DEVELOPMENT OF SAUCE RECIPE FROM BILIN

By

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DECLARATION

The work described in this thesis was carried out by me at the Faculty of Applied Sciences under the supervision of Ms. Dimuthu Peterson and Mrs M.Y. Jasmine mannapperuma. A report on this has not been submitted to any other degree.

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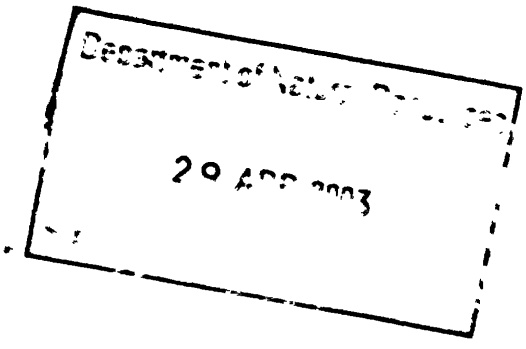

AFFECTIONATELY DEDICATED

TO MY EVER LOVING

PARENTS, BROTHER, SISTER,

TEACHERS AND FRIENDS.

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ABSTRACT

Bilin *(Averrhoa bilimbi)* is a small tree, growing in mid and low country of Sri Lanka. It yields small, acidic fruits, which are used as seasonings to eat with curries, or cooked as a curry or for medicinal purposes. The tree yields fruits seasonally, and during harvesting season, a considerable amount of harvest is been wasted. There are no bilin-based products in Sri Lankan market. Therefore, this study was carried out to prepare a value added product from bilin fruits, and to determine the best ingredients levels for bilin sauce. With the objective of minimizing the wastage of fruits during the harvesting season.

Sauce samples were prepared using various ingredient combinations with respect to stipulated experiment design. Three most influential variables with two levels of thickeners, spice content and sugar content added to bilin pulp were used to develop eight samples. The most preferable levels of thickeners, spice content, and sugar level were selected by sensory evaluation using hedonic scale and analysed under non-parametric method. Then two samples were prepared by using only bilin pulp and bilin pulp with pumpkin as a filler with selected ingredient levels. Most preferable sample was selected by paired comparison test.

The selected sample contained bilin pulp, 10% pumpkin, 2% corn flour, 30%sugar and low spice content. It's chemical analysis indicated a Brix° 38 and pH of 3.45, total solids 38.25 %, total soluble solids35.87 %, total sugars 23.96 %, and titrable acidity 4.2%.

Microbial count and chemical tests including pH, Brix values were done periodically to establish microbial safety and evaluate shelf life. Shelf life evaluation was not completed. Further studies should be done to complete shelf life evaluation and should conduct a market survey to evaluate consumer acceptance and demand.

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CHAPTER 1

1.1 INTRODUCTION

Bilin is a small tree called as cucumber tree. It is native to Malaysia but now it grows in India and other tropical countries, known only as a cultivated and naturalised plant. This tree is commonly cultivated for it's acidic fruits, which are cooked with sugar, or made in to seasonings for eating with curries and also for medicinal purposes.

Cucumber tree is a common garden plant in the mid and low country in Sri Lanka. It flowers from March to May and during November. The tree yields fruits during mid summer. In the harvesting period a considerable portion of harvest is being wasted due to difficulties in storing, because of Bilin fruit contain a lot of water and soft skin. Dried and salted fruits are stored in a dry container by using traditional methods.

If preserved properly to develop new fruit products using scientific methods Bilin fruit can be more useful in day today use. Malays prepare a pickle "Sunti" from the halfy ripen, fruits. Fresh fruits can be made in to jam or pickle. Pickled and dried Bilin fruits are very popular in Southern part of Sri Lanka.

Extracted Bilin pulp is suitable for sauce preparation. According to preparation technique, traditional sauces are categorised into main three classifications: Starch thickens sauces, egg base sauces and meat, poultry and vegetable gravies. Food formulators make sauce in less traditional ways to satisfy consumer needs. Sauce can be prepared using Bilin pulp developing a new value added product.

Bilin is a vitamins rich fruit. Fruits are highly acidic. Mainly it contains oxalic acid. It improves of flavours, with added salt and other ingredients. The pulp fruit has gelling ability when sugars, acids and salts are presented. But it contains less carbohydrate compared to other fruits. So higher degree of sugars should be added to develop new products.

There are two harvesting periods during a year, therefore, continuous production through out the year can be maintained. Compared to other fruit sauces, Bilin sauce has a less cost of production due to availability of fruits. It is an additional benefit to the consumers. Development of sauce from Bilin is a useful to reduce the wastage of Bilin during the harvesting periods and make a variety to the diet.

1.2 Objectives

- To utilise Bilin in a form of a value added product to minimize wastage during the Season.
- To determined the ingredients and their levels for Bilin sauce.
- To evaluate the shelf life of the developed sauce.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Bilin *(Averrhoa bilimbi)*

2.1.1 Description

Sinhala - Bilin, Bimbiri
English - Bilimbi, Bilimbing ,Cucumber Tree
Tamil - Kochitta , marattai , Pilimbi , Pulichakkay , Pulima

Bilin is a small tree, 5 - 7m tall, rusty pubescent on young parts and petioles, bark reddish brown. Leaves alternate, imparinnate, exstipulate, each confined into 11 - 35 leaflets. Flowers are bisexual, small fragrant, arising from the trunk and branches in villous panicles. Fruits are fleshy, large, drooping, oblong berries, 5 - 10cm long, furrowed length-wise, indehicent, seeds flat and exaxillate (Jayaweera, 1982).

2.1.2 Distribution

The tree is native to the Malaysia (Jayaindra, F. 1997) but now grows in India and other tropical countries. Known only as a cultivated and naturalised plant. It is a common garden plant in mid and low country in Sri Lanka (Jayaweera, 1982).

2.1.3 Climatic requirement

Full sun, rich and moist soil .The soil should be well drained.

2.1.4 Harvest

The tree yields fruits during midsummer (The wealth of India, 1948). Flowers from March to May and during November (Jayaweera, 1982). Fruits should be allowed to be half ripen on the tree before harvesting. Commonly they are harvested by hand.

2.1.5 Edible part

The fruit is the edible part. It is soft when ripen but has a very acid taste. Fruit contains 42.2% of juice of pH 4.47 (The wealth of India, 1948). The main acid is oxalic acid (Burkil,I.H, 1960).

