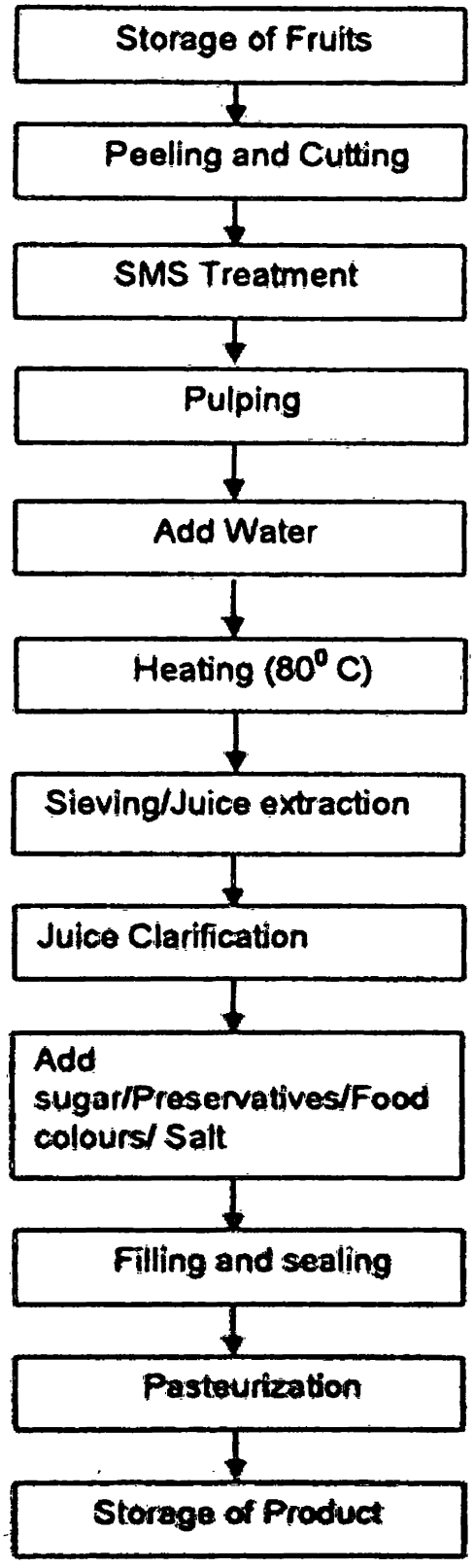


Figure 3.1: Manufacturing process

3.3.1. Storage of fruits.

Fruits were stored for 2 to 3 days until it become fully ripen. This ripening step is lead the break downing of complex starch components into simple sugars and to hydrolyze pectic substances into simple sugars. It is important to impart the typical banana flavour to the juice and to facilitate the clarification of juice.

3.3.2. Peeling and cutting.

Was carried out manually with the aid of stainless steal knives. Just after cutting, SMS treatment was done for preventing the enzymatic browning reactions.

3.3.3. Pulping.

Pulping was done with an electric pulper.1:1 ratio (fruit: water)was used for pulping and then water was added until the ratio become 1:4 of fruit :water. Then the whole liquid was subjected to the heat treatment process at 800C for the purpose of extraction of fruit constituents into juice.

3.3.4. Sieving.

After extraction of juice, it contains varying amount of suspended matter with consist of broken fruit tissues, seeds, skin, various gums and pectic substances. Sieving was done by using stainless steel mesh.

3.3.5. Juice clarification.

Extracted fruit was poured into pre cleaned measuring cylinders and allowed to precipitate. After one hour, clarified fruit juice was siphoned off from 'top layers' of cylinders by using a glass tube.

Before adding ingredients, existing levels of sugar, acidity were measured.

3.3.5.1. Measuring the sugar content present in juice.

Existing sugar content was measured as soluble solids. Laboratory refractometer (scale 0-30 brix) was used.

Determination of sugar content present in juice.

The glass lence of the hand refractometer was washed well with distilled water and wiped out with filter paper. A drop of banana juice was placed on the prism of the refractometer.

The corresponding soluble solid content (Sugar content) is shown directly by weight of the solution.

