Developing an organic preservation technique for canning of "Rose apple"(*Syzygium samarangense*) In Tropical Health Food (Pvt) Ltd.

By

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(03/AS/084)

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DECLARATION

The work described in this thesis was carried out by me at the Department of Food Science & Technology, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, under the supervision of Mrs. T.C.Kananke and Mr. A.Weerasuriya. The report on this has not been submitted to another university for another degree.

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ABSTRACT

The study was carried out to develop an organic preservation technique for the canning process of Rose apple (*Syzygium samarangense*) using 3 types of osmotic solutions in the Tropical Health Food (Pvt) Ltd. Rose apple (*Syzygium samarangense*) is a tropical fruit tree which belongs to guava family (*Myrtaceae*). Though the whole fruit of rose apple is edible, products made out of these are not commonly available in the market. As a result the post harvest loss of rose apple is very high.

The canned products that are produced from rose apple fruits with improved organoleptic qualities by the diversification processes result in higher utilization of the less exploited fruit crop. The production of value added products from this underutilized crop will increase gainful employment opportunities in the country. The end products resulting from the organic preservation of rose apple contain organic ingredients and no artificial food additives or preservatives. Canning process is a processing method which mainly used high temperature to preserve food. Rose apple fruits are usually high in acid, this prevents the growth of bacteria, molds, and yeasts in the product.

The study was carried out using three canned samples of rose apple made out of with different concentrations of salt solution, sugar syrup and pineapple juice. Then most suitable concentration for each salt and sugar solution was selected prior to obtain optimum organoleptic properties. Samples were exhausted, sealed and pasteurized in an auto clave. Each product was analyzed during and after processing to determine pH, brix and titratable acidity. Then the level of preference for each sensory attribute (Colour, Smell, Appearance, Taste, Overall acceptability) in 3 samples were identified through a sensory evaluation by using 30 un-trained panelists. Obtained results from the sensory evaluation were analyzed by Minitab statistical analysis software with the aid of Kruskal- wallis test at 5% significant level.

According to the sensory evaluation, the canned product with sugar syrup was the most preferable. So that, canned rose apple fruits with 75g/l concentrated sugar syrup were more suitable for the local market. But the product with pineapple juice was selected by Tropical Health Food (Pvt) limited for the exporting purpose according to the preference of German people. The selected product was proximately analyzed and it contained 92% water, total sugar content of 9.74%, 2.2 % ash, 0.31% protein and 1.3% fat.

CONTENTS

LIST OF ABREVIATIONS

App.	Appendix
Conc.	Concentrated
E.g.	Example
Fig.	Figure
Ltd	Limited
Ove.	Overall
Pvt	Privet
Tit.	Titrable
Wt	Weight

LIST OF FIGURES

LIST OF TABLES

Tables **Pages**

CHAPTER 01

INTRODUCTION

1.1. Background

Rose apple (*Syzygium samarangense*) is a tropical fruit tree which belongs to guava family (*Myrtaceae*). Rose apple is about 5 cm long, pear shaped fruit and color variations exist including red, shiny skinned fruits. Fruits are ripen over an extended period of time. Ripe fruits are with snow white, juicy pulp. Normally, Fruits are eaten in fresh nature Rose apple (*Syzygium samarangense)* is one of the fruit types which is underutilized but commonly available in any area of Sri Lanka. So, the product of canned rose apple is very important to increase the utilization of the less exploited fruit crop to prepare a value added product.

Fresh fruits are termed perishable commodities and they have an inherent tendency for spoilage which causes lose of quality, edibility or nutritive value of food. Some estimates suggest that about 30 -40% of fruits are lost in Sri Lanka after leaving the field. Post harvest loss of this magnitude represents a significant food loss and a considerable economic loss to the country. Furthermore, farmer gets low price for his commodities and consumer gets low quality products.

Tropical Health Food (Pvt) Ltd is a company which that processed different under utilized fruits for the exporting purpose. They export organic preserved canned tropical fruits such as pineapple, mango and papaya to the Germany. Preserving the fruit allows processors to export the nutrient-rich product with use of highly available, low cost fruits to the foreign market where demand is on the rise. Organic preservation is the Processing of organic food usually contains organic ingredients and no artificial food additives or preservatives.

Canning is the method which used for preserving fruits which extending shelf life of fruits with processes that stop or greatly slow down spoilage caused or accelerated by micro-organisms and by the activity of endogenous enzymes. During the Canning

process, the food is processed and sealed in an airtight container which is then heated to such a temperature that all harmful microorganism and spores capable of growth during storage of the can at normal temperature are killed.

So that, under utilized rose apple fruits can be preserved by organic preservation successfully to prepare value added product.

1.2. Overall Objective:

To introduce an organic preservation technique for the canning process of rose apple (*Syzygium samarangense*) in Tropical Health Food (Pvt) Ltd, for the exporting purpose.

1.3. Specific Objectives:

1. To establish critical parameters for the canning process of rose apple.
2. To study the changes in organoleptic properties of the rose apple after the heat process.
3. To select the best osmotic solution that can be used for the rose apple canning through a sensory evaluation.
4. To proximately analyse of canned rose apple product.
5. To increase the utilization of underutilized rose apple to prepare a value added product.

CHAPTER 02

LITERATURE REVIEW

2.1. Fruits

Foods commonly designated as fruits are freshly or pulpy characters, often juicy and usually sweet with fragnant, aromatic flavors.

2.1.1. Chemical composition of fruits

- Water: The major portion of most of fruits is water and it may be varied between 70% - 96%
- Carbohydrate: Most of fruits are high in sugars (3-27%) as they contain large amounts of dextrose and levulose and in many cases other sugars as well.
- Protein: Most of fruits contain low amount of protein.
- Fat: Nearly all the fruits are very low in fats.
- Vitamins: Most fruits are excellent source of vitamin C, several are good sources of carotene and many contain moderate amounts of pyridoxine, Inositol, folic acid and biotin.
- Minerals: Fruits are rich source of potassium. They also contain much calcium, sodium, magnesium, phosphorus, chlorine, sulpher, iron, copper and other minerals needed by the body.
- Fibre: The fibre content of fruit is low for most of fruits.(0.2% 3.1%)

(Arya 1993)

2.1.2. Nutritional value

Fruits in general, do not contribute considerable amounts of either calories or proteins to the diet, but they are of outstanding value because of their content of various vitamins and minerals

2.2. Organic food

"Organic" usually means foods which are produced without extensive use of synthetic chemicals (eg: fertilizers, pesticides, antibiotics, hormones), substantially free of genetically modified organisms.

Processed organic food usually contains only (or at least a certain specified percentage of) organic ingredients and no artificial food additives, and is often processed with fewer artificial methods, materials and conditions (eg: no chemical ripening, no food irradiation). So that, organic preserved foods no contain chemical preservatives.

2.3. Food preservation

Food preservation is the process of treating and handling food to stop or greatly slow down spoilage caused or accelerated by micro-organisms. Microbial activities cause loss of quality, edibility or nutritive value of food.

Preservation usually involves preventing the growth of bacteria, fungi, and other micro-organisms, as well as retarding the oxidation of fats which cause rancidity. It also includes processes to inhibit natural ageing and discolouration that can occur during food preparation such as the enzymatic browning. Some preservation methods require the food to be sealed after treatment to prevent recontamination with microbes. Food preservation is a way of preparing food that can be stored for future use. (Wikipedia 2008)

2.3.1. Principles of food preservation

The basis principles of food preservation primarily involves the process of inhibiting

1. the growth and activity of microorganisms
2. activity of endogenous enzymes
3. chemical reactions which may deteriorate the quality of food and
4. invasion and spoilage by insects and rodents.

In addition, spoilage of foods may be caused during mechanical handling, processing, packaging, storing and transportation. Appropriate care has to be exercised to prevent deterioration of quality of food.

Several methods are available for preservation of foods based on the above principles. The methods include;

1. Preventing the accessibility of food to microorganisms by asepsis and packaging
2. Physical removal of microorganisms from food by filtration or centrifugation
3. Hindering the growth and activity of microorganisms by use of preservatives, use of low temperature, atmospheric control in packaging and storing of foods and decreasing water activity in foods by drying or evaporation,
4. Killing the microorganisms by use of high temperatures and ionizing radiation
5. Inactivation of endogenous enzymes by moderate heating
6. Inhibition of chemical reactions through the use of chemical additives and
7. Fermentation of foods to yield more stable or less perishable food products.

Food preservation as it is practiced in industry always involves the use of combination of methods for achieving maximum effectiveness.

(Sivasankar 2003)

2.3.2. Preservation methods

Since these microorganisms are the main cause of food spoilage, food preservation depends on rendering conditions unfavorable for their growth. Processes of preservation may be generally classified as drying, heating, refrigeration , use of chemicals or other particular agencies, vacuum treatment ,radiation and submersion in a strongly saline, acid, base, osmotically extreme (for example very sugary) or other microbe-challenging environments

2.4. Use of high temperatures for food preservation

2.4.1. Introduction

Preservation of foods by the use of heat finds very wide applications compared to other methods. The high temperatures ensure that microorganisms and their spores are killed and the enzymes are inactivated due to thermal denaturation of proteins and enzymes of the micro organisms .The temperature varies with the kind of organism.

its state and the environment during heating. After heat processing, any remaining spores from micro organisms will not have the right conditions to grow into bacteria and microbial contamination from outside is prevented. The type of heat treatment depends on the kind of organisms to be killed, other preservative methods to be employed and the effect of heat on the food. The use of heat also affects the food adversely and hence it is necessary to use only mild heat treatment that ensures eliminating of pathogens and enzyme activity and enhance the shelf life of the food.

(Sivasankar 2003)

2.4.2. Advantages and disadvantages of heat treatment

As with other methods, heating has advantages and disadvantages as outlined below.

Advantages

1. Most micro-organisms are destroyed so there is less chance of spoilage.
2. After being sterilized and stored, the food can be kept longer and more safely.

Disadvantages

1. Heating requires the following investments:
   1.1. Heat-resistant storage containers (which can be difficult to obtain) such as cans or glass jars. The latter are preferred because they can be reused.
   1.2. Cooking utensils, such as a steamer
   1.3. Fuel
2. These investment costs will have to be represented in the final cost of the product.
3. This method is labour intensive.
4. It requires access to abundant clean water.
5. Preserved fruits and vegetables have a lower nutritional value and generally less taste than fresh products. However, fewer nutrients are lost using the heating method than any other preservation method.