Table 2.1.1 Composition of Bilin Fruit

Component		Amount
1. Moisture	(g)	94.4
2. Energy	(k cal)	2. 19
3. Proteins	(g)	0.5
4. Fats	(g)	0.3
5. Carbohydrates	(g)	3.5
6. Calcium	(mg)	15
7. Phosphorus	(mg)	10
8. Iron	(mg)	1.2
9. Vitamin A	(mcg)	–
10.Carotene	(mcg)	18
11.Thiamine	(mcg)	90
12. Riboflavin	(mcg)	40
13.Niacin	(mg)	0.6
14.Vitamine C	(mg)	82
15.Waste % as purchased		14

(Values are per 100g of edible portion)

Source : Modified from Dr. Perera, *et al* , 1979.

2.1.6. Food uses

Fresh fruits are eaten in fresh. It can be cooked as a vegetable and made in to seasonings for eating with curies.

Fruits of the Bilimbi are candied or cooked with sugars as a preservative. Candied bilin is added as raisin to fruit cakes and pies (Rajapaksha,U. 1998).

It also yields refreshing beverages cabbab and soliven (The wealth of India, 1948).

Uncooked fruits are prepared as a relish in Suriname. They are also to prepare into chutney.

The fruit can be made in to jam, or pickle (Burkill,I.H , 1966).

The Malays prepare a pickle –'Sunti' from the fruit, which can be kept for about three months.

2.1.7 Medicinal uses

Heyne reports that a decoction of the leaves of this tree is given for inflammation of the rectum in Java. A paste of the leaves is applied for mumps rheumatism and pimples. The fruit is used for piles and fever.

The juice of the fruit made in to a syrup is used in cases of haemorrhage from bowels, stomach and internal haemorrhoids (Jayaweera,D.M., 1982).

Burkill and Haniff record that the leaves are used medicinally as a hot paste applied for itch,taken internally, fresh or fermented, for syphilis; as an infusion taken internally after childbirth as a protective medicine, and for coughs with other simples. According to Guerrero, in the Philippine Islands, the juice of the fruit, as a syrup, is administered as a cooling drink in fevers (Burkill,I.H , 1966).

2.1.8 Other uses

The juice is used for removing stains from linen and also for polishing brass.

The wood is white, tough, soft and evenly grained.

Sour bilimbing fruits are an adjunct in dyeing silk orange being used in the mordanting (Burkill ,I.H, 1966).

2.2 Sauces

Sauces may be defined as a range of formulated liquid or semi-solid food products , which when added to a food , alter or enhance the sensory appeal of that food , by adding richness of flavour and / or enhancing the mouth feel.

2.2.1 Types of sauces

Sauces are categories in to two groups according to the using stage of the meal.

(I) Make a meal and pasta sauce

Sauces included in this group are used at the preparation stage of a meal. Certain degree of flavour needs to be introduced in to the food before cooking products in this category range from of simple sauces used for flavour such as chilli sauces, added to spice a meat dish to more complicated savoury cooking sauces as creamy mushroom sauce.

(ii) Pour over sauces

These sauces which are added to a complete meal as an accompaniment in order to enhance or alter its sensory characteristics according to the consumer's preference. There are main three subgroups.

(a) Emulsified sauces

These are a group of sauces, which consist of a viscous oil-in-water emulsion, often stabilised by egg yolk and normally containing vinegar. The oil content range from 80% plus in mayonnaise to the "virtually oil free" sauces containing little or no fat. Emulsified sauces, therefore, have widely varying oil contents, with the mouth feel and texture being modifiable by the inclusion of various fat substitutes.

(b) Non emulsified sauces

These are non-fat based sauces, and are often manufactured by a process that may include a heating stage of sauces, the classic example being tomato ketchup. Other sauces falling within this subgroup include brown sauce, various other ketchups and ethic style sauces.

© Fruit based sauces

These may be subdivided in to 'savoury' fruit-based products such as red-current Jelly, corn berry sauce, and the sweet confectionery sauces.
They normally have a high soluble solids content, coupled with a pH of less than 4, which inhibits most spoilage organisms. The process of manufacture often includes a heating stage that has a pasteurisation effect (Taoukis and Labuza, 1996).

2.2.2 Sauce preparation technique

Preparation of sauce involves various important steps. High quality sauces are prepared by maceration of spices, herbs, fruits and vegetable in cold vinegar or by boiling them in vinegar.

(a) Selection of fruits /vegetables

All selected fruits and vegetables should be of the highest quality and of the required level of maturity, otherwise whole batches may be spoiled by the presence of a small quantity of unsound material.

(b) Washing

It is recommended that incoming fruits be washed in clean chlorinated water before processing, and any that may have been treated with pesticides and other chemicals should receive particular attention. The fruits should be thoroughly rinsed in clean water after this treatment.

(c) Preparation of fruit

The preliminary preparation of fruit involves processes such as peeling, destoning, and slicing. In order to help control the quality of the final product, these operations should be performed to give pieces of fruit as uniform in size as possible.

(d) Pulping and sieving

Juice or pulp can be extracted from fruits in several ways.

- With a fruit press, fruit mill or hand pulpier sieve (contact points should be of stainless steel).
- Crushing / pulping with a mortar and pestle or blender and sieves.

(e) Straining

The pulp is also filtered through a fine or coarse mesh sieve of non-corrodible metal, according to the quality desired. The skin, seeds and stalks of fruits, vegetables and spices used, should not be allowed to pass through the sieve as they spoil the appearance of the sauce (Fruit and vegetable processing, 1988).

(f) Mixing of other ingredients

For preparation of sauces of high quality, the spice herbs, fruits and vegetables are macerated in cold vinegar. Sometimes, sauces are also prepared by boiling them in vinegar. In addition to its contribution to acidity of the sauce, usually malt vinegar is used to improve its flavour. The acidity should not however, exceed 3 - 4 per cent as otherwise the sauce would taste sharp.

The sugar content may usually vary from 15 to 30 per cent according to the kind of sauce made. The sweetness is derived partly from fruits like date, raisin, sultanas, apple and partly from the sugar added.

The colour of the sauces varies with the raw material used. Some times, a little caramel is added. Thickening agents also are added to prevent or retard sedimentation of solid particles in suspension in the sauce. The starches of maize, potato, arrow root, sago and rye also are used as thickening agents in preservation of fruits and vegetables (Lal *et al.* 1960).

(g) Heat treatment

Liquid products such as drinks and sauces are needed to be pasteurised before filling in to clean previously sterilised bottles. Brown fruit sauce should be heated to 71°C and held at that temperature for 15 minutes. (SBP Hand books). Pasteurisation has three advantageous effects in respect to product shelf life.

(i) Thermal destruction of spoilage micro-organisms, permitting a lower acetic acid content to be used.

(ii) Total or partial thermal inactivation of enzymes of vegetable or of microbial origin, thus preventing deteriorate changes caused by enzymes.

(iii) In the case where self-venting closures are used, removal of air during pasteurising and retention of headspace vacuum on cooling, thus minimising oxygen dependent and oxidative changes (Man and Jones, 2000).

