DEVELOPMENT OF SAUCE RECIPE FROM TAMARIND

By

H.A.E. Nalaka Ariyasingha

Thesis submitted in partial fulfillment of the requirements for the Degree of Bachelor of science in Food science and technology of the Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, Buttala, Sri Lanka

December 2000

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

DECLARATION

The work described in this thesis was carried out by me at the Faculty of Applied Sciences under the supervision of Mrs I. Wikramasinghe and Mrs. M.Y. Jasmine Mannapperuma A report on this has not been submitted to any other University for another degree.

H.A.E.Nalaka Ariyasinghe
Date: 2000/12/14

Certified by,

Mrs. M Y.Jasmin mannapperuma
External supervisor
Directress
Technical Services Division
Industrial Development Board
Katubedda
Moratuwa

Date: 2000/12/14

Mrs I Wikramasinghe
Internal supervisor
Lecturer
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala

Date: 5/12/2000

Mr M A Jagath Wansapala
Course coordinator
Degree program of Food Science and Technology
Department of Natural Resources
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala
Sri Lanka

Date

AFFECTIONATELY DEDICATED TO MY EVER LOVING PARENTS, BROTHERS, SISTERS, TEACHERS AND FRIENDS.

ACKNOWLEDGEMENT

First and foremost I wish to express my deepest gratitude to my internal supervisor Mrs I. Wickramasinghe lecturer, Department of Natural Resources, Faculty of Applied Sciences, Sabaragamuwa university of Sri Lanka for her valuable advice, encouragement and guidance to this study and for reading the manuscript and sparing her valuable time in bringing this study to a successful completion.

I would like to thank Mrs A.M.Y.J Mannapperuma directress Technical Service Division, Industrial Development Board for providing me this opportunity.

I whish to express my sincere thank to Mr. Jagath Wansapala, co-ordinator, Food science and technology program of the Sabaragamuwa University, of Sri Lanka for his advices. Also I would like to thank to Dr. K K.D.S. Ranaweera, Dean of the Faculty of Applied Sciences.

Thanks also extended to food science laboratory technical staff including Mr Dammika for their assistance and support.

Finally with my deepest gratitude I should thank my batch mates and other colleagues in the faculty for helping me to do practical and sensory evaluation.

ABSTRACT

Tamarind grows all over the Sri Lanka and a considerable portion of tamarind will be wasted in the harvesting season. To prepare a value added product from tamarind here a study was carried out and determined the best ingredients and ingredient levels for tamarind sauce. In two-occasions consumer idea was got for the sauce development. In the first occasion developing the sauce recipe, specification of sauce according to consumer preference were known by doing a marketing survey. Here marketing survey is not complete one and aim was to collect consumer ideas about sauce. Nine sauce varieties were prepared by changing ingredients and ingredient levels. In the second occasion a sensory evaluation was done with 17 judges for the selection of the best sauce sample.

But there is no significant different at 5% level between sauce samples. Total solids, total soluble solids, acidity and total sugars were analyzed in quantitatively of sauce sample that got lower rank sum The sauce recipe was not developed from this study completely. For the completon of the sauce recipe development, further studies should be done about the shelf life of the sauce and on stabilizers

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CHAPTER I

INTRODUCTION

Tamarind tree grows widely all over Sri Lanka. It grows in dry arid areas also. But in Sri Lanka tamarind tree does not grow as a crop and mostly it grows as a wild plant. India is the only country in which tamarind grows as a crop. From ancient times this tree has been recorded from Sri Lanka. *Ruwanmal Nigandu* which was written by King Parakramabahu in 1410 BC recorded about tamarind tree. Tamarind tree is popular in Sri Lanka for medicinal purposes and as a curry-tasting agent. Tamarind paste and chutney are available in Sri Lankan market but they are not popular yet.

In Sri Lanka especially tamarind tree is largely found in North Western, Eastern and North Central provinces. Tamarind can be harvested in April, May and June months. In tamarind season, a considerable portion of harvest is being wasted due to difficulties in harvesting, low price, poor market and insect attacks in stores.