3.3.5.2. Measuring the titrable acidity in juice.

Acidity of the juice is caused by Malic acid present in banana. To measure the acidity, titration method was carried out.

Determination of titrable acidity of juice.

Known amount of juice was diluted with distilled water and two drops of phenolphthalein indicator was added. Then it was titrated with standard sodium hydroxide solution until pink colour was obtained.

3.3.5.3. Development of formula.

After determination of soluble solid content and titrable acidity, three different recipes were developed with the range of RTS standards by varying the sugar content and acidity of the juice.

Table 3.1: Formula A for banana RTS (Sample no: 425)

Item.	% value.	Amount.
Fruit.	5%	200 g
Sugar.	16%	624 g
Citric acid.	0.3%	----
SMS.	70 ppm	0.28 g
Salt.	----	5 g.
Colours.(egg yellow)	----	0.1 g
Water.	----	3170 g

Table 3.2 : Formula B for Banana RTS (Sample no: 387)

Item.	% value.	Amount.
Fruit.	5%	200 g
Sugar.	17%	664 g
Citric acid.	0.4%	15.4 g
SMS.	70 ppm	0.28 g
Salt.	----	5 g.
Colours.(egg yellow)	----	0.1 g
Water.	----	3115 g

Table 3.3: Formula C for Banana RTS (Sample no: 245)

Item.	% value.	Amount.
Fruit.	5%	200 g
Sugar.	18%	704 g
Citric acid.	0.5%	19.4 g
SMS.	70 ppm	0.28 g
Salt.	---	5 g.
Colours.(egg yellow)	---	0.1 g
Water.	---	3071 g

Ingredients are mixed and stirred until they completely dissolved and the juice was filtered through a net cloth.

3.3.6. Filling and sealing.

The banana fruit drink was filled into cleaned and washed bottles and they were sealed air tightly by a hand sealer.

3.3.7. Pasteurization.

The sealed bottles were pasteurized at the temperature of 90^{0}C in a water bath and cooled into room temperature.

3.4. Sensory evaluation test.

One week after the preparation of RTS banana drink, sensory evaluation test was conducted for three samples. 25 untrained panelists were participated.

A hedonic scale rating test was used to measure the degree of pleasurable and unpleasurable experience of panelists with the scale of 9 points from "like extremely" to "dislike extremely".

Sensory evaluation was conducted for testing the flavour and acidity of the product and overall acceptability of panelists for the product.

3.5. Microbiological quality of the product.

After preparation of final product, initial microbial quality of the product was evaluated. For that, Yeast mould count and Total bacterial count was measured.

- Potato dextrose agar (PDA) medium was used for the determining the mould and yeast count.
- Nutrient agar medium was used for determining the bacterial count.

- Used apparatus are,
  - Autoclave
  - Petri dishes
  - 1 ml Pipettes
  - Conical flasks
  - Incubators
  - Analytical balance
  - Water bath
  - Bunsen burner

3.5.1. Determining the Yeast and mould present in the sample.

Agar medium was put into a conical flask closed the orifice by cotton and covered with an aluminium paper. Then it was autoclaved (20 min in 121^{0}C under 15lb/in^2) After that PDA was added to all Petri dishes and 1 ml of fruit samples was added.

3.5.2. Determining the bacterial count present in the samples.

Nutrient agar medium was sterilized by using an autoclave and added to Petri dishes. (15 ml for one plate) Fruit juice samples were mixed well with nutrient agar separately. Then Petri dishes were placed at 35^{0}C for the growth of bacteria.
All microbiological tests were done in aseptic conditions.

CHAPTER 04
RESULTS AND DISCUSSION

4.1. Results.

After statistical analyzing of the results of sensory evaluation test, following results were obtained for each characteristic feature of samples.

Table 4.1: Results of sensory evaluation test

Sensory characteristics	Average ranks for each samples		
	425	387	245
Flavour	37.5	42.3	34.3
Acidity	37.0	41.7	35.3
Overall acceptability	38.1	39.5	36.4

Table 4.2: Results of the microbial quality tests. (Yeast and Moulds)

Fruit juice samples	No. of colonies present (Yeast and Moulds)		
	Initially	After 2 weeks	After 4 weeks
425	0	0	0
387	0	0	0
245	0	0	0

Table 4.3: Results of the microbial quality tests. (Bacteria)

Fruit juice samples	No. of colonies present (Bacteria)		
	Initially	After 2 weeks	After 4 weeks
425	0	0	0
387	0	0	0
245	0	0	0

4.2. Discussion.

4.2.1. Production process.

Raw materials for the process (Banana fruits) should be in good quality and well ripened. It is important to maintain the proper sanitation practices during the production process.