(h) Packaging

The traditional packaging material used for sauces is glass, which provides practically a perfect gas as well as water vapour barrier. In addition, where ever necessary, hot filling is possible with glass containers, which could be a useful alternative to in-container pasteurisation. Developments in packaging materials, particularly in plastics materials, have led to the introduction of multilayer "squeezable" bottles for sauces. A typical structure for this type of bottle is inside polypropylene (PP)/adhesive/EVOH/adhesive/ PP outside, EVOH being the gas barrier layer and PP the water vapour barrier layer. While this type of container offers the consumer convenience in use, it is not commonly filled hot although it could withstand hot filling up to 70°C.

The oxygen barrier property of EVOH is affected by the relative humidity of the environment and this has to be taken in to account when designing storage trials for products packaged in this container (Man and Jones, 2000).

2.2.3. Action of preservatives

(i) Acetic acid

The level of acetic acid is believed to be the single most important factor in determining microbiological safety and thus shelf life in sauces. The percentage of un-dissociated acetic acid has a direct effect on its efficiency as a preservative agent, and this is affected by the pH of the aqueous phase and the acid dissociation constant.

Acetic acid has the characteristic that at the pH of many sauces it is mainly in the un-dissociated form, thereby exerting maximum anti microbial effect. More over, the fact that acetic acid has a very low oil water partition coefficient compared with sorbic and benzoic acid, its preservative effect is retained within the aqueous phase of the emulsified sauce (Man and Jones, 2000).

(ii) Sugar and salt

Salt and sugar contents affect the water available to micro-organisms by modifying the osmotic balance. This available water is expressed as water activity (a_w) and is directly related to the equilibrium relative humidity of the system. The water activity has a major implication in the survival of micro-organisms. The contribution of salt and sugar is indeed included in the CIMSCEE formulas.

$$15.75(1- x)(\text{total acetic acid \%})+3.08(\text{salt \%})+(\text{hexose \%}) +0.5(\text{disaccharide \%}) = \Sigma$$

For any sauce based on acetic acid, if the value of this formula (Σ) exceeds 63, microbial spoilage should not occur (Man and Jones, 2000).

(iv) Sodium benzoate

This is a salt of benzoic acid and is used in the preservation of fruit juices and squashes. Benzoic acid is the effective agent. Sodium benzoate is more soluble than benzoic acid Chemically pure sodium benzoate is practically tasteless and odourless. The quantity of sodium benzoate required would depend on the extent and type of microbial infection

Benzoic acid is more effective against yeast than against moulds. (Lal *et al*, 1960)

2.2.4 Quality control

Quality control need not be costly and its importance cannot be over stressed. All firms should introduce some form of quality control, regardless of the size of operation, to ensure consistency and to reduce losses from rejections.

Table 2.2.1 The Summary of main quality control points

Stages in process	Quality check
Selection of Fruit	- Ripeness, no mould or bruising, correct sizes and colours, no insect damage, correct varieties.
Preliminary preparation	- All unwanted parts (stones, skins, dirt, insects, etc) removed.
Straining	- Clear juice/ pulp produced.
Minor ingredients	- Correct weights added, no contamination from dirt, insects, etc
Boiling /pasteurisation	- Correct temperature for correct time. No burning on sides of vessel Adequate stirring to ensure all juice is properly heated. Refractometer to establish sugar content for sugar based preserves.
Filling	- Correct weight. Clean lid on container for good sealing.
Packaging	- Cleaned, no cracks or other damage, correct size and shape. Vacuum formed under lid.
Final Product	- Good appearance, no contamination, correct lable and fill weight.

(Fruit and vegetable processing, 1988)

2.2.5 Problems in preparation of sauces

(i) Deterioration due to metallic contamination

Trace metals, particularly copper, accelerate oxidative rancidity in various products. Traces of iron result in sulphide blackening of vegetables by reacting with tanin derived from ingredients such as whole or ground spices, especially cloves or others extracted from wood.

(ii) Growth of yeast, moulds or bacteria.

Because of their low pH , sauces present no risk of microbiologically food poisoning. This problem occurs in un pasteurised packs. Is largely one micro-organism capable of tolerating acetic acid. Microbial contamination can be avoided by proper handling and hygienic conditions.

(iii) Deterioration due to interaction of components

Physical interaction between caramel and onion cells results in rapid staining of onions in vinegar coloured with an unsuitable caramel. Chemical interaction of components present is exemplified by mallard browning reaction.

(iii) Deterioration of sauces due to physical or chemical changes

Sauces may separate with a layer of clear liquid at the top. This type of separation should be distinguished from syneresis, in which there is also a separation of fluid and which is often a side effect of gellina, which may result from the use of unsuitable thickener, or from incorrect processing of liquor decreasing viscosity on storage may result from the gradual acid hydrolysis
of some types of thickener.

(v) Deterioration due to un satisfactory packaging

Imperfect sealing of closures may be due to imperfect neck-ring finish on glass containers or defective closures, or incorrect capping machine adjustment or the trapping of particles between the glass rim and the closure, and may result in leakage of liquor intoxidative deterioration reactions and in the case of pasteurised low-acid packs, in post-process contamination and consequent micro biological spoilage.
The interior of closures must be suitably resistant to acetic acid to protect against corrosion (SBP Hand Book).

(vi) Deterioration due to poor storage conditions

High temperature of storage reduces of shelf life of the product due to faster deterioration rate.

2.3 Sensory evaluation of food.

Sensory evaluation is a subjective evaluation of food, very important in food industry. It is a scientific method used to evoke, measure, analyse and interpret those responses to products perceived through the sense of sight, smell, touch , taste and hearing.
Consumer testing is necessary throughout the various stages in the product cycle. These stages include the development of the product it self, product maintenance, product improvement and optimisation, assessment of market potential, (Anna. 1998). There are standards for all sensory evaluating methods given by institutes like Sri Lanka Standard institute.

2.3.1 Types of tests

The most commonly used tests are divided in to tree groups. Each group contains difference tests as following.

(a) Difference tests used to determine whether a sensory difference exists between two products.
   (i) Paired comparison test
   (ii) Triangular test
   (iii) Duo – trio test
   (iv) Two – out of five test
   (v) "A" – "not A" test

(b) Test using scales and categories, to estimate the order or size of difference or the categories or classes to which samples should be allocated.
   (i) Ranking
   (ii) Classification
   (iii) Rating
   (iv) Scoring
   (v) Grading

(c) Analytical or descriptive tests, used to identify the specific sensory attributes present in a sample, the tests may also be quantitative.
   (i) Simple descriptive test
   (ii) Quantitative descriptive and sensory profile test (S.L.S.931: 1991)

2.3.2 Rating test

Method of classification involving categories. Each category is composed of ordered scale. The points on each scale are of an ordinal nature.