If preserved properly to develop new food products with scientific methods, tamarind can be more useful in day today use. For instance, tamarind paste, powder, chutney etc are already available in other countries as well as in Sri Lanka.

Tamarind pulp is suitable for sauce preparation. Traditional sauces are often categorized or put in to main classifications according to their method of preparation. Roux sauces, starch thickens sauces, egg based sauces and meat, poultry and vegetable gravies are the main categories belong to above classification. (Foote *et al*, 1993) These days food formulators make sauce and soups in less traditonal ways to satisfy consumer needs. For example, Barbecue is one of the most popular type of sauce in America. However, it is noted that regional variation of traditonal Barbecue profiles are also steadily rising (F.T., 2000) Like wise a sauce, which can be prepared using tamarind pulp, can different from traditional sauces.

Tamarind pulp contains naturally good quality pectin, like apple pectin. When sugar, acid, salt and water are present pectin can form a gelly. That gel can retain the liquid and give a good consistency to the sauce. Tamarind pulp has an appetizing ability and this is one of the good characteristic of sauces. Tamarind pulp has several medicinal values and that is an extra benefit, which we can obtain from tamarind sauce. Ripen fruit pulp of tamarind is fairly rich in free sugar constitutes such as D-glucose, D-mannose, D-maltose and D-arabinose

Also reported the presence of six amino acids, serine, proline, β-alanine, pipecolinic acid, phenylalanine and leucine (Hansan *et.al.* 1978). Tartaric, citric, oxalic and succinic acids are also detected Those are the nutritional benefits which can be gained from tamarind sauce. Tamarind has an attractive natural flavour and aroma. These are new flavours and aromas when compared with those of traditional sauces. It can add a variety to the diet and meet consumer desires for new flavours and aromas

Objectives

- To determine the best ingredients and the best ingredient level for tamarind sauce.
- To add a value to tamarind which is easily found in the country.

CHAPTER II

LITERATURE REVIEW

2.1 Tamarind

Tamarind is a large evergreen tree, which grows to a height of 24m with a circumference of 7m. It is a long-lived tree and sometimes still productive after 200 years.

2.1.1 Origin and distribution

Tamarind is native to tropical Africa and is now widely planted and naturalized everywhere in the tropics. It has been reported that long ago the Tamarind reached the new world, probably brought with the first shipments of slaves from West Africa. In ancient times Arab traders introduced the tree to Asia.

2.1.2. Climatic requirement

The tree is well adapted to both dry savanna regions and monsoon area with well-drained soils. But tree is sensitive to frost.

2.1.3.Harvest

The pods should be allowed to ripen on the tree until the outer shell is dry and can be separated from the pulp without adherence. They are harvested by merely shaking the branches and should not be beaten down with sticks since this process materially injuries the blossoms and the buds of future leaves. The pods that are left on the tree are gradually blown off later and are picked up good full-grown tree yields 180-225kg of fruit per season (The welth of India row materials 1976)

2.1.4. Fruit

The fruit of Tamarind tree is most acidic of all natural foods. Both tartaric and malic acids are present in the leaves and these are translocated to the berries. Tartaric acid is a uncommon plant acid and cannot metabolized further in leaves. Hence it is translocated to the bernes. Tartaric acid and its content vary from 14-18%.

Tamarind pulp contain pectin and is similar in composition to apple pectin as both contain Galacturonic acid, glucose and Arabinose. Tamarind fruit contains 32% seed and 68% pulp. Following analysis of Tamarind fruit has been reported
(Hansan and Ijas, 1972).