2.4.3. Various degrees of preservation by heating

There are various degrees of preservation by heating to prevent them from rotting and to prepare them for storage in glass jars or tins.

a. Sterilisation.

sterilisation results complete destruction of micro-organisms. Because of the resistance of certain bacterial spores to heat, this frequently means a treatment of at least 121° C (250° F) of wet heat for 15 minutes or its equivalent. It also means that every particle of the food must receive this heat treatment. If a can of food is to be sterilised, then immersing it into a 121° C pressure cooker or retort for the 15 minutes will not be sufficient because of relatively slow rate of heat transfer through the food in the can to the most distant point.

b. Pasteurization

Pasteurized means a comparatively low order of heat treatment, generally at a temperature below the boiling point of water. The more general objective of pasteurization is to extend product shelf-life from a microbial and enzymatic point of view; this is the objective when fruit or vegetable juices and certain other foods are pasteurized. Pasteurization is frequently combined with another means of preservation - concentration, addition of chemical agents, acidification, etc.

c. Blanching

It is a type of pasteurization usually applied to vegetables mainly to inactivate natural food enzymes. Depending on its severity, blanching will also destroy some microorganisms.

(Hotchkiss and Potter 1996)

2.4.4. Heat processing of fruits

2.4.4.1. Importance of heat processing of fruits

The high percentage of water in most fresh foods makes them very perishable. They spoil or lose their quality for several reasons:

- Growth of undesirable microorganisms-bacteria, molds, and yeasts,
- Activity of food enzymes,
- Reactions with oxygen,
- Moisture loss.

Microorganisms live and multiply quickly on the surfaces of fresh food and on the inside of bruised, insect-damaged, and diseased food. Oxygen and enzymes are present throughout fresh food tissues.

2.4.4.2. Use of high temperature for fruits

The heating method for fruit is different than for most vegetables. Fruit has a low pH level and it can be heated in boiling water (100°C), whereas most vegetables have to be heated at temperatures above 100°C, because they have a higher pH and are thus more susceptible to bacterial contamination. (Tressler 1976)

However, some micro-organisms are unfortunately less sensitive to heat: *Clostridium* and *Staphylococcus* can still multiply and spoil the food through the poisonous substances they produce. *Clostridium* can cause botulism and result in tragic deaths. This bacteria does not thrive as well in more acidic products such as fruit (pH < 4.5).This preservation method produces the best results, but only if fresh products are used and the instructions for heating are followed exactly.

2.4.5. Factors affecting heat resistance of microorganisms

Cells and spores differ widely in their ability to resist high temperatures. Even within a population of cells and spores the heat resistance varies as indicated by the thermal death time* or frequency distribution.

*Thermal death time: The time required at a certain temperature to kill a stated number of organisms or spores under specific condition. The thermal death time varies with the type of organism and temperature.

In general, a small number of cells have low resistance, most of cells have a medium resistance and a large number have a high resistance. The various factors influencing the heat resistance (thermal death time) of micro organisms include the following.

1 Temperature-time relationship

The time required for killing cells or spores under a given set of conditions decreases as temperature is increased.

E.g. The time required to kill the spores of *C. botulinum* at an initial population of $6 \cdot 10^{10}$ in buffered medium at pH 7 has been estimated to be 260 minutes at 105°C, 120 minutes at 105°C,36 minutes at 110°C and 5 minutes at 120°C.

II. Initial concentration of spores or cells

When the large number of spores or cells present, greater is the heat treatment required to kill them.

E.g. The thermal death time of the spores of *C. botulinum* (in a buffer at pH7) at 100oC was found to be 110 minutes for an initial population $3.2 \cdot 10^7$ and 50 minutes for an initial population of 1.64×10^4.

III. Composition of the substrate

The composition of the substrate or food in which the cells or spores are heated has a profound influence on the heat resistance of the organism.

a. Moisture content- Moist heat is more effective as a killing agent than dry heat.

b. pH of the medium- Cells or spores have greater heat resistance at or near neutral pH values. Hence foods may be classified on the basis of their pH in to four broad categories.

   i. High acid foods: pH value lower than 3.7 (e.g.Berries)

   ii. Acid foods: pH3.7-4.5 (e.g.tomato,pear,pineapple)

   iii. Medium acid foods: pH 4.5-5.3 (e.g.beet,pumpkin,spinach)

   iv. Low acid foods: pH value greater than 5.3 (e.g. corn, peas, beans, meat, fish, poultry and milk)

   The heat process required in the canning of food increases with their pH.

c. Other constituents in food, particulary, sodium chloride in low concentration has a protective effect on spores. Sugars may protect some spores; glucose protects *E.coli* and *Pseudomonas flourescens* against heat better than sodium chloride at water activity levels near the minimum water activity level required for growth.

d. The concentration of solutes may affect the heat process necessary for sterilization. Hence canners classify foods further as high-soluble solid

foods (e.g. syrups and concentrates) and low soluble solid foods such as fruits, vegetables and meat.

e Antiseptic or germicidal substances in the substrate aid in the destruction of micro organisms. Thus hydrogen peroxide with heat is used to reduce bacterial content of sugar and milk for cheese making.

(Sivasankar 2003)

2.5. Process of Canning

2.5.1. Introduction

Canning is a preservation method, in which prepared food is put in glass jars or metal cans that are hermetically sealed to make airtight containers and then heated to a specific temperature for a specified time to destroy disease-causing microorganisms and prevent spoilage. The killing of micro organisms by heat is supposed to be due to denaturation of the protein and especially to inactivation of enzymes required for metabolism.

Canning was invented in 1809 by Nicholas Appert. Canning leads to a loss of nutrient value in foods, particularly of the water-soluble vitamins.

(Wikipedia 2008)

2.5.2. Categories of foods for canning

It is possible to classify foods to be canned on the basis of acidity and pH value.

2.5.2.1. Important food groups

- Low acid food group - Meat, fish, poultry, dairy products, and vegetable .These foods generally fall into a pH range of 5.0 to 6.8.
- Medium acid food group - Manufactured food items such as soups and spaghetti products fall in to this group. These foods have pH values between 4.5 and 5.0.
- Acid foods - foods with pH values between 4.5 and 3.7 Most of fruits are fall into this group.
- High acid foods - Berries, pickle products and fermented foods The pH values range from 3.7down to 2.3.

2.5.2.2. Microorganisms associated with the food groups

Foods with pH values greater than 4.5 require relatively sever heat treatments. The lower limit of growth of an important food poisoning organism, *Clostridium botulinum*, is at a pH value of 4.5.

(Desrosier 1987)

2.6. General Canning procedure of fruits

Before canning fruits, need to make decisions about three things:

1. If an anti-darkening agent is needed.
2. Whether syrup, water, or fruit juice will be used as the packing liquid.
3. If fruit will be hot- or raw-packed.

Fruits are usually high in acid. High acidity prevents the growth of bacteria, molds, and yeasts that are present in atmosphere.

Proper canning practices include:

- carefully selecting and washing fresh food,
- peeling some fresh foods,
- hot packing or raw packing of foods,
- adding acids or syrups to some foods,
- using acceptable jars and self-sealing lids,
- Processing jars in a boiling-water or pressure canner for the correct period of time.

Collectively, these practices remove oxygen; destroy enzymes; prevent the growth of undesirable bacteria, yeasts, and molds; and help form a high vacuum in jars. Good vacuums form tight seals which keep liquid in and air and microorganisms out.

2.6.1. Preparation of fruit

Fruits for canning should be fresh, firm, of good quality, and not over-ripe. Some of the spores may survive in over-ripe fruits during the boiling process, and then fermentation will take place in a short time.

(Mcwilliams 1984)

So that. Start with fruit that is fully ripened, yet still firm and free from bruises or soft spots. After preliminary sorting, the fruits are graded. This is necessary to obtain a pack of uniform quality as regards to size, colour etc. There are several mechanical Graders such as screen graders, roller graders, and rope or cable graders.

- Washing: The graded fruits are washed with cool water in different ways ,such as soaking or agitating in water to remove any dirt or residues .
- Peeling, coring and pitting: The washed fruits are prepared for canning by peeling, coring, blanching etc. Fruits are peeled in a variety of ways.

1. By hand or with knife
2. By machine
3. By heat treatment (scalding in steam or boiling water)
4. By lye solution (dipping fruits in boiling caustic soda or lye solution of 1 to 2% for short periods)

In all cases there will be a need for visual inspection and some hand trimming to remove any remaining skin or blemishes.

(Khader 1999)

2.6.2. Packing of fruits

Fruits and vegetables may be packed in raw nature or they may be preheated and then packed into canning jars. The hot pack yields better color and flavor, especially when foods are processed in a boiling water bath. The packaging prevents microorganisms from entering and proliferating inside. Plain cans are used generally, although in the case of coloured fruits.

(Mcwilliams 1984)

Cans can be filled by machine or by hand and filled weight also be controlled. Jar filler will help when filling the jars with small foods. Correct filling is not only desirable for economic reasons but also technically important

2.6.2.1. Sterilization of Cans

When cans are reused, they have to wash with water or subjected to steam jet to remove any adhering dust or foreign matter. In large canneries, the cans are washed with jets of compressed air or water.

2.6.2.2. Raw pack

Raw-packing is the practice of filling jars tightly with freshly prepared, but unheated food. Fruits which are packed in raw should be packed tightly because they will shrink during processing.

2.6.2.3. Hot pack

Hot-packing is the practice of heating freshly prepared food to boiling, simmering it 2 to 5 minutes, and promptly filling jars fairly loosely with the boiled food as shrinkage has already taken place. .

Hot-packing is the best way to remove air and is the preferred pack style for foods processed in a boiling-water canner. At first, the color of hot-packed foods may appear no better than that of raw-packed foods, but within a short storage period, both color and flavor of hot-packed foods will be superior.

2.6.2.4. Blanching

Treatment of fruits with boiling water or steam for short periods followed by cooling prior to canning is called blanching. Blanching is a way of preheating of fruits and preparing them for raw packed. The hot filling also reduces the processing time where heat penetration may be slow, but conversely, cooling of the contents of large cans may be very slow, with consequent loss of quality. It facilitates close filling in the can and drives out the air from the tissues. Further it helps to clean the fruit and to eliminate micro organisms. It also inactivates the enzymes, thus preventing the possibility of discoloration. Hard water should not be used for blanching, as it toughen the tissue and destroy the natural texture. During the blanching operation, nutritional value of the food is loss and it can be minimized by keeping the blanching time as short as possible.

(Khader 1999)

2.6.3. Packing liquid

The liquid (juice, syrup, or water) that is added to the fruit in the jars helps remove air from food tissues, shrink food, keep the food from floating in the jars, increase the vacuum in sealed jars, and improve shelf life.

The cans are filled with hot sugar syrup or juice for fruits and the objective of adding syrup or brine is to improve the taste of the canned product to fill up the interspace between the fruits in the can and facilitate future processing. Fruits are usually canned in sugar syrup, although there is an increasing use of fruit juice in these more health-concious days. (Khader 1999)

Whether food has been hot-packed or raw-packed, the juice, syrup, or water to be added to the foods should also be heated 78 ^{0}C to 82 ^{0}C to boiling before adding it to the jars. There should be enough syrup, water or juice to fill in around the solid food in the jar and to cover the food. The entrapped air in and around the food may cause discoloration within 2 to 3 months of storage. If not covered by liquid, food at the top tends to darken and develop unnatural flavors due to browning reactions.