Applications

Rating test is recommended for use as a means of evaluating

- The intensity of one or more attributes
- The degree of preference.

Analysis of data

For raring on a discrete with a small number of points, the results for one sample may be treated as for the classification. Continuous data or discrete data with a large number of points may be grouped and summarised by frequencies in each interval. When more than one sample is rated, a non-parametric method should be used to compare the distribution obtained. After transformation of at-test may be used.

2.3.3 Paired comparison test

A t test in which samples are presented in pairs for comparison and detection of differences on the basis of some defined criteria. This test is applied to determine if there is a difference, and if so, the direction of a different between

two samples.

- Establishes if there is a preference (paired preference)
- For the selection and training of assessor.

2.4 Shelf-life evaluation

2.4.1 Shelf-life determination

The first stage in a shelf life determination must be the assessment of microbiological safety. Once microbiological safety has been established, storage trails can be carried out. From past experience, it can be said that most quality deterioration's tend to manifest themselves as sensory changes so that shelf-life tests are usually selected to monitor them. Different conditions of storage may be used and the following are the more common conditions.

Chilled	0 – 4°C
Ambient (UK)	15 – 25°C
	(Tropical 25°C, 75% RH)
Accelerated	30 – 37°C
	(Tropical 37°C 95% RH)

For sauces, sampling for analysis is normally carried out on a monthly basis and where appropriate, samples stored under different conditions are compared. The followings are examples of the more common tests that are carried out for shelf-life determination of sauces.

(a) Sensory analysis

Aroma, flavour, colour, texture, mouth feel, visual appearance (signs of separation and apparent viscosity and consistency).

(b) Chemical analysis :

pH, total volatile acidity, peroxide value and free fatty acid content of extracted oil, specific components such as the volatile and pungent isothiocyanates in horseradish.

(c) Instrumental analysis :

Viscosity measurement is using a Brookfield viscometer or Bostwick consistometer and colour measurement using Minolta Chrome meter.

These tests can be used to give some indication of the rate of change, and help to locate the end point of the shelf-life .The aim of any shelf-life determination is to find the level of change in respect of each critical quality attribute beyond which the product is regarded as unacceptable. Shelf-life studies must inevitably include a degree of judgement regarding the levels at which the deteriorative changes have become unacceptable. Such decisions are usually made jointly by the technical, sales, and marketing departments (Man and Jones, 2000).

CHAPTER 3

3 MATERIALS AND METHODS

3.1 Materials for

3.1.1 Sauce preparation

- Halffy matured Bilin Fruits
- Ginger, garlic, cinnamon, cloves, cardamom and chilli powder
- Powdered salt
- Gold pumpkin
- Com flour
- Sodium benzoate
- Electronic balance
- Measuring cylinder
- Petridishes, beakers
- Stainless steal saucepan
- Wooden spoon
- Blender
- Stainless steals strainer
- Sterilised RTS bottles and lids
- Gas cooker
- Hand refractometer
- Bottle sealer
- Water bath

3.1.2 Sensory evaluation

- Ballot papers
- White porcelain plates
- Yoghurt spoons
- Cream cracker biscuits
- Glasses with water
- Panellists selected from 20- 25 age group

3.1.3 Chemical analysis

(i) Total solid determination

- Moisture cans
- Oven - MEMERT
- Desicator
- Analytical balance

(ii) Total soluble solid determination

- Petridishes
- Beaker
- Hot water
- Filter papers
- Butcher's funnel
- Oven
- Analytical balance
- Centrifuge – JENWAY moddle

(iii) Titrable acidity determination

- 0.1 N sodium hydroxide solution
- Phenolphthalein indicator
- Burette
- Petridishes
- Conical flask
- Measuring cylinder

(iv) Total sugar determination

* Anhydrous dextrose
* Copper sulphate ($CuSO_4. 5H_2O$)
* Sodium hydroxide
* Concentrated Sulphuric acid – H_2SO_4 acid
* Rochelle salt (Potassium sodium tartarate)
* 96% v / v ethanol
* Ethylene blue
* Calcium carbonate
* Lead acetate
* Potassium oxalates
*Glassware requires for titration

(v) Shelf-life determination

(a) Materials for pH and soluble solid determination

pH meter

Refractrometer

(b) Matenals for microbial count

*Culture media – Buffered pepton water

Potato dextrose agr

*petridishes

*Test tubes

*Colony counter

*Pipettes

*Incubater

3.2 Methods

3.2.1 Method of ingredient combination

This experiment was designed to develop a sauce recipe by combining ingredients with bilin pulp. Three most influential variables with two levels such as, thickeners, spice content, and sugar level made use for this study to select best ingredient levels.

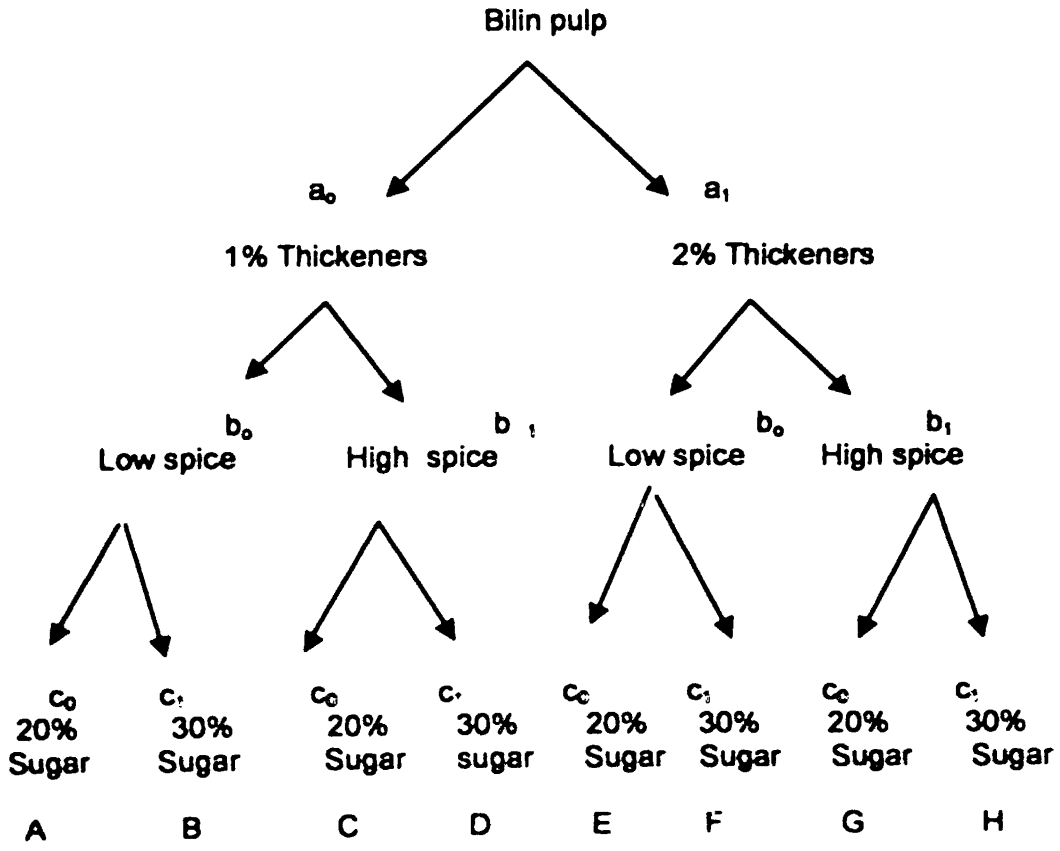

Figure: 3.2.1 Ingredients combination method.