Table 2.1.1 Composition of tamarind Fruit

Composition	Percent
Moisture	62.5 - 69.2
Proteins	1.4 - 3.3
Fat and oils	0.71 - 0.81
Cellulose	8.4 12.4
Tartaric acid	8.4 -12.4
Total sugars	21.4 -30.85
Ash	1.16 -1.72
Potassium oxide in the ash	44.5 -48.9
Pentoses	4.2 -4.8
Total acidity calculated as tartaric acid	17.1-18.4

Source Modified from Hanson and Ijas,1972

2.1.5. Medicinal value of the fruit

The ripe fruit is regarded as a refrigerant, digestive, carminative and laxative. The pulp of the fruit is used as purgative, diaphoretic and emollient. Other parts of the tamarind tree like seed, leaves, roots, flowers etc. are used for medicinal purposes (Jayaweera, 1981)

2.1.6.Food products from tamarind

Several research papers and reports can be found about tamarind. Some research papers are deal with food uses. Non-food uses of tamarind are not discussed here. Several research papers which deal with food uses of tamarind are mention below

(a) Food thickeners from modified tamarind kernel powder - work was undertaken in the national laboratory in Poona India. Modified tamarind kernel powder (TKP) is possible to use as a food thickener, which is suitable to substitute fruit pectin in certain processed foods. The data recorded in this research show that modified TKP is more efficient and more economical than other food thickeners (Varma et al,19??)

(b) Tamarind concentrate - The present domestic method of extracting the fruit by soaking in water and squeezing out juice is inconvenient and wasteful. Storage of the fruit for a long period is a problem. Tamarind concentrate gives a solution for above problems. This is easy to disperse in hot water. The quantity of the product does not deteriorate over a period of one year's storage. Test market of the product showed it is to be quite popular (IFP 1970).

(c) Jujubes from tamarind seed jellose - Jujubes available in the market are mostly Gelatin based and are there for unacceptable to the vegetarians. Jellose a constituent of tamarind seed can be used in place of Gelatin. Tamarind seed is being an inexpensive commodity the cost of production is mainly contributes by sugar and it works out cheaper than the current price of Gelatin based jujubes.

(d) Starch from tamarind seed - Tamarind seed starch is possible to use for food products where starch is used currently and also suitable for cassava starch and sago starch.

(e) Soft drink - Study was done both in Sri Lanka and Brazil. Brazil researches did there research by mixing soursop and tamarind as a mixed soft drink. Indian researches expect this mixed soft drink will popular due to their rich flavor and aroma (Benro, 1973).

(f) Tamarind powder - This research was done at CFTRI India. They expected a bright future for this product. Tamarind powder is packed in high-density polyethylene pouches (Tamarind powder, 1970).

Other than the above products tamarind chutney available in Sri Lanka market.

2.2. Sauce

The French word sauce comes from the Latin saltus or salted, reminding us that sauces were originally liquid seasonings for food. Sauces are used to complement the flavor, texture and appearance of foods. A sauce should never overpower the dish it accompanies but bring harmony and balance. (Foote *et al.*,1996)

There is no essential difference between sauces and ketchup. However sauces are generally thinner and contain more total solids (minimum 30%) than ketchup (minimum 28%) sauces are of two kinds.

(I) Thin sauces of low viscosity consisting mainly of vinegar extract of flavoring materials like herbs and spices

(ii) Thick sauces that are highly viscous.
(Srivastava and Kumar, 1994)

2.2.1. Sauce Preparation Techniques

Sauces are prepared from fruit or vegetable pulp or juice used in sieved after cooking to remove the skin, seed and stalks of fruit vegetables and spices. This sieving gives smooth consistency to the final product. However cooking takes longer because fine pulp or juice is used.

Some sauces develop a characteristic flavor and aroma on storing in wooden barrels. Freshly prepared products often have a row and harsh taste and therefore, to be matured by storage.

High quality sauces are prepared by maceration of spices, herbs, fruits and vegetable in cold vinegar or by boiling them in vinegar. The usual commercial practice is preparing cold or hot vinegar extracts of each kind of spices and fruit separately and blend them suitably.
Thickening agents are also added to the sauce to prevent sedimentation of solid particles. Apple pulp is commonly used for this purpose in India but starch from potato, maize, arrowroot (cassava) and sago are also used.