- **Sugar syrup**

Mix sugar with water or with juice extracted from some of the fruit. Heat sugar and water or juice together until the sugar dissolves. Sugar helps canned fruit hold its shape, color and flavor but is not needed to prevent spoilage. The syrup is usually prepared from granulated sugar obtained from beet or cane. But it is possible to use other sugars, such as.

Type of syrups: Very light (10% sugar)

Light (20% sugar)

Medium (30% sugar)

- **Extracted juice**

Fruit can be canned in fruit juice (apple juice, pineapple juice, or mango juice) and the best choice is juice made from the fruit that is being canned. To prepare such a juice thoroughly crush ripe, sound, juicy fruit And Strain through a muslin cloth.

- **Sweeteners other than sugar**

Light corn syrup, brown sugar or mild-flavored honey, dextrose can replace as much as half the sugar used in canning fruit. It is best not to use molasses, sorghum or other strong-flavored syrups. Their flavors overpower the fruit flavor and they may darken the fruit.

- **Hot water**

  Packing fruit in water is another option; however, water-packed fruits do not retain the flavor, color, and texture of the fruit.

2.6.3.1. Use of osmotic solutions

2.6.3.1.1. Osmosis

Osmosis is the movement of solvent, such as water, through a barrier from a less concentrated solution into a more concentrated solution. It occurs when two solutions are separated by a semipermeable membrane which allows only the solvent to pass through.

2.6.3.1.2. Effect of osmotic solution on microorganisms

Microbes in the food are surrounded by salt, sugar, or fruit juice in high concentrations. Outside the cell membrane of microbes, there is a solid with low content of water, and inside the cell membrane is a solution with relatively high water.

High concentrated solution causes shrink cells in micro organisms through osmosis process. When, a high concentrated solution is existed outside cell membrane of microbes compared to inside, water tends to move out of the organism preventing its growth and ultimately killing it.

2.6.4. Exhausting

Many fresh foods contain from 10 percent to more than 30 percent air. How long canned food retains high quality depends on how much air is removed from food before jars are sealed. Exhausting helps to remove air from food tissues, shrinks food, helps keep the food from floating in the jars, increases vacuum in sealed jars, and improves shelf life.

2.6.4.1. Process of exhausting

Exhausting is the process of removing air and entrapped gases from the can before closing. It can be achieved by several methods depending on the type of food product. When the product occurs as a thin liquid, only rarely occlude gases below its surface and, therefore, only requires the removal of the air in the headspace. Viscous and semi-solid products may contain a considerable amount of entrapped air when filled into the can.

Fruits and vegetables tissues also may contain CO_2 evolved from the respiratory process. The syrup used for covering fruits is normally filled as hot as possible, so the air in the headspace is partially displaced by the steam from the hot liquid. Air bubbles trapped inside the jar may rise to the top during processing, causing too much head space. This can result in the jars not sealing properly.

(Arthey 1998)

To make sure that air bubbles have not been trapped inside the jar, run a bubble freer or any plastic or rubber knife-like utensil around the edges of the jar, gently shifting the food, so that any trapped air is released.

2.6.4.2. Head Space

This is the unfilled space in the jar between the inside of the lid and top of the food or it's liquid. The amount of head space needed depends on the type of food being processed. Starchy foods for instance, tend to swell when heated and therefore require more head space.

Fig.2.1. Head space of a glass jar

If the jars are filled too full (leaving too little head space) the contents may boil out during processing. If too much head space is left at the top of the jar, the processing time may not be long enough to drive out all the extra air from the top of the jar. This would mean that a tight vacuum seal may not be formed. Also, the air left inside the jar could cause the food to discolor.

2.6.4.2.1. Controlling headspace

Directions for canning specify leaving ½-inch for fruits are processed in boiling water, and from 1- to 1¼-inches in low acid foods to be processed in a pressure canner. This space is needed for expansion of food during processing and for forming vacuums in cooled jars.

The extent of expansion is determined by the air content in the food and by the processing temperature. Air expands greatly when heated to high temperatures while foods expand less than air.

2.6.5. Closing the Jars

After maintaining the proper headspace in the jar, the rims of the jars are wiped off with a clean, damp cloth. Any foreign matter such as food particles, seeds, grease, sugar, syrup or brine on the rims of the jar may prevent an airtight seal from forming. The air enclosed in the can will affect the final vacuum, which influences the shelf life of the product.

Closing of glass jars:

When using metal lids which has turn and lift system (by turning the lift one quarter,

it already lifts from the jar) place on the filled jar, center it, and hold in place with fingers. Then screw the band down fingertip-tight. These lids will not require further tightening, after processing. Tightening the screw band too tight will prevent the air from escaping as is necessary during processing.

Closing of tin cans:
Cans are closed by placing the lid on a filled can and sealing into the body by the formation of double seam in tin cans.

2.6.5.1. Can vacuum

In general, the presence of an adequate vacuum in a can is a sign of good canning practice. The presence of a vacuum ensures that the can ends are concave, thus allowing a visual means of detecting cans that have an internal pressure resulting from gas formation caused by spoilage.
The vacuum in a can is normally measured with a Bourdon type gauge, which has a sharp tapering hypodermic needle projecting through a thick rubber washer.

(Arthey 1998)

2.6.6. Heat Processing

The term processing as used in canning technology, means heating or cooling of canned foods to inactivate bacteria. Absolute sterilization is difficult to attain, because many bacteria can produce highly heat resistant bodies called spores which can be killed only by either very high or very low temperature treatment or prolonged cooking. Generally speaking, almost all fruits can be processed satisfactorily at a temperature of 100°C, as the presence of acid retards the growth of bacteria and their spores. The center of the can should reach these high temperature and the processing time is therefore of great importance. In order to achieve microbiological stability of canned fruit, it is necessary to submit the sealed can to a heat process that will destroy, or render inactive, all microorganisms capable of causing spoilage

(Khader 1999)

2.6.6.1. Methods of heat treatment

2.6.6.1.1. Pasteurization

Pasteurization temperature and time will vary according to:

- Nature of product; initial degree of contamination;
- Pasteurized product storage conditions and shelf life required.

In pasteurization processes, it is possible to define three phases:

- Heating to a fixed temperature;
- Maintaining this temperature over the established time period (pasteurization time);
- Cooling the pasteurized products: natural (slow) or forced cooling.

Pasteurization is a mild heating treatment at temperatures up to 100°C. This method causes only a slight decrease in taste and nutritional value. The enzymes are inactivated and most, but not all, bacteria are killed. To prevent the surviving spore-producing microorganisms from multiplying, the products should be stored in temperatures below 20°C. The more acid or sugar contained in a pasteurized product, the longer it will stay good because the remaining micro-organisms do not have a chance to develop. Fruits have to be pasteurized at temperatures between 60 and 95°C.

2.6.6.1.2. Sterilization in a bath of boiling water

Sterilization in a boiling water bath is performed at 100°C. This process will kill all the micro-organisms present, but not the spores they produced. Under the right conditions, these spores can grow into spoilage-causing bacteria. Since the spores do not grow well in acidic conditions, acid is often added to the preserved food. Sugar has the same preventative effect. Thus by adding sugar or acid, that even after heating at just 100°C the preserved product can be considered to be sterilized: its shelf-life is much longer than a product heated at 100°C to which no extra acid or sugar has been added

2.6.6.1.3. Sterilization with a pressure cooker or autoclave

Sterilization carried out properly in an autoclave or pressure cooker will kill not only the micro-organisms but also the spores. In this way a long shelf-life can be achieved without adding extra acid or sugar.

In an autoclave or pressure cooker the boiling point of water is at a temperature higher than 100 C and all foods with a high pH have to be preserved at a temperature above 100°C.

The advantage of an autoclave over a pressure cooker is that it can be cooled down faster. On the other hand, an autoclave requires more water and thus more energy to heat.

2.6.6.2. Impact of pH on heat preservation

pH of the food plays main part in the heat preservation of fruit. Under acid condition (pH values less than 3.7) bacteria will not multiply and consequently only a pasteurization process is necessary. This process is carried out by immersing the sealed can in boiling water or steam at atmospheric pressure for relatively short times. For products with pH values between 3.7 and 4.5, there are a few bacteria that are able to multiply in this range and these products require a longer heat process.

2.6.7. Cooling jars

Cooling. After processing, the cans are cooled rapidly to stop the cooking process and to prevent stock burning .Cooling of jars can be done for 12 to 24 hours. After the cans are correctly and swiftly cooled and dried, they are stored under the correct conditions. It should be in a cool, dry and clean area preferably away from direct sunlight. (Arthey 1998)

Cooling is done by

1. Immersing or passing the hot cans in tanks containing cold water.
2. By spraying with Jets of cold water.
3. By turning in cold water into the pressure cooker.
4. By exposing the cans to air in small lots when water supply is scare

(Khader 1999)

Jars may be cooled on racks to minimize heat damage to counters. The food level and liquid volume of raw-packed jars will be noticeably lower after cooling. Air is exhausted during processing and food shrinks.

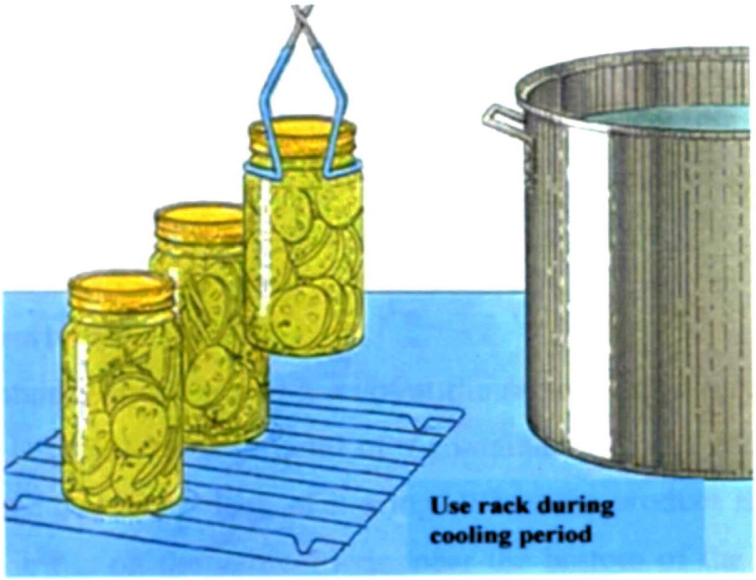


Fig. 2.2. Cooling of heat processed jars

2.6.8. Labeling and packing

The outer surface of the tin cans should be perfectly dry as even small traces of moisture are likely to induce rusting. The both tin cans and glass jars are then labeled by hand or by machine and packed in strong wooden cases or corrugated cardboard cartons, in standard packing.