Table 3.2.1 Sample preparation method.

Type of sauce	combination
A	1% Com flour, Low spice, 20% Sugar
B	1% Com flour, Low spice, 30% Sugar
C	1% Com flour, High spice, 20% Sugar
D	1% Com flour, High spice, 30% Sugar
E	2% Com flour, Low spice, 20% Sugar
F	2% Com flour, Low spice, 30% Sugar
G	2% Com flour, High spice, 20% Sugar
H	2% com flour, High spice, 30% Sugar

Among these eight samples levels of thickness, spice taste and sugar content were selected by sensory evaluation. Two sauce samples were prepared by changing fruit base using pumpkin as filler with combined selected ingredient levels,

I – Without filler

II – With filler

Paired preference test was done to select the sample more prefered sample out of with filler or without filler samples.

Ingredients:

- Bilin Pulp 1kg
- Bilin Pulp 1kg + Pumpkin pulp 10%
- Salt 15%
- Vinegar 50ml

Low spice

High spice

Low Spice	High spice
*Ginger 0.5%	*Ginger 1.0%
*Garlic 0.5%	*Garlic 1.0%
*Chilli powder 1.0%	*Chilli powder 1.5%
*Cardamom 0.5%	*Cardamom 1.0%
*Clove 0.5%	*Clove 1.0%
*Cinnamon 0.5%	*Cinnamon 1.0%

Percentages were taken on the weight of Bilin Pulp

*Sodium benzoate 450ppm was added as a preservative

3.2.2 Method of sauce preparation

Trimming and washing with water prepared Bilin fruits. It was blanched by dipping in hot water for 3 minutes. Seeds and stems of fruits were removed. Bilin pulp was prepared by blending blanched fruits. Pulp was strained through stainless steel strainer. Extracted pulp was weighed and as a percentage of that weight other ingredients which were added. Spices were grounded with adding small portion of vinegar. Bilin pulp was heated. While stirring sugar, salt, chilli powder and vinegar was added. Ground spices were kept in a small cloth bag and dipped in sauce while heating and sugar, vinegar, salt and chilli were added to pulp when it was heating. When it has reached to about Brix ^{0}30. Sodium benzoate and cornflower mixture was added to the sauce. It was stirred until removed from fire. When Brix value reached about 35 the sauce was removed from fire. Then it was fill in to pre sterilised RTS bottles and sealed Filled sauce bottles were kept in water bath at 80° C for 30 minutes.

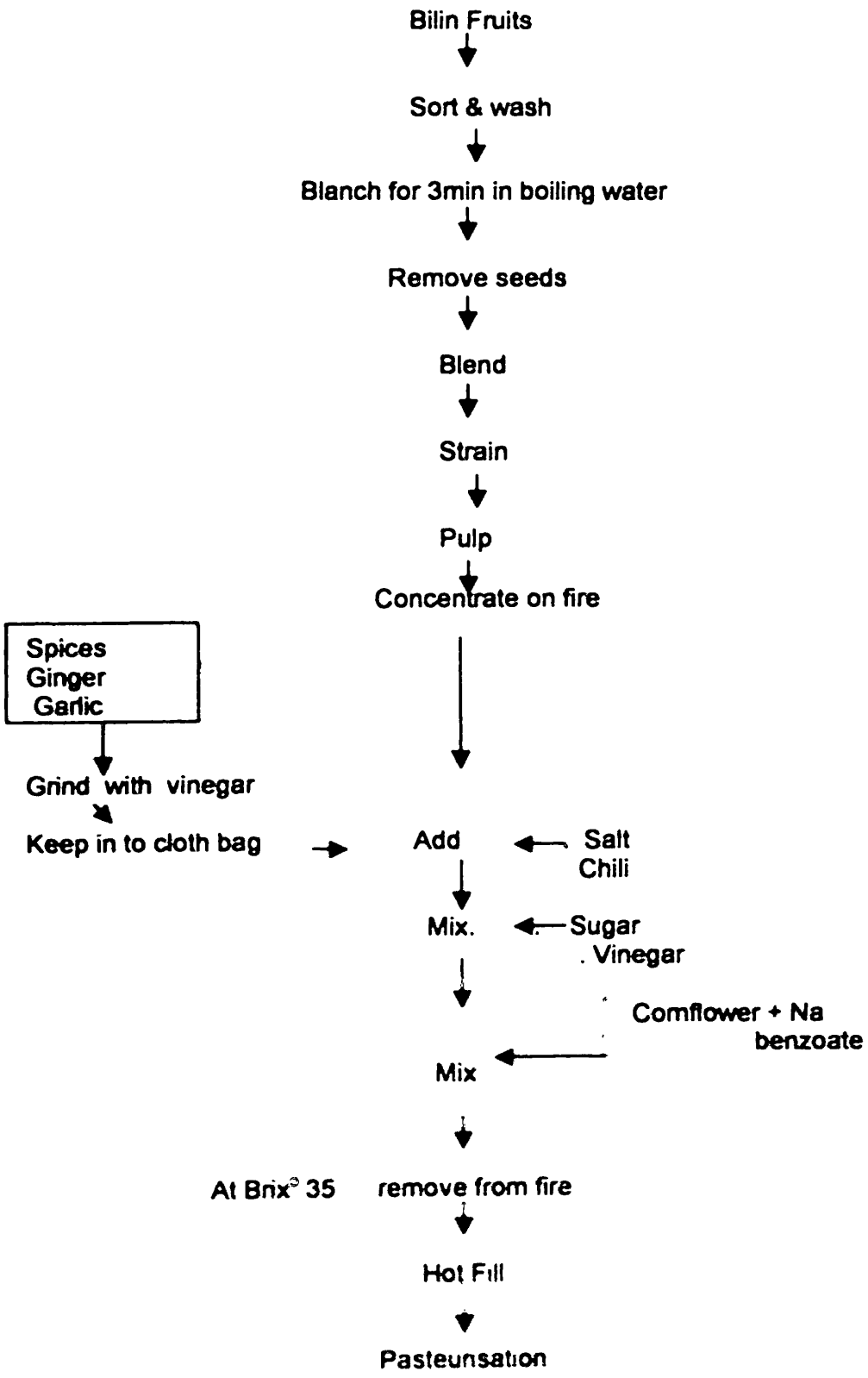

Figure 3.2.2 Sauce Preparation Procedure

3.2.3 Method of sensory evaluation

An untrained sensory panel of twenty-five members was untrained sensory panel was selected from 20- 25 age group at the faculty.