As fruit is ripen, starchy components and other complex components are broken down into simple compounds. It is beneficial for the clarification process of juice.

After peeling and cutting, fruits should be treated with 0.1% SMS solution. It is important to reduce the occurrence of browning reactions in fruits.

Pulping is important to extract the fruit components to the juice. The purpose of heating juice after pulping is to further extraction of fruit constituents to the juice. It was done at the temperature of $80^{0}C$ in a water bath.

Stainless steel sieving equipment was used for the sieving operation. To calculate the fruit content of the final product, we should know the weight of the in filterable fruit parts (fibrous and starchy components) in the sieve. So, initial weight of the sieving equipment should be measured before the process.

We should keep the juice for adequate time period (about 1 hour) for proper precipitation of large fruit particles.

After final clarification, we should know the total weight of fruit component, which was removed during the clarification process.

During the production process, Sugar, Citric acid, SMS, Salt and Food colours were added. Sugar is used as a sweetening agent and citric acid plays a large role in the product.

- It adjusts the p^H and acidity of the product.
- Stabilize the product.
- Prevent cloudy precipitation.
- Inhibit oxidation.
- Eliminate the microbial activity of the product.

Small amount of egg yellow colouring was added to the product for enhancing the attractive colour of the product. Salt provide the appropriate salty taste for the final product.

Sodium metabisulphate (SMS) is used as a permitted preservative agent. It inhibit the growth of yeast, mould and aerobic bacteria and also prevent the browning of fruits due to enzymatic reactions. The equilibrium of SO_2 depends both on the p^H of the food and other reactive species present in food, such as free carboxyl groups in sugar or disulphide groups in proteins. The antimicrobial activity of SO_2 is due to undissociated HSO_3.

Finally fruit drinks are again preserved by pasteurization. It is relatively mild heat treatment, usually performed below 100°C , which is used to extend the shelf life of fruit drinks. It preserves fruit drinks by inactivating the enzymes and destruction of relatively heat sensitive micro organisms (non spore forming bacteria, yeast, mould). But causes minimal changes in the sensory characteristics or nutritive value of the food.

4.2.2. Sensory evaluation.

After statistical analysis of the results of sensory evaluation test, sample (387) shows highest sensory quality comparing to other two samples. It contains sugar content of (17%) and acidity of (0.4%).

Sample (245) shows lowest sensory quality comparing to other two samples. It contains sugar content of (18 %) and acidity of (0.5%).

Sample (425) shows intermediate sensory quality comparing to other two samples. It contains sugar content of (16 %) and acidity of (0.3%).

So, above results shows that the sample (387), having the sugar content of (17%) and acidity of (0.4 %) is the most suitable and consumer acceptable sample among three samples.

4.2.3. Microbial quality of the product.

According to initial microbial count, it shows that the initial product is in microbial safe level. Even four weeks after processing, microbiological aspects are within the range of SLS stands of RTS fruit drinks.

4.3. Cost evaluation of the product.

Total expenses: (In rupees)

Banana fruit	75.00
Sugar	70.00
Bottle caps	10.00
Preservatives and other miscellaneous	20.00
No of drink bottles prepared	25
Production cost per one bottle	7.00

4.4. Final conclusion.

The production cost is desirable for the manufacture. But there are some problems associated in the production process.

- It is very difficult to impart the palatable banana flavour to the product.
- Final yield of the product is very low. We have to remove higher amount of fruit content during clarification process.

So, RTS banana fruit drink is not much suitable as a competitive marketable product.

CHAPTER 05

FURTHER STUDIES AND RECOMMENDATIONS

During clarification, we siphoned off the juice and remove the precipitated fruit particles. So, reduction of final yield is caused during the heat clarification method. Therefore, if we are possible to carry out the enzymatic clarification method (using peetolytic enzyme) it is more successful.