(Khader 1999)

2.6.9. Storage and consumption

Always the preserved foods are stored in a cool place, at a temperature preferably below 20℃. Glass bottles and jars are kept out of the light and the storage area has to be dry and have a consistent temperature.

When opening canned preserved food, A bulging lid or tin indicates gas formation by bacteria and thus food spoilage. Look carefully at the food and smell it

2.7. General Canning Information

2.7.1. Processing time

Each food has its own processing time which is needed to reach temperature to destroy all dangerous microorganisms. The length of time required varies with the denseness of the food, its packing liquid and its pH.

(Beckett 1995)

Under-processing can result in spoiled food, while over-processing results in overcooked food. Heating food for a longer time decreases the chance of spoilage, but it also decreases the foods taste and nutritional value.

2.7.2. Cold point determination

All points within a container being heated are not at the same temperature. The zone of the slowest heating is called the cold point of a container. It is the zone which is most difficult to sterilize due to the lack of heating. When the product is heated by convection, the cold point is on the vertical axis, near the bottom of the containers. When the product is heated by conduction have the point of slowest heating approaching the center of the container, on the vertical axis. If cold point isn't reaching the required temperature, bacteria will grow during the storage of the product.

(Desrosier 1987)

2.8. Ensuring Safe Canned Foods

2.8.1. *Clostridium botulinum*

Growth of the bacterium *Clostridium botulinum* in canned food may cause botulism a deadly form of food poisoning. These bacteria exist either as spores or as vegetative cells. The spores can survive harmlessly in soil and water for many years. When ideal conditions exist for growth, the spores produce vegetative cells which multiply rapidly and may produce a deadly toxin within 3 to 4 days of growth in an environment consisting of:

- a moist, low-acid food
- a temperature between 40° and 120°F

- less than 2 percent oxygen

Botulinum spores are existing on most fresh food surfaces. Because they grow only in the absence of air, they are harmless on fresh foods. Washing fresh food reduces their numbers only slightly but peeling process reduces their numbers greatly. Blanching also helps, but the vital controls are the method of canning and making sure the recommended research-based process times are used.

Botulinum spores are very hard to destroy at boiling-water temperatures; the higher the canner temperature, the more easily they are destroyed. The exact time depends on the kind of food being canned, the way it is packed into jars, and the size of jars. The time needed to safely process low-acid foods in boiling-water canner ranges from 7 to 11 hours; the time needed to process acid foods in boiling water varies from 5 to 85 minutes.

2.8.2. Impact of Food acidity and processing methods on microorganisms

Whether food should be processed in a pressure canner or boiling-water canner to control *botulinum* bacteria depends on the acidity of the food. Acidity may be natural, as in most fruits. Low-acid canned foods are not acidic enough to prevent the growth of these bacteria. Acid foods contain enough acid to block their growth, or destroy them more rapidly when heated. The acidity level in foods can be increased by adding fruit juice, citric acid, or vinegar.

2.9. Rose apple (*Syzygium samarangense*)

The rose apple is native to the East Indies and Malaya and is cultivated and naturalized in many parts of India, Sri Lanka. Rose apple (*Syzygium samarangense*) is a tropical fruit tree which belongs to guava family (*Myrtaceae*).

(Chundawat 1995)

Fig.2.4. Rose apple (*Syzygium samarangense*)

2.9.1. Climate

The rose apple flourishes in the tropical and near-tropical climates only. In Indian sub continental, it ranges up to an altitude of 4,400 ft (1,350 m);

2.9.2. Soil

A deep, loamy soil is considered ideal for the rose apple but it is not too exacting, for it flourishes also on sand and limestone with very little organic matter.

2.9.3. Propagation

Most rose apple trees are grown from seeds, which are polyembryonic (producing 1 to 3 sprouts), but the seedlings are not uniform in character nor behavior.

2.9.4. Season

In Sri Lanka, blooming usually occurs in January, with fruit ripening in March and April.

2.9.5. Rose apple fruits

Rose apple is about 5 cm long, pear shaped fruit and color variations exist including red skinned fruits. The skin is thin, waxy and shiny. Fruits ripen over an extended period of time. Ripe fruits are with snow white, juicy pulp. Normally, Fruits are eaten in fresh nature. Fruits are hollow; the core contains a small amount of inedible fluff.

(Ashton 1997)

2.9.6. Flowers of rose apple tree

Rose apple flowers are large and showy, white to pale cream and sweetly scented. The flowers are a rich source of nectar for honeybees.

2.9.7. Yield

A mature rose apple tree will yield 5 lbs (2 kg) of fruit each season. The fruits are, of course, very light in weight because they are hollow.

2.9.8. Food Uses

Around the tropical world, rose apples are mostly eaten in fresh. They are seldom marketed. In the home, they are sometimes stewed with some sugar and served as dessert. In some area of Sri Lanka, the fruit is processed into chutney, or more frequently preserved in combination with other fruits of more pronounced flavor. In other countries, it is also made into jam, jelly and syrup which is used as a sauce or to flavor cold drinks.

2.9.9. Composition of rose apple fruit (Food Value per 100 g of Edible Portion)

Nutrient	Quantity
Moisture	84.5-89.1g
Protein	0.5-0.7 g
Fat	0.2-0.3 g
Carbohydrates	14.2 g
Fiber	1.1-1.9 g
Ash	0.4-0.44 g
Calcium	29-45.2 mg
Phosphorus	11.7-30 mg
Sodium	34.1 mg
Potassium	50 mg
Ascorbic Acid	3-37 mg

Table 2.1.Biloogical composition of rose apple

(Source: Morton 1987)

CHAPTER 03

MATERIALS AND METHODOLOGY

3.1. Canning of rose apple fruits

1 Preparation of fruits

Fresh, ripe uniform sized rose apple fruits were selected and washed with pure water .Then they were cut into two halves and seeds or other inedible parts were removed.

2. Packing in glass jars

The certain weight of Rose apple pieces were arranged tightly in glass jars.

3 Preparation of osmotic solutions

3.1. Preparation of salt solutions

Salt solutions in three different salt concentrations were prepared by dissolving salt (NaCl) in distilled water as follows. Then, each salt solution was heated up to 70°C

Salt (NaCl) (g)	Distilled water (ml)	Concentration of solution (g/l)
10	300	33.3
15	300	40.0
20	300	66.6

Table 3.1. Preperation of different concentrated salt solution

3.2. Preparation of sugar syrups

Three different concentrated sugar syrups were prepared by dissolving cane sugar in distilled water and sugar syrup was heated up to 70°C

Sugar (g)	Distilled water (ml)	Concentration of solution (g/l)
120	300	400
60	300	200
22.5	300	75

Table 3.2. Preperation of different concentrated sugar syrups

3.3. Preparation of pineapple juice

Matured, undamaged pineapple fruits were sorted and then they were peeled and cored. Sliced fruits were crushed and pulp was sieved through a muslin cloth to obtain pineapple juice. It was used to prepare first sample. Pineapple juice was sieved again using a clean cloth to prepare second sample. Prepared pineapple juices were heated up to 70°C.

4. Filling jars with osmotic solutions

   Three kinds of samples were prepared by pouring different osmotic solutions on rose apple pieces in glass jars. Certain volume of solutions or juice was added into each jar leaving ½ inches head space.

5. Exhausting

   Filled jars were sent through an exhausting tunnel which was at 78°C for 6 minutes.

6. Controlling headspace

   After exhausting process, the level of osmotic solution can be decreased in some jars. They have to be refilled to maintain the head space at about 1/2 inches.

7. Closing the jars

   The jars with contents were sealed with metal screw type lids by a capping machine.

8. Pasteurization

   Sealed jars were placed in an auto clave and heated at 95°C for 30 minutes.

Hot water sprays or steam jets were directed into containers to increase temperature of jars. The cold point in a filled jar during the heating process was measured by using a maximum thermometer.

9 Cooling the jars

Heated jars were allowed to cool under normal air naturally.

3.2. Raw material analysis

pH, brix and titrable acidity of rose apple fruits and different concentrated osmotic solutions were measured.

3.2.1. Raw material analysis on rose apple

pH, brix and titrable acidity of rose apple fruits which were used for canning purpose were measured to prepare high quality end product.

3.2.1.1. Preparation of rose apple juice

3.2.1.1.1. Materials and equipments:

Electric blender

Filter papers (whatmann)

pH meter

3.2.1.1.2. Methodology:

Sorted, fresh and ripe rose apple fruits were cut into pieces and inedible parts were removed. Then fruit pieces were crushed using an electric blender and juice was filtered through whatmann filter papers to obtain clear juice.

3.2.1.2. Determination of pH

3.2.1.2.1. Materials and equipments:

pH meter

Beaker

3.2.1.2.2. Methodology:

The pH of the prepared juice was measured by using a pH meter which was inserted directly into the juice

3.2.1.3. Determination of Brix value

3.2.1.3.1. Materials and equipment:

Refractometer

3.2.1.2.2. Methodology:

The juice was tested using a refractometer to determine the brix value.

3.2.1.4. Determination of titrable acidity

3.2.1.4.1. Materials and equipments:

Burettes

Pipettes

Volumetric and conical flasks

3.2.1.4.2. Reagents:

0.1M Sodium hydroxide (NaOH) solution

Phenophthalein indicator

3.2.1.4.3. Methodology:

5 ml of filtered fruit juice was pipetted into 100 ml volumetric flask and made upto level with distilled water. Then, 10 ml of prepared sample was titrated with 0.1M NaOH solution in the presence of phenopthalin. The NaOH required for the titration was noted.

The titrable acidity can be expressed as ml 0.1M NaOH per 100 ml of fruit juice.

3.2.2. Raw material analysis of pineapple juice

Prepared pineapple juice for the canning process was tested for pH, Brix and titrable acidity as same as for rose apple.

3.2.3. Raw material analysis of salt solutions and sugar syrups

Brix ,pH and titrable acidity values for prepared salt and sugar solutions were determined by using the refractometer, pH meter and titration method as same as for rose apple.

3.3. Analysis of finished products after processing

3.3.1. Determination of pH, Brix and titrable acidity of finished products after processing

Three categories of samples which were dipped in different osmotic solutions were tested to determine pH, Brix, titrable acidity of each product after canning process. Above mentioned procedures for raw materials analysis were carried out to determine pH, Brix, titrable acidity of the finished products also.

3.3.2. Determination of vacuum in each canned product

3.3.2.1. Equipment:

Vacuum meter

3.3.2.2. Methodology:

Vacuum meter was pressed on the lid of each canned product and the reading was noted.