Rating test

This sensory test was done to select the acceptable thickness, spice content, and sweetness level. The 9 point Hedonic scale (Appendix - 1) is the rating scale that has been used for this test. Ballet papers were provided for each panellist to collect data. Data was analysed according to non-parametric statistical analysis method using Kruskal – Wallis test.

Paired comparison test

Paired comparison test was done for the two samples which were prepared one with as only bilin pulp and the other bilin pulp with pumpkin as a filler, combining with selected ingredient levels. Vessels containing samples were coded using two digit numbers. Samples were presented in following order,

1. 12 panellists A first (A,B)
2. Remaining 13 panellists B first (B,A)

Same sensory panel and same conditions were used for both the tests.
If a statistical preference for one sample over another is significantly in paired preference test was determined and analysed according to the non parametric method using Mann-Whitney test.

3.2.4 Chemical analysis

Chemical analyses were done for the sample, which was selected from sensory evaluation.

(i) Total solid determination

Sauce sample was weighed in to a moisture can and thinly distributed in an even layer over bottom of the can It was dried at 100 c in an oven until consecutive weightings made at two hour intervals do not vary more than 1mg.

Calculation

$$\text{Total solid} = \frac{\text{Total weight} - \text{Weight loss}}{\text{Sample weight}} \times 100$$

(ii) Total soluble solid determination

Total soluble solids were determined by subtracting the percent by mass of insoluble solids from percent by mass of total solids.

Insoluble solids

20g of sauce sample was weighed and wash repeatedly with hot water, centrifuge after each addition of water and clear supernatant was filtered through weighed filter papers on Buchner funnel. After transfer, remaining insoluble matter on filter papers were dried in a covered dish for 2hours at 100°C. Cooled in dissector and weighed.

Calculation

$$\text{Insoluble solids \%} = \frac{m2 - m1}{m} \times 100$$

Total soluble solid % By mass = Total solid % - insoluble solid %

m = mass, in grams , of the test portion
m1 = mass, in grams, of the dried filter papers
m2 = mass, in grams, of the filter paper with residue after drying

(iii) Titrable acidity determination

0.1N standard sodium hydroxide solution was prepared. Phenolphthalein indicator solution was prepared by dissolving 0.5g of phenolphthalein in 200ml of 50% ethyl alcohol by volume. 5g of sauce sample was weighed and transfered in to a conical flask with 100ml of recently boiled and cooled distilled water. 1ml of phenolphthalein indicator solution was added and tritrated with standard sodium hydroxide solution.

$$\text{Acidity (as oxalic acid) present by mass} = \frac{n\ v}{m}$$

v = volume in ml, of standard sodium hydroxide required for titration

n = Normality of standard sodium hydroxide solution

m = Mass in gram of, the sauce taken for the test

(iv) Total sugars determination

Standard dextrose, methylein blue indicator, Fheling's A solution, Fheling's B solution according to S.L.S 581;1982 method. Standardisation of fheling's solution, preparation of sample solution were done according to the above .

Calculation

Milligrams of anhydrous dextrose present of 1ml of the

Prepared solution $= m = \frac{\text{dextrose factor}}{\text{titre}}$

Total sugars (as invert) present by mass $= \frac{200 \times m}{M1}$

Where

m = milligrams of reducing sugar in 1ml of the solution of the material

M1 = mass in g, of the prepared sample used for making 250ml of solution.

3.2.5 Method of Shelf life evaluation

For the shelf life determination of selected sauce sample, storage trials were carried out to monitor the quality deterioration. Sauce samples were prepared from the samplewhich was selected from the sensory evaluation. They were stored under two different conditions as chill.(0 - 4° C) and room temperature. Triplicates samples from chill temperature and room temperature were analysed in every two weeks. Under chemical analysis pH value, titrable acidity and Brix value of samples were checked.

Microbial count

Microbial count was done to the establish the initial quality of samples and again after in every one month from stored samples.

Culture media and diluent

* Potato dextrose agar was prepared as a medium that is more suitable for growth of molds and yeast.
* Dilution series were prepared as follows

20g of sample was weighed and mixed with 200ml of peptone water and shaked well.

1ml of above mixture was pipette out to a tube containing 9 ml of peptone water.

From first dilution, transfer with the 1.0ml was transfered to second dilution tube containing 9ml of peptone water. This was repeated for three times.

1.0ml of dilution was poured in to potato dextrose agar containing petridishes was mixed thoroughly and allowed to solidify. Incubated at 20 – 25°C for 5 days. Colonies were Counted and mold (Refai, 1979).

CHAPTER 4

4 RESULTS AND DISCUSSION

4.1 Results of sauce preparation

Eight types of sauce samples were prepared as follows;

A - 1% corn flour, low spice content, 20% sugar
B - 1% corn flour, low spice content, 30% sugar
C - 1% corn flour, high spice content, 20% sugar
D - 1% corn flour, high spice content, 30% sugar
E - 2% corn flour, low spice content, 20% sugar
F - 2% corn flour, low spice content, 30% sugar
G - 2% corn flour, high spice content, 20% sugar
H - 2% corn flour, high spice content, 30% sugar

Table 4. 1.1 Brix° values of Bilin pulp and prepared sauces

Sauce sample	Brix° value of Bilin pulp	Brix value of sauce
A	6	33
B	6	35.4
C	7	36.2
D	6	32.4
E	7	35
F	7	36 8
G	6	36
H	7	36 6

Brix values of eight sauces are vary within 35 to 40 mainly due to variation of ingredient levels Brix values of Bilin pulp vary between two values This variation in t Brix° value is may be due to variations of maturity stage of fruits

4.2 Results of sensory evaluation

4.2.1 Results of Rating test

The data collected under hedonic scale from sensory evaluation were analysed according to Kruskal - Wallis test. There was three variables used in two levels. To determine best ingredient levels data collected for four parameters.