The complex pectin components present in fruit juice are broken down into simple components by enzymes and they are filterable. So, higher amount of fruit content can be utilized for the production. Then we can increase the yield of the product.

- Enzymatic clarification method may impart the banana flavour also. After broken down the complex fruit particles, flavour constituents which are present inside the tissues also be released to the fruit juice.

  These flavour constituents may impart the typical banana flavour.
- Shelf life evaluation of the product should be continued further.
- If it is possible to produce a byproduct such as banana jam by using the removing banana pulp, it is more profitable to the producer.

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Appendix I

Instructions for sensory evaluation test.

(1). Ask judges not to smoke, consume chewing gums, eating and drinking at least 30 minutes before tasting. Because these factors can affect tasty feelings of judges.

(2). Ask judges to forget everything, which they know about the sample preparation and ingredients used. Because it can affect the ranking.

(3). Before start the tasting and in-between the tasting two samples, ask panelists to eat piece of Cream Cracker biscuit and drink some water. They can neutralize mouth from other tastes.

(4). Tell judges to examine the sample bottles to get real idea about thickness, colour like characteristics.

(5). Panelists are asked not to talk with other panelists and not to look their ballot papers.

Appendix II

Sensory evaluation sheet

- Product: Ready To Serve Banana fruit drink.
- Indicate how much you like or dislike each sample after tasting.
- Assess the samples individually.
- Give numerical values to rank the samples.
- Rinse your mouth with water after tasting each sample.

Point scale	Points
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither likes nor dislikes	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Sensory aspects:

Parameters	Sample numbers		
	425	387	245
Flavour			
Acidity			
Overall acceptability (colour, viscosity, appearance)			

- Comments:
- Date:
- Name:

Appendix III.

- **Initial chemical Analysis of fruit juice.**

Titrable acidity = $\frac{\text{Mol.wt of Malic acid} \times \text{Req.V of NaOH} \times \text{NaOH Con}^{n} \times 100}{1000 \times \text{Vol. of sample}}$

- Molecular wt of Malic acid = 67.03 g
- Req.V of NaOH = 4.5 ml
- NaOH Con^{n} = 0.1 M
- Vol. of sample = 10.0 ml

T.A. = $\frac{67.03 \times 4.4 \times 0.1 \times 100}{1000 \times 10}$

= 0.3 % //

- Initial brix value of fruit juice = 8%

Appendix IV.

- Development of formula:

First, decide the quality parameters of Nectar, which is going to be prepared.
E.g.: If it is as follows;

Fruit content	10%
Sugar content	18%
Acidity level	1 %
SMS level	70ppm

If we take 10 Kg of fruit ———— Can obtain 100 Kg nectar
So, if 1Kg of fruit ———— Can obtain 10 Kg nectar

After clarification,
Measure the Brix value ———— If it is a %,
Means,
Fruit 100 Kg contain ———— a Kg of natural sugar
So, Fruit 1 Kg contain ———— a / 100 Kg of natural sugar

In nectar,
Sugar content should be ———— 18 %
Means,
Nectar 100Kg contain ———— 18 Kg of sugar

So, nectar10 Kg should contain ———— $\frac{18 \times 10}{100}$
It is ———— 1.8 Kg

Required Cane Sugar amount ———— 1.8 – (a / 100) Kg
It is considered as ———— X
If measured titrable acidity is b %,
Acidity in 1 Kg ———— b / 100 Kg (naturally)
In nectar,
Acid level should be ———— 1 %
Means,
100 Kg nectar should contain ———— 1 Kg acid
So, nectar 10 Kg should contain ———— 1 / 10 Kg

Have to add ———— $\frac{1}{10} - \frac{b}{100}$ Kg
It is considered as ———— Y

Required water volume ———— (Total nectar volume - Fruit + Ingredients)

———— [10 – (1 – X +Y)]

Formula can be developed as follows;

- Fruit juice ——————1.5 Kg
- Water ——————— Z Kg
- Sugar ——————— X Kg
- Citric acid ——————— Y Kg
- SMS ——————— 0.7 g
- Colours
- Flavours
- Salt

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