3.3.3. Determination of head space in each canned product

3.3.2.1. Equipment:

Electronic vernier caliper

3.3.2.2. Methodology:

The height between the top level of the glass jar and level of liquid that existing on fruits was measured.

3.4. Determination of organoleptic properties of finished products

Organoleptic properties (Colour, Odour, Taste, and Texture) of each product were determined using an organoleptic evaluation sheet. (Appendix I)

3.5. Selection of most preferable concentrations for osmotic solutions

Most preferable concentrations for salt solution and sugar syrup were determined based on organoleptic properties.

3.6. Sensory evaluation of three different products

3.6.1. Materials and equipments:

Water glasses

Glass dishes

Spoons

Ballot papers

Pens

3.6.2. Methodology:

Canned rose apple products which were containing different osmotic solutions were subjected to sensory evaluation. The sensory evaluation was done using 30 untrained panelists in University of Sabaragamuwa. Sensory evaluation was carried out under condition which avoids influences of external forces. Same quantities of 3 Samples were presented in identical glass dishes with separate spoons to panelists. Samples were coded with 3 digit random numbers. These numbers were 256, 568, and 714.

3 Samples representing each ingredient combination were placed before the panelist alone with the ballot paper. (App. II) Level of preference for each sensory attribute (Colour, Smell, Appearance, Taste, Texture, Overall acceptability) in 3 samples was recorded according to the 7 point hedonic scale. Obtained results were analyzed by Minitab statistical analysis software with the use of Kruskal- Wallis test at 5% significant level after testing for the normality.

3.7. Proximate analysis of the final product

3.7.1. Determination of Moisture (oven drying method)

3.7.1.1. Materials:

Moisture dishes

Drying Oven at 105°C

Electric balance

Desiccator

3.6.1.2. Methodology:

A sample from the product of rose apple with pineapple juice were chopped finely with a knife. Weights of Sample was measured (up to three decimal points) into a

cleaned, dried, previously weighed moisture dish. The content in the dish was thoroughly shaked until the content was evenly distributed. The dish was placed in the oven, maintained at 105^0C, and dried for 2 hours. Then the dish was cooled in a desiccator and weighted. Heating, cooling and weighing processes were repeated at 30 minutes intervals until the difference between two successive weighing was not exceed 0.002g. The lowest mass was noted. The % of moisture was calculated by following formula. Above procedure was repeated for three replicates.

$$\text{Moisture percentage (wt/wt)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 Initial Weight of empty moisture dish

W_2 Weight of dish with sample

W_3 Final Constant Weight of dish with the sample after drying

3.6.2. Determination of Crude Protein (Kjeldhal Method)

3.6.2.1. Reagents:

0.1M Hydrochloric acid (HCl)

Concentrated sulphuric acid (H_2SO_4)

30% Sodium hydroxide (NaOH) solution

4% Boric acid

Catalyst tablets

Kjeldhal indicator (Methyl red Bromocresol green mixture)

Diethyl ether

3.6.2.2. Materials and equipments:

Kjeldhal Digestion unit

Kjeldhal distillation unit

Analytical balance

Common laboratory glass wares

3.6.2.3. Methodology:

2g of sample was accurately weighted to a kjeldhal digestion flask. Then, one catalyst tablet ($K_2SO_4.SeSO_4$) and 15ml of Conc. H_2SO_4 were added in to the flask and placed in the Kjeldhal digestion unit for 4 hours until a clear solution was obtained. After the digestion, flask was removed from digester and allowed to cool. The content was transferred to a volumetric flask and diluted using 50ml distilled water. Then diluted sample was placed in the Distillation unit. Conical flask containing 25ml of 4% boric acid (containing indicator) was placed under the condenser outlet. Steam generator was fixed to the mouth of the distillation unit while other end that emits the gas out, was dipped in the conical flask that contained boric acid. 30% NaOH was dispensed and distilled until the diluted sample was turned to dark blue colour.The formed ammonium borate solution was titrated with 0.1M HCl ,until dark blue colour turned to greenish yellow colour by using phenolphthalein as the indicator. The above procedure was done for three replicates and one blank.

$$\text{Nitrogen\%} = \frac{(\text{sample titre- Blanka titre}) \times N_{HCl} \times 14 \times V_D \times 100}{\text{Aliquot of the digestion taken} \times \text{Weight of sample} \times 1000}$$

$$\text{Protein\%} = \text{Nitrogen\%} \cdot 6.25$$

Where,

N_{HCl} - Normality of HCl

V_D - Volume made of the digestion

(James,1999)

3.6.3. Determination of Fat (Soxhelt extraction method)

3.6.3.1. Reagents:

Petroleum ether

3.6.3.2. Materials and equipments:

Soxhlet distillation flask and extractor

Analytical balance (Accuracy .0001)

Water bath at 65°C

Reflux condenser

Fat-free extraction thimble

Drying Oven at 105°C

Desiccator

3.6.3.3. Methodology:

Finely chopped canned rose apple sample was dried in an oven at 105°C for 2 hours. After drying process, allowed it to cool in a desicator.2g of sample was taken and transferred into extraction thimble it was set to the Soxhlet apparatus. Previously dried, weighed 250 ml distillation flask was fixed to apparatus and 150 ml petroleum ether was added to it. Then extraction unit was assembled over electric heating source and extraction process was carried out for 5 hours. After that, extraction unit was removed from heating source and flask was placed in a water bath at 65°C to evaporate solvents. Then flask with content was placed in the oven at 105°C, and dried for 1 hour. The flask was cooled in a desiccator and weight of the flask with content was measured. Heating, cooling and weighing processes were repeated until the difference between two successive weighing was not more than 0.002g. This procedure was carried out for three replicates.

$$\% \text{ fat content of sample} = \frac{W_2 - W_1}{W_3} \times 100$$

Where, W_1 Weight of empty flask (in grams)

W_2 - Weight of the flask with fat (in grams)

W_3 Weight of the food sample (in grams)

(James,1999)

3.6.4. Determination of ash content

3.6.4.1. Materials and equipments:

Crucibles

Desiccator

Muffle furnace at 550°C

Drying oven at 105°C

3.6.4.2. Methodology:

A sample from canned rose apple product was chopped and dried in an oven at 105°C. Dried sample was cooled in a desiccators and 2g of it was weighed accurately. Then the sample was placed in a porcelain crucible which was weighed accurately. Then the crucible with content was transferred to a muffle furnace at 550°C for about 6 hours until a white or light gray ash resulted. The resulted ash with crucible was allowed to cool in desiccators and reweighed accurately.

$$\% \text{ of ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where;

W_1 Weight of empty crucible

W_2 Weight of crucible + food before ashing

W_3 Weight of crucible + ash

(James, 1999)

3.6.5. Determination of sugar content (Lane and Eynon method)

3.6.5.1. Materials and equipments:

Burette

Volumetric flasks

Glass crucible

Conical flasks

Bunsen burner

3.6.5.2. Reagents:

Fehling's solutions A and B

Methylene blue indicator

Phenolphthalein

Conc. HCl

10% NaOH solution

3.6.5.3. Determination of reducing sugar

10g of chopped rose apple product was mixed with 100ml of distilled water. Then crushed solution was filter through a glass crucible containing stacked bed of activated charcoal. The clear solution was neutralized with 10% NaOH solution in the presence of phenolphthalein. Neutralized solution was transferred to a 250 ml volumetric flask and volume made up to the 250 ml using distilled water. Then the solution was filled into a burette and it was titrated with 10 ml Fehling's solution contains Methyl blue indicator which was in a conical flask. The Fehling's solution was prepared by mixing 5ml Fehling's A solution and 5ml Fehling's B solution together and 50 ml distilled water was added to it. When the titration was done, the solution was brought to boil it was continued until blue colour was disappeared. The volume of solution that was used for the titration was recorded.

The above procedures were carried out for three replicates of canned rose apple fruits with pineapple juice.

$$\% \text{ Reducing sugar (as glucose)} = \frac{49.5 \times 250}{T \times W \times 10}$$

Where; T - Titre of sugar solution

W - Weight of sample used

3.6.5.4. Determination of total sugar

10 g of chopped rose apple product was mixed with 100ml of distilled water.10ml of conc. HCl was added to the solution and boiled for 10 minutes. Then it was allowed to cool and mixed by shaking .After that the solution was filter through a glass crucible containing stacked bed of activated charcoal. The filtered solution was subjected to the neutralization with 10% NaOH and then same procedures were carried out as same as to determine reducing sugar. Three replicates were carried out using above procedure.

$$\% \text{ Total sugar (as glucose)} = \frac{4.95 \cdot 250 \cdot 2.5}{T \cdot W \cdot 10}$$

Where, T - Titre of sugar solution

W - Weight of sample used

CHAPTER 04

RESULTS AND DISCUSSION

4.1. Raw material analysis

	pH	Brix	Titrable acidity
Rose apple	2.78	5.4^0	0.74
Salt solution			
33.3 g/l	7.13	3.4^0	0
40.0 g/l	7.09	4.2^0	0
66.6 g/l	7.16	5.2^0	0
Sugar syrup			
75 g/l	7.08	22.0^0	0
200 g/l	7.10	26.2^0	0
400 g/l	7.14	32.0^0	0

Table 4.1. Variation of pH, Brix and Titrable Acidity among raw materials

When the pH values of each finished products with different concentrated osmotic solutions are less than pH 4, it is important for the organic preservation process without adding any chemical preservatives.

To maintain the pH of finished product below pH 4 , it is important that pH of raw materials below pH 4. The rose apple fruits are highly acidic fruits. So, it is very important of preparation of high acid food. Pasteurization heat treatment is enough to kill microorganisms in high acidic food.

Titrable acidity is varied according to the variation of pH in each product. When the pH decreased, titrable acidity will be increased.

4.2. Analysis of finished products

Type of finished product	pH	Brix value	Titrable acidity
Rose apple + Pineapple juice	3.25	9.2^0	0.82
Rose apple + salt solution			
33.3 g/l	2.69	3.8^0	0.40
40.0 g/l	3.34	3.8^0	0.53
66.6 g/l	3.82	4.2^0	0.45
Rose apple + sugar syrup			
75 g/l	3.64	4.4^0	0.11
200 g/l	3.32	9.8^0	0.16
400 g/l	3.28	15.8^0	0.21

Table 4.2. pH, Brix and Titrable Acidity of raw materials of finished products

Determination of pH, Titrable acidity and brix value of each finished product is important to determine whether the condition in food is favorable for the growth of micro organisms or not. Salt solution, sugar syrup and pineapple juice act as osmotic solutions and when, a high concentrated solution is existed outside cell membrane of microbes compared to inside, water tends to move out of the organism preventing its growth and ultimately killing it.