Thickness

Table 4.2.1 Analysed result for thickness

Kruskal – Wallis test

Treatment	N	Median	Avg. Rank	Z
A	25	6	70.3	-2.79
B	25	6	76.0	-2.26
C	25	6	67.1	-3.26
D	25	6	77.3	-3.08
E	25	7	121.9	-1.98
F	25	8	154.7	5.00
G	25	7	115.1	1.35
H	25	7	121 6	1.95
Overall 200				
H = 26.75		DF = 7		P = 0.00
H = 23.40		DF = 7		P = 0.00
				(adjusted for ties)

H_o : There is no significant difference between sauce samples at 5% level

H_1 There is a significant difference between sauce samples

According to the results. P value is less than 0 05 significant level So H_o is rejected and H_1 is accepted There is a significant difference between sauce samples for thickness at 5% level Sample which got highest average rank. is the sample having best thickeners level Selected sample is F

Spice taste

Table 4.2.2 Analysed result for spice taste

Treatment	N	Median	Avg. Rank	Z
A	25	6	98.3	-0.56
B	25	6	106.0	0.66
C	25	6	76.3	-1.81
D	25	6	87.1	-1.74
E	25	7	95.3	-1.50
F	25	8	123.5	3.42
G	25	7	92.1	-1.69
H	25	7	101.6	-0.74

Overall

H = 19.30 DF = 7 P = 0.007

H = 20.65 DF = 7 P = 0.004

(Adjusted for ties)

H_o : There is no significant different between sauce samples at 5% level

H_1 : There is a significant different between sauce samples

According to the results P value is less than 0.05 at 5% significant level. So H_o is rejected and H1 is accepted. There is a significant difference between sauce samples at 5% level Sample, which got highest average rank, is a sample having best spice content Selected sample is F, having low spice content.

Sweetness

Table 4.2.3 Analysed result for sweetness

Treatment	N	Median	Avg. Rank	Z
A	25	6	86.0	-1.34
B	25	8	142.6	3.88
C	25	6	82.6	-1.65
D	25	6	79.3	-1.95
E	25	7	118.8	1.29
F	25	7	123.6	1.87
G	25	6	85.8	-1.35
H	25	7	89.67	-1.25
Overall				

H_0 = 27.40 DF = 7 P = 0.000

H_1 = 29.31 DF = 7 P =0.000

H_o : There is no significant different between sauce samples at 5% level

H_1 : There is a significant different between sauce samples

According to the results P value is less than 0.05 at 5% significant level. So H_o is rejected and H1 is accepted. There is a significant difference between sauce samples at 5% level. Sample, which got highest average rank, is a sample having best sugar content. Selected sample is B, having law sugar content. Sample F got the next high average rank.

4.2.2 Results of paired comparison test

This test was done for select best food base. Preference test done for two samples

F1: Bilin pulp based

F2: Bilin pulp + 10% pumpkin based

H_0 :sample 1= sample2

H_1 : Sample 1< sample2

Data was analysed with Mann's Whitney test and according to the results there is a significant difference between tow samples at 0.0003 level but there is no significant difference at 5% level. Second sample got the highest median value. (Refer appendix 5)

4.3 Results of chemicals analysis

Table 4.3.1 Characteristics of selected sauce

Characteristics	Results (percent by mass)
Total solids	38.25
Total soluble solids	35.87
Acidity (oxalic acid)	4.2
Total sugars (as invert sugars)	23.96

(For calculations refer Appendix – 7)

To evaluate the quality of developed Bilin sauce, there are no specific standard requirements. Because of Bilin sauce is not available in the market. So the results of quantitative chemical analysis for selected sauce sample was compared with SLS requirement for chilli sauces.

Table 4.3.2 Comparison of Bilin sauce with chilli sauce SLS requirements.

Characteristic	Requirement for chilli sauce(as percent by mass)	Bilin sauce (as percent by mass)
Total solids	25 min	38.25
Total soluble solids	20 min	35.87
Acid	1.2 min (as acetic)	4.2
Total sugar	10 min	23.96

When comparing Bilin sauce with chilli sauce requirements, there are far better values for the characteristics of sauce.

4.4 Results of shelf life evaluation

Microbial count

At the initial stage of after preparing sauce microbial count was done.

There is no colonies found on agar and no micro organisms. Due to higher acidity and the heat treatment micro organisms can't be grow well in the sauce at earlier stages of sauces.

Chemical changes during storage

(a) Samples at chill (0- 4^0) condition

Table 4.4.1 Chemical changes of sauce at chill condition

Time duration	pH	$Brix^0$
Fresh sauce	3.45	38
After 2 weeks	3.45	38
After 4 weeks	3.45	38
After 6 weeks	3.45	38

(c) Samples at room temperature

Table 4.4.2 Chemical changes of sauce at room temperature

Time duration	pH	$Brix^0$
Fresh sauce	3.45	38
After 2 weeks	3.45	38
After 4 weeks	3.44	38
After 6 weeks	3.44	37

According to that results up to one and half month there is no considerable changes in the samples, which were stored at the chill temperature. But changes of pH and Brix value in the samples stored at room temperature after six weeks. This time period not adequate and it should be continue for several months.

CHAPTER 5

CONCLUSION

The Bilin sauce, which prepared with bilin pulp and low spice content, 2% corn flour and 30% sugar content is the selected sample having ingredient levels which got highest average rank at 5% level. There is no significant difference between two samples of, only with bilin pulp and bilin pulp + 10% pumpkin at 5% level. But the sample with bilin pulp and pumpkin was got the highest median value. Ingredient combination of developed recipe is bilin pulp, 10% pumpkin, 2% corn flour, 30% sugar, 1.5% salt, 1.0% chilli powder, 0.5% ginger, 0.5% garlic, 0.5% clove, 0.5% cinnamon. Chemical parameters of the sauce having, above ingredient combination levels are: total solids 38.25 %, total soluble solids 35.87 %, and acidity 4.2%, and total sugars 23.96%.This selected sample having Brix^0 38 and pH 3.45.

Comparing to standards of chilli sauce these values are far better. The shelf life evaluation could not completed. Up to one and half month sauce samples were establish microbiological safety and chemically no changes in pH and Brix ^{0} values in the samples stored under chill temperature.

Recommendations for further studies

In this study selecting best ingredients and their levels developed a recipe for bilin Sauce. To complete developed the product further more studies can be Recommended as below.