4.3. Determination of vacuum and head space of the each product

Type of finished product	Vacuum (mbar)	Head space (mm)
Rose apple + Pineapple juice	120	9.63
Rose apple + salt solution		
33.3 g/l	220	12.61
40.0 g/l	240	14.01
66.6 g/l	210	11.34
Rose apple + sugar syrup		
75 g/l	120	9.84
200 g/l	140	11.0
400 g/l	180	10.03

Table 4.3. Variation of vacuum with headspace

If air entrapped inside the product is not removed properly by exhausting process, it can be collected on top of the jar during heat treatment. It increases the head space in the sealed jar. So that, when head space is increased, it will increase the vacuum inside the product respectively. The air enclosed in the jar will affect the final vacuum, which influences the shelf life of the product.

4.4. Determination of organoleptic properties

Fig 4.1. Samples with pineapple juice, salt and sugar solutions respectively

Sample	Colour	Odour	Taste	Texture
Rose apple + Pineapple juice	yellowish pink	Fruity odour	Rose apple + sour	Good bite
Rose apple + salt solution				
33.3 g/l	light pink	Pickle odour	Pickle taste	Good bite
40.0 g/l	Light pink	Pickle odour	salty taste	Good bite
66.6 g/l	light pink	Salty odour	salty taste	Good bite
Rose apple + sugar syrup				
75 g/l	Reddish pink	Pickle	Light Sweet	Good bite
200 g/l	Reddish pink	Pickle	High sweet	Good bite
400 g/l	Reddish pink	Pickle	Very high sweet	Good bite

Table 4.4. Organoleptic properties of different canned products of rose apple

When considering organoleptic properties of each concentrated osmotic solutions, rose apple product with 40 g/l salt solution, 75 g/l sugar syrup were selected for the sensorly evaluation with the product contained pineapple juice.

4.5. Sensory evaluation of the products

The sensory evaluation was carried out using the same human subject serving for three samples at the same time and thus the effect of panel on evaluation of quality parameter was not significant. So, there was no any bias.

Sample	Type of osmotic solution which was added
256	Salt solution
568	Pineapple juice
714	Sugar syrup

Table 4.5. Samples coded with 3 digit random numbers

When performing Kolmogorov-Smirnov tests generates a normal probability plot and performs a hypothesis test to examine whether or not the observations follow a normal distribution.

H_0: Data are normally distributed

H_1: Data are not normally distributed

P-values of all sensory attributes indicate that, at α levels greater than 0.05, there is enough evidence that the data do not follow a normal distribution.

Kruskal-Wallis test was selected to analyze the results of sensory attributes in canned rose apple samples with different osmotic solutions. Once samples are seemed to have a statistically significant difference, mean ranks were calculated separately for those attribute, in order to determine the degree of difference and to select the best sample. Outcomes from the treatments can be summarized as in the following table.

Sensory Attribute	P-Value	Mean Rank			Median			Best Sample
		256	568	714	256	568	714	
Colour	0.000	33.3	37.2	66.0	5	5	6	714
Odour	0.020	37.4	55.2	43.9	5	5	5	568
Texture	0.000	36.5	34.5	65.5	4	5	6	714
Taste	0.037	36.2	47.5	52.8	5	5	6	714
Ove.Acceptability	0.021	35.7	48.3	52.6	5	5	6	714

Table 4.6. Sensory evaluation records

H_0; There is no significant difference between sensory attribute of samples.
H_1; There is a significant difference between sensory attribute of samples.

At the 5% significant level, the test statistic had $P< 0.05$ in all cases. So that there is an enough evidence to reject H_0 It emphasize that there is a statistically significant difference among samples coded as 256, 568 and 714 in all tested sensory attributes (Appendix III). Based on corresponding rank means and medians, it is possible to say that sample code 714 is the best sample except in odour of the sample.

According to the sensory evaluation, the rose apple fruits which were canned in sugar syrup were more preferable to Sri Lankan consumers than other two products. But, Tropical Health Food (Pvt) Limited was selected rose apple fruits which were canned in pineapple juice for the exporting purpose as the preference of the German people to food is different from Sri Lankan people. They much prefer sour taste rather than sweet taste.

4.6. Proximate analysis

The proximate analysis of the selected product (with pineapple juice) was carried-out for further analysis of the product.

Nutrient	Composition %
Moisture	92.0
Protein	0.31
Fat	1.30
Total sugar Reducing sugar	9.74 8.03
Ash	2.20

Table 4.7.Nutrient content in the canned rose apple product

CHAPTER 05

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The acidity of rose apple was below than pH 3.0. It was important for the production of rose apple products which were in high acidic food category. Pasteurization of the product kills micro organisms who present in the food product. The growth of remaining microorganisms in the product was retarded due to the acidic nature of the product.

Among three different concentrations of osmotic solutions 40 g/l concentrated salt solution and 75 g/l concentrated sugar syrup were selected by using evaluation of organoleptic properties of them. The selected two products and rose apple product with pineapple juice were sensorily evaluated for different sensory attributes (Colour, Odour, Taste, Texture) using 7-point Hedonic scale. According to the results, rose apple product with sugar syrup was more preferable to consumers than other two products. Plain Glass jars were used as packaging materials and it increased the attraction to the product due to the view of rose apple through the packing material.

In Tropical Health Food (pvt) limited, the canned rose apple product was prepared for the exporting purpose. The existing products of the company are exported to the Germany and it was found that the consumers prefer sour taste than the sweet taste. So that, company selected rose apple product with pineapple juice for the exporting purpose. However, The product with sugar syrup at 75 g/l concentration was more suitable for Sri Lankan market according to the consumer preference.

The product with pineapple juice was proximately analyzed and it contained 92% Moisture,0.31% Protein, 1.3% Fat, 9.74% Total sugar, 8.03% Reducing sugar and 2.2 % Ash.

5.2. Recommendation

Further studies should be carried out to investigate, the presence of micro organisms in the canned rose apple product after heating process. Microbiology testing on *Clostridium botulinum* has to be performed to determine the shelf life of the product.

Ability of other varieties of rose apple to process into canned products has to be identified.

Still, rose apple is an underutilized fruit and this canned product related with rose apple will be popularized among food producers and customers due to the use of low priced raw material for the preparation of value added product.

REFFERENCES

Arthey, D and Asthurst, P.R. (1998). Fruit Processing, First Edition, Blackie Academic and Professional, 247p.

Arya, A. (1993). Tropical Fruits diseases and pests, First Edition, Kalyani Publishers, 208p

Asthon, M., Dassanayake, M.D., De Zoysa, N., Gunatilleke, N., Gunatilleke, S. and Wijesundara, S. (1997). A Field Guide to the Commen Trees and Shrubs of Sri Lanka, First Edition, WHT Publications (Pvt) Ltd., 432p.

Beckett, S.T. (1995). Physico Chemical aspects of Food Processing, First Edition, Blackie Academic Professional, 465p.

Canning (Available from http://en.wikipedia.org, accessed on 08/12/2008)

Chundawat, B.S. (1995). Arid Fruit Culture, First Edition, Oxford and IBH Publishing Co. Pvt Ltd., 208p.

Desrosier, J.N. and Desrosier, N.W. (1987).The Technology of food preservation, First Edition, CBS Publishers and Distributors, 556p.

Hotchkiss, J.H. and Potter, N.N. (1996). Food Science, Fifth Edition, CBS Publishers, 608p

James, C.S. (1999). Analytical chemistry of Foods, An Aspen Publications, First Edition, 178p.

Khader, V. (1999). Preservation of Fruits and Vegetables, First Edition, Kalyani Publishers, 229p.

Mcwilliams, M and Paine, H (1984). Modern Food Preservation, First Edition, Surjeet Publication, 198p

Singh, A (1990). Fruit Physiology and Production, Third Edition, Kalyani Publishers, 565p

Sivasankar, B. (2003). Food Processing and Preservation. First Edition. Prentice hall of India (Pvt) Ltd., 360p.

Tressler, D. and Woodroof, J.G. (1976). Food Vegetable and Nut Products. Volume 03 (Food Products Formulary). First Edition. The AVS Publishing Company Inc., 278p.

Vangarde, S.J. and Woodburn, M. (1999). Food Preservation and Safety Principles and Practices. First Edition. Surabhi Publications. 261p.

APPENDIX I

Organoleptic evaluation

1) Clarity

Very low	Low	Medium	High	Very high

2) Colour

a) Uniformity of pieces

Very low	Low	Medium	High	Very high

b) Range of pieces

Pale pink	Light pink	Pink	Dark pink

c) Range of solution

Pale pink	Light pink	Pink	Dark pink

3) Odour

a) Natural odour of pieces

Non	Slightly	Medium	High	Very high

b) Natural odour of solution

Non	Slightly	Medium	High	Very high

4) Taste

a) Taste of pieces

Very sour	Sour	Sour + Sweet	Sweet	Very sweet

b) Taste of solution

Very sour	Sour	Sour + Sweet	Sweet	Very sweet

5) Cooked flavour

a) Cooked flavour of pieces

Non	Cooked	Over cooked

b) Cooked flavour of solution

Non	Cooked	Over cooked

6) Texture

a) Texture of pieces

Very soft	Soft	Medium	Firm	Very firm

7) Flowbility

Low	Medium	High

APPENDIX II

Sabaragamuwa University of Sri Lanka

Faculty of Applied Sciences,

Department of Food Science & Technology

Questionnaire for Sensory Analysis (Seven Point Hedonic Test)

Name: ..... Product: **Canned rose apple**

Date: ..... Time : .....

- Assess the sample individually.
- Indicate how much you preferred each sample after testing.
- Rinse you mouth with water after tasting each sample.
- Give numerical values ranking from Like very much to Dislike very much.

Point Scale	Points
Like very much	7
Like moderately	6
Like slightly	5
Neither like nor dislike	4
Dislike slightly	3
Dislike moderately	2
Dislike very much	1

Sensory Aspects	Sample code		
	256	568	714
Colour			
Smell			
Appearance			
Taste			
Overall acceptability			

Comments:

.....

.....