- Should continue the shelf life evaluation
- Check the consumer acceptance and demand by conducting market survey

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Appendix 1

Ballet paper for sensory test

Rating test

Name Date

Product

Please fill the spaces were given that best reflects your feelings about these samples

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike verymuch	Dislike moderately	Dislike slightly	Neither like nor dislike	like slightly	like moderately	like verymuch	like extremly

Parameter	275	534	937	725	528	682	826	346
*Thickness								
*Spice taste								
*Sweetness								

Thank you

Paired preference

Ballet paper for paired preference test

Name Date

Product . Bilin sauce

In front of you are two samples Beginning with the sample on the left. taste each one and circle the sample that you prefer

326 535

Thank you

Appendix 2

Results of sensory evaluation

Thickness

Treatement	A	B	C	D	E	F	G	H
1	6	5	5	6	7	9	8	7
2	5	8	6	6	9	8	7	7
3	6	7	5	7	7	9	6	8
4	5	6	5	7	6	7	7	8
5	7	5	7	6	8	8	6	7
6	4	5	6	5	6	7	7	6
7	6	7	5	6	7	9	8	7
8	6	5	7	6	8	7	7	8
9	6	7	6	8	7	8	7	9
10	7	7	8	6	7	9	6	7
11	4	5	6	5	6	7	7	6
12	7	5	7	6	8	8	6	7
13	6	7	5	7	7	9	6	8
14	5	8	6	6	9	8	7	7
15	5	6	5	6	7	6	8	7
16	6	5	5	6	7	9	8	7
17	8	7	8	6	6	8	6	7
18	6	5	5	7	6	7	8	6
19	6	6	7	5	6	7	7	6
20	7	7	8	6	7	9	6	7
21	5	4	7	6	8	7	6	6
22	6	6	6	5	7	8	7	7
23	7	7	6	4	7	8	7	6
24	6	5	5	6	7	9	8	7
25	8	7	8	6	6	8	6	7

Appendix 3

Results of sensory evaluation

Spice taste

Treatement	A	B	C	D	E	F	G	H
1	6	7	5	8	7	6	8	7
2	8	8	6	6	9	8	7	8
3	6	7	5	7	8	9	6	6
4	5	6	5	7	6	7	7	8
5	7	5	7	6	8	6	6	7
6	4	5	6	5	6	7	7	6
7	7	7	5	6	7	9	8	7
8	6	5	7	6	8	6	7	8
9	8	7	6	8	7	8	7	7
10	7	7	8	6	7	9	6	9
11	4	5	6	5	6	6	7	6
12	8	5	7	6	8	8	6	7
13	6	7	5	7	7	9	6	8
14	7	8	6	8	9	7	7	8
15	5	6	5	8	7	6	8	7
16	7	5	5	6	7	9	8	8
17	8	7	8	6	6	6	6	7
18	6	5	6	7	8	7	8	9
19	7	6	7	5	6	8	7	6
20	7	7	8	6	7	9	6	7
21	5	4	7	6	8	7	6	6
22	8	6	6	5	7	6	7	7
23	7	7	6	4	7	8	7	6
24	6	5	5	6	7	9	8	7
25	6	7	8	9	6	7	6	8

Appendix 4

Results of sensory evaluation

Sweetness

Treatement	A	B	C	D	E	F	G	H
1	7	5	5	6	7	9	8	7
2	6	8	6	6	9	8	7	7
3	8	7	5	7	7	9	6	8
4	7	6	5	7	6	7	7	8
5	6	9	7	6	8	8	6	7
6	7	5	6	5	6	7	7	6
7	6	7	5	6	7	9	8	7
8	8	8	7	6	8	7	7	8
9	6	7	6	8	7	8	7	9
10	7	7	8	6	7	9	6	7
11	8	5	6	5	6	7	7	9
12	7	9	7	6	8	8	6	7
13	6	7	5	7	7	9	6	8
14	5	8	6	6	9	8	7	9
15	7	7	5	6	7	6	8	7
16	6	5	5	6	7	9	8	5
17	8	7	8	6	6	8	6	7
18	5	8	5	7	6	7	8	6
19	6	6	7	5	6	7	7	8
20	9	7	8	6	7	9	6	7
21	5	8	7	6	8	7	6	9
22	6	7	6	5	7	8	7	7
23	7	9	6	4	7	8	7	6
24	8	6	5	6	7	9	8	7
25	8	8	9	7	6	6	6	8

Appendix 5

Mann-Whitney Confidence Interval and Test

first N = 25 Median = 2.0000

second N = 25 Median = 1.0000

Point estimate for ETA1-ETA2 is 1.0000

95.2 Percent CI for ETA1-ETA2 is (-0.0000,0.9999)

W = 800.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0017

The test is significant at 0.0003 (adjusted for ties)

Appendix 6

Dextrose table for 10ml of fehling's solution.

Ml of sugar solution require	Dextrose factor	Mg dextrose per 100ml
15	49.1	327
16	49.2	307
17	49.3	289
18	49.3	274
19	49.4	260
20	49.5	247.4
21	49.5	235.8
22	49.6	225.5
23	49.7	216.1
24	49.8	207.4
25	49.8	199.3
26	49.9	191.8
27	49.9	184.9
28	50.0	178.5
29	50.0	172.5
30	50.1	167.0
31	50.2	161.8
32	50.2	156.9
33	50.3	152.4
34	50.3	148.0
35	50.4	143.9
36	50.4	140.0
37	50.5	136.0
38	50.5	132.0
39	50.6	129.6

Mg of dextrose corresponding to 10ml of Fehling's solution.

Source: SLS 581: 1982.

Appendix 7

Calculations of chemical analysis

(i)Total solids

Weight of moisture cane = 26.86g

Weight of the sample = 8.00g

Final weight of the moisture cane + dried residue = 29.92g

Total solids = $\frac{3.060}{8.00}$ x100

(ii)Total soluble solids

Weight of the sauce sample = 20.00g

Weight of the filter papers = 0.532

After the drying residue + filter paper = 39.578 – 38.57 – 0.532

= 0.476

Weight of the insoluble solids percent = $\frac{0.476}{20.00}$ x 100

2.38%

Total soluble solids =Total solids % – insoluble solids %

38.25 – 2.38

= 35.87%

(iv) Titrable acidity

Weight of the sauce = 5 00g

Required NaOH = 8.8 ml

Acidity = 4 2%

(v) Total sugars

Standardization of Fehling's solution and find

Correction factor concentration, in mg/ 100ml of

Anhydrous dextrose solution =167.0

Titre in ml, obtain by dried titration =28.0

Dextrose factor for 28.0ml of standard dextrose =50.0

Dextrose solution = titre in ml x No of mg of anhydrous dextrose in 1ml of std dextrose solution

Solution

Correction to be applied to dextrose factor derived

From table =46.0-50.0

= -3.24

Milligrams of anhydrous dextrose percent in 1ml of = m = dextrose factor

The prepared solution ——————

titre

Dextrose factor =50.0-3.26

Required sample solution =36.0

$$M = \frac{46.76}{36}$$

Total sugar (as invert) percent by mass $= 200.0 \times \frac{1.2}{10.015}$

=23.96%

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