Thank you Signature

APPENDIX III

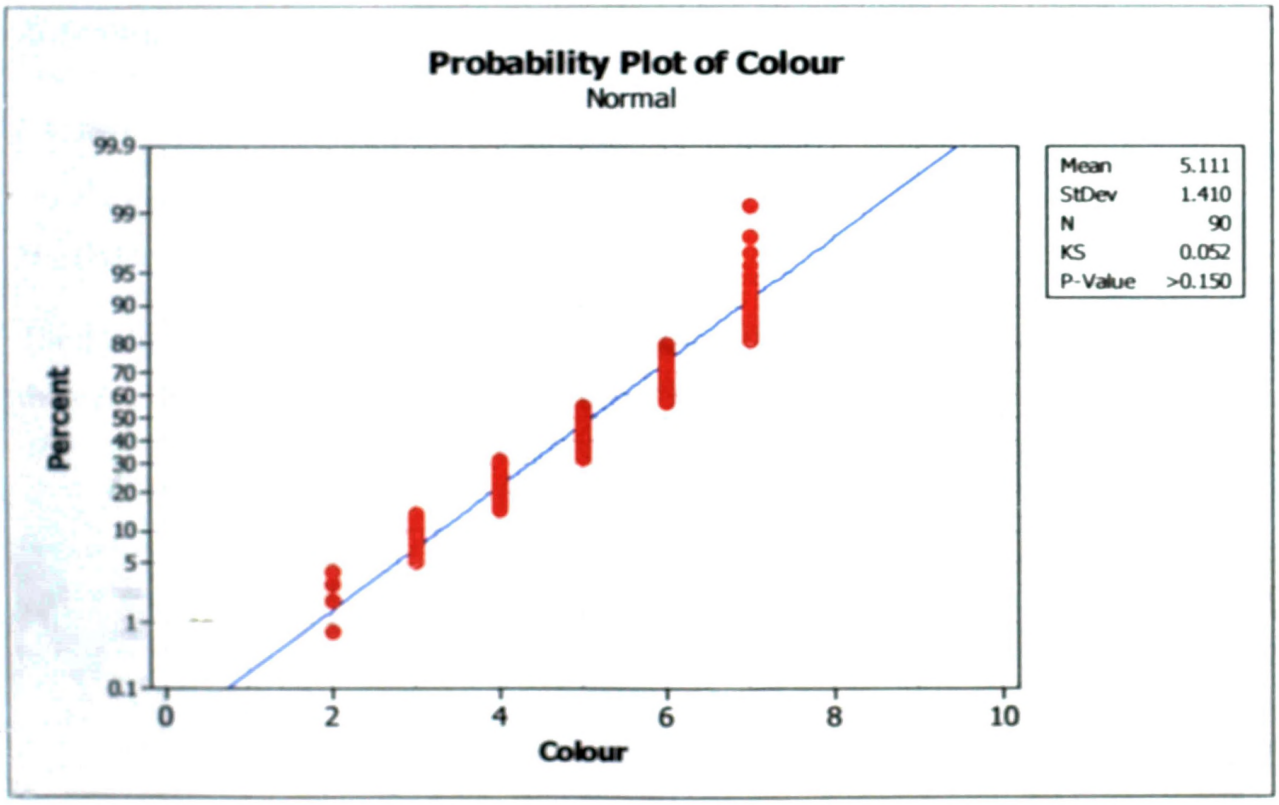
1). Testing for colour

Normality Test (Colour)

H_0: Data are normally distributed

H_1: Data are not normally distributed

The Kolmogorov-Smirnov test's p-value indicates that, at α level greater than 0.150, there is evidence that the data do not follow a normal distribution.



Kruskal-Wallis Test: Colour versus Sample

```
Kruskal-Wallis Test on Colour

Sample     N  Median  Ave Rank      Z
1         30   5.000      33.3  -3.13
2         30   5.000      37.2  -2.14
3         30   6.000      66.0   5.27
Overall   90              45.5

H = 28.08  DF = 2  P = 0.000
H = 29.33  DF = 2  P = 0.000  (adjusted for ties)
```

Sample1, 2 and 3 representing samples coded as 256, 568 and 714 respectively.

Interpretation of results

H_0; There is no significant difference between colour of samples.

H_1; There is a significant difference between colour of samples.

At the 5% significant level, the test statistic had a p-value of 0.000 and P< 0.05 .So that there is an enough evidence to reject H_0 So, at least one sample significantly different from others with regard to colour.714 sample has highest average rank. Colour of 714 sample is more preferable than other two samples.

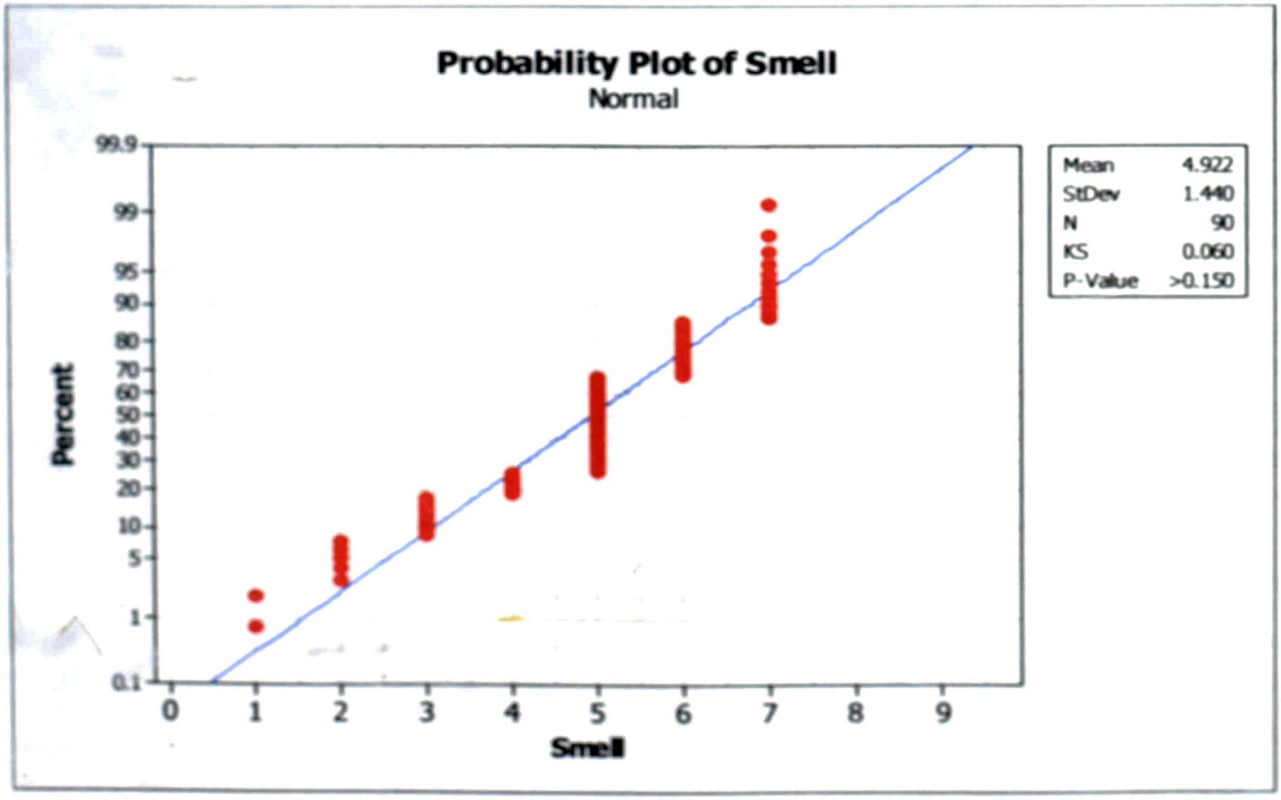
2).Testing for odour

Normality Test (odour)

H_0: Data are normally distributed

H_1: Data are not normally distributed

The Kolmogorov-Smirnov test's p-value indicates that, at α level greater than 0.150, there is evidence that the data do not follow a normal distribution.



Kruskal-Wallis Test: Odour versus Sample

```
Kruskal-Wallis Test on odour

Sample     N  Median  Ave Rank      Z
1         30   5.000      37.4  -2.08
2         30   5.000      55.2   2.49
3         30   5.000      43.9  -0.41
Overall   90              45.5

H = 7.14  DF = 2  P = 0.028
H = 7.81  DF = 2  P = 0.020  (adjusted for ties)
```

Sample1, 2 and 3 representing samples coded as 256,568 and 714 respectively.

Interpretation of results

H_0; There is no significant difference between odour of samples.

H_1; There is a significant difference between odour of samples.

At the 5% significant level, Test statistic had P value 0.020 and $P < 0.05$ .So that there is an enough evidence to reject H_0 So, at least one sample significantly different from others with regard to odour.568 sample has highest average rank. Odour of 568 sample is more preferable than other two samples.

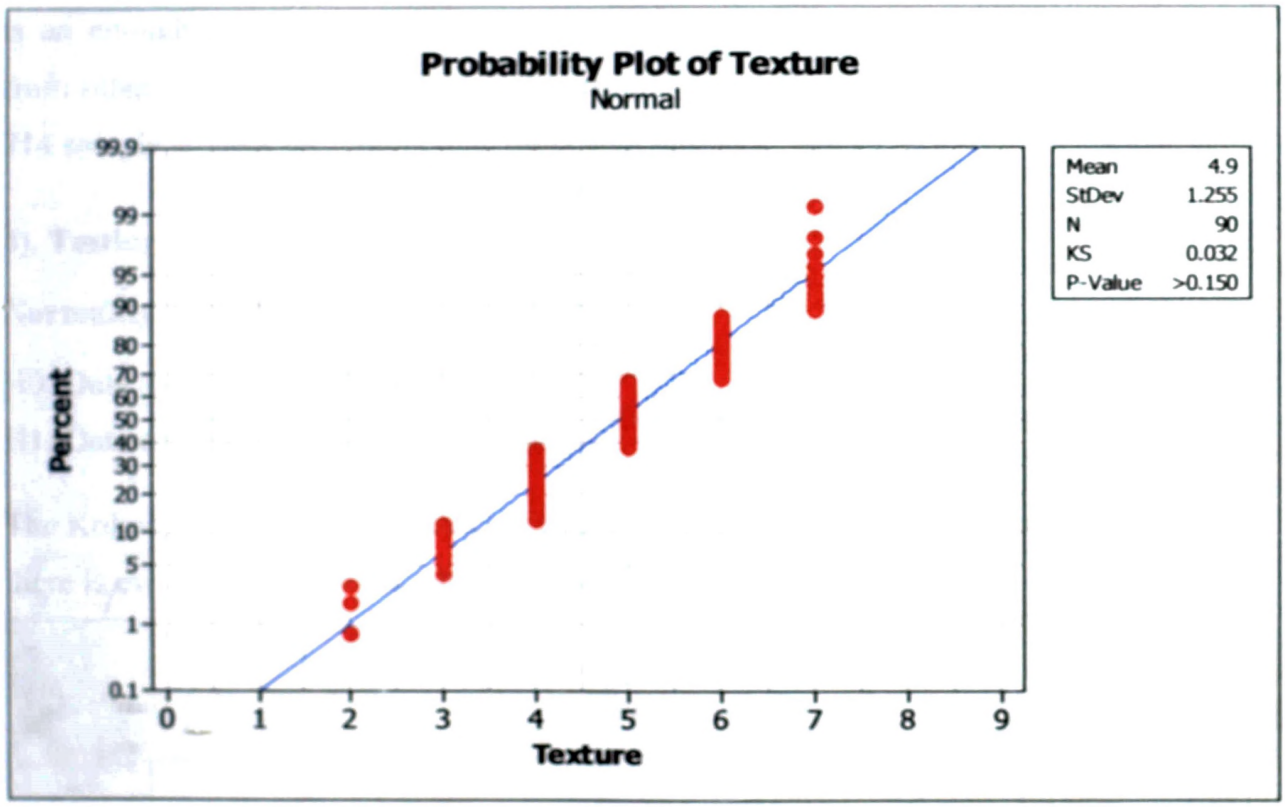
3). Testing for Texture

Normality Test (Texture)

H_0: Data are normally distributed

H_1: Data are not normally distributed

The Kolmogorov-Smirnov test's p-value indicates that, at α level greater than 0.150, there is evidence that the data do not follow a normal distribution



Kruskal-Wallis Test: Texture versus Sample

```
Kruskal-Wallis Test on Texture

Sample     N  Median  Ave Rank      Z
1         30   4.000      36.5  -2.30
2         30   5.000      34.5  -2.82
3         30   6.000      65.5   5.13
Overall   90              45.5

H = 26.38  DF = 2  P = 0.000
H = 27.91  DF = 2  P = 0.000  (adjusted for ties)
```

Sample1, 2 and 3 representing samples coded as 256,568 and 714 respectively.

Interpretation of results

Kruskal-Wallis Test: texture versus Sample

H_0; There is no significant difference between texture of samples.

H_1; There is a significant difference between texture of samples.

At the 5% significant level, Test statistic had P value 0.000 and P< 0.05 .So that there is an enough evidence to reject H_0 So, at least one sample significantly different from others with regard to texture.714 sample has highest average rank. Texture of 714 sample is more preferable than other two samples.

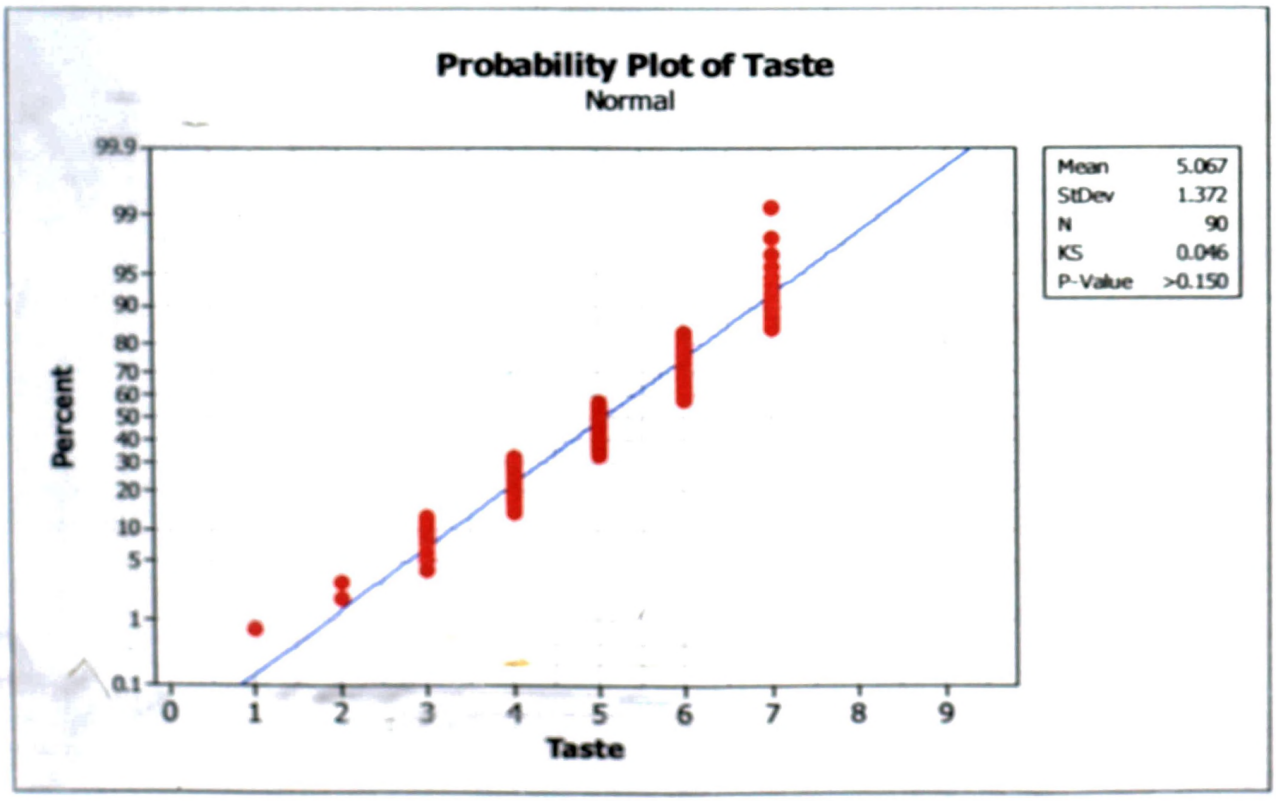
4). Testing for taste

Normality Test (Taste)

H0: Data are normally distributed

H1: Data are not normally distributed.

The Kolmogorov-Smirnov test's p-value indicates that, at α level greater than 0.150, there is evidence that the data do not follow a normal distribution.



Kruskal-Wallis Test: Taste versus Sample

```
Kruskal-Wallis Test on Taste

Sample     N  Median  Ave Rank      Z
1         30   5.000      36.2  -2.38
2         30   5.000      47.5   0.52
3         30   6.000      52.8   1.87
Overall   90              45.5

H = 6.29  DF = 2  P = 0.043
H = 6.59  DF = 2  P = 0.037  (adjusted for ties)
```

Sample1, 2 and 3 representing samples coded as 256,568 and 714 respectively.

Interpretation of results

Kruskal-Wallis Test: Taste versus Sample

H_0; There is no significant difference between taste of samples.

H_1; There is a significant difference between taste of samples.

At the 5% significant level, Test statistic had P value 0.037 and $P < 0.05$ .So that there is an enough evidence to reject H_0. So, at least one sample significantly different from others with regard to taste.714 sample has highest average rank. Taste of 714 sample is more preferable than other samples.

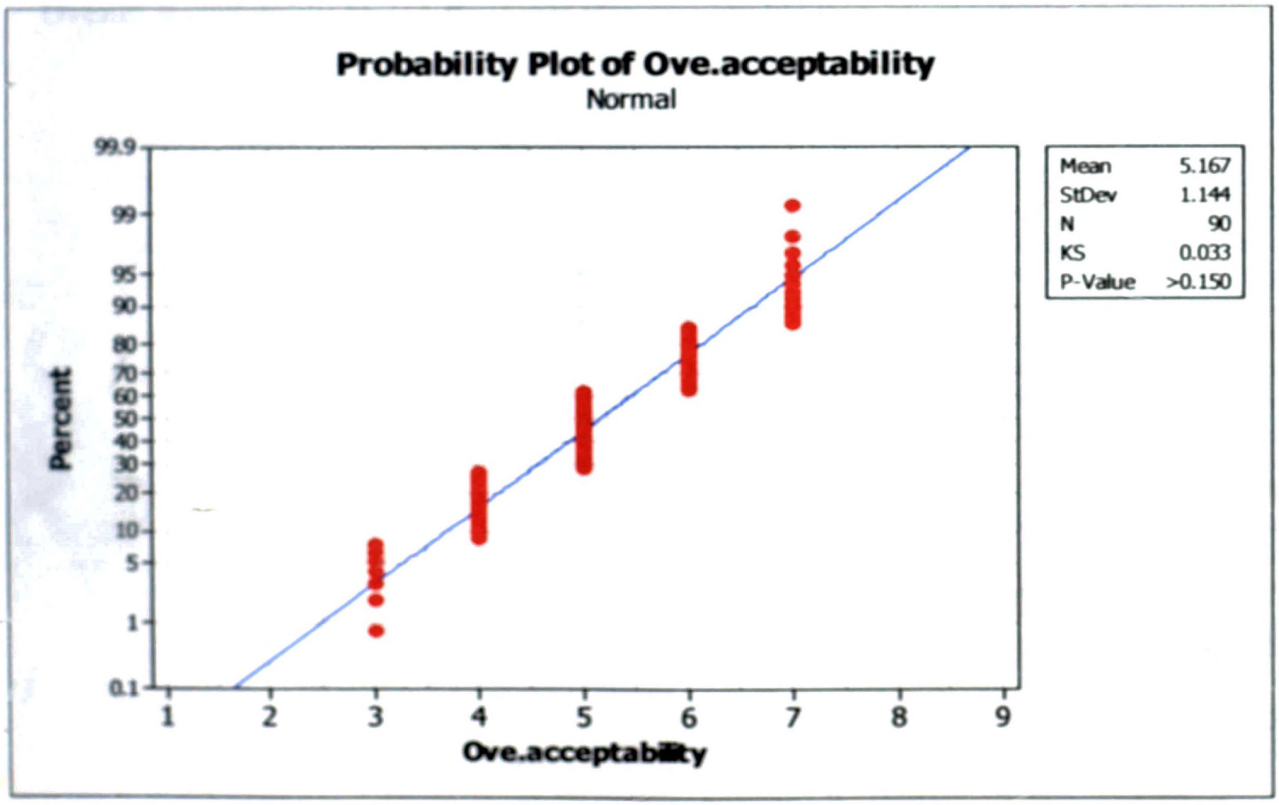
5).Testing for overall acceptability

Normality Test (Overall acceptability)

H_0: Data are normally distributed

H_1: Data are not normally distributed

The Kolmogorov-Smirnov test's p-value indicates that, at α level greater than 0.150, there is evidence that the data do not follow a normal distribution.



Kruskal-Wallis Test: Ove.acceptability versus Sample

```
Kruskal-Wallis Test on Ove.acceptability

Sample     N  Median  Ave Rank      Z
1         30   5.000      35.7  -2.52
2         30   5.000      48.3   0.71
3         30   6.000      52.6   1.81
Overall   90              45.5

H = 6.74  DF = 2  P = 0.034
H = 7.21  DF = 2  P = 0.027  (adjusted for ties)
```

Sample1, 2 and 3 representing samples coded as 256, 568 and 714 respectively.

Interpretation of results

Kruskal-Wallis Test: Ove. acceptability versus Sample

H_0. There is no significant difference between overall acceptability of samples.
H_1. There is a significant difference between overall acceptability of samples.

At the 5% significant level, test statistic had p value 0.027 and P< 0.05 .So that there is an enough evidence to reject H_0 So, at least one sample significantly different from others with regard to overall acceptability.714 sample has highest average rank. Overall acceptability of 714 sample is more preferable than other samples.

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