The color of the sauce should be bright. Sauce usually thickens slightly on cooking. By using a funnel hot sauce is filled in bottles leaving a 2cm headspace at the top and the bottles are sealed or cooked at once. The neck of the bottles, when cold, is dipped in paraffin wax for airtight sealing. It is advisable to pasteurize sauce after the bottling since there is always a danger of fermentation, especially in tomato and mushroom-based sauces. Other sauces are more acidic and less likely to ferment but should be pasteurized all the same. For these the bottles are kept in boiling water for about 30 minutes. (Srivastava and Kumar, 1994)

2.2.2. Commonly used ingredients in sauce

Commonly used ingredients in sauce other than it's main fruit or vegetable materials are.

Acetic acid (vinegar) - This act as a preservative and spices extracting solution. It's preservatives action is mainly due to the undissociated acetic acid molecules.

Sugar - Color, appearance, sucrose content, moisture, foreign matter and buffering power is important.

Salt - Salt gives better taste to sauce. Salt should be low in calcium and iron content. (Jayasinghe 1998)

Spices - Spices and herbs gives pleasant odor and flavor to sauces. e.g.:- Garlic, onion, ginger, pepper, cinnamon, clove and cardamom

Clove should be used only after removing the flower - head. Because the flower head of clove contain tannin, which cause browning, black neck ring formation in sauce. There are two methods to add spices to sauces.

(I) Grounded spices suspending in a bag in the boiling fruit pulp.

(ii) As a vinegar extract - spices are simmered for 2hrs in a covered vessel with a portion of the vinegar and then strain the extract. (Donald and Woodroof, 1976)

Preservatives (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)

2.2.3 Problems in the preparation of sauces

Black neck - Formation of black ring in the neck of bottles is known as black neck. It is caused by the iron, which gets into the product from the metal of the equipment and the cap/crown cork through the action of acetic acid. This iron coming into contact with tannins in spice, forms ferrous tannate that is oxidized to black ferric tannate

Black neck can be prevented by

(I) Filling hot sauce at a temperature not less than 85° c

(ii) Leaving very little headspace in bottle. (The more the air the greater is the blackening)

(iii) Reducing contamination by iron, source of iron can be salt and metal equipments

(iv) Partial replacement of sugar by corn syrup or glucose syrup, which contain sulfur and prevent blackening

(v) Addition of 100 ppm sulfur dioxide or 100mg ascorbic acid

(vi) Storing bottles in horizontal or inverted position to diffuse the entrapped air (o_2) throughout the bottle thus reducing its concentration in the neck sufficiently to prevent blackening

(vii) Using cloves only after removing the flower-head

(Srivastava and Kumar, 1994)

2.3. Sensory Evaluation Of Food

Sensory evaluation is commonly used in quality assurance and new product development. A sensory evaluation is made by the sense of taste, smell, touch and hearing when food is eaten. Here people are used as a measuring instrument, and then it is necessary to rigidly control all testing methods and conditions to overcome errors caused by psychological factors. The physical and mental condition of the panelist and the influence of the testing environment affect the sensory tests. (Larmond, 1977) There are standards for all sensory evaluating methods given by institutes like Sri Lanka standard institute.

2.3.1. Type of tests

The most commonly used tests are divided in to 3 groups. Each group contains difference tests like below

(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 differences 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. Ranking

Definition - Test in which a series of three or more samples is presented to an assessor at a same time and which are to be arranged in order of intensity or degree of some specified attributes

Application - Ranking has wide application but it is not very discriminating. It is recommended for use.

(a) As a screening test, to aid the planning of a more precise assessment
(b) For selection of a product
(c) As a consumer test for acceptance and determination of the order of preference.
(d) For training assessors
(S.L S. 931:1991)

2.4. New food product development

The definition of new product development can be broded to either the development or introduction of a product not previously manufactured by a company in to the market place or the
presentation of an old product into a new market not previously explored by a company
(Fuller, 1994)

There is no single process for the development of new products For some companies and some products the process occurs over a period of years For other companies and products it can take as little as few months New product development generally is a complex organizational task involving literally dozens of individuals from multiple disciplines Food development projects will frequently involve the following persons (Little will vary)

- Vice president (V P) marketing
- Director (or V P) new products

- Marketing research personnel
- Research and development
- Research suppliers
- Marketing consultants

Increasingly (and importantly), manufacturing and sales persons are involved in new product development. (Graf and Saguy, 1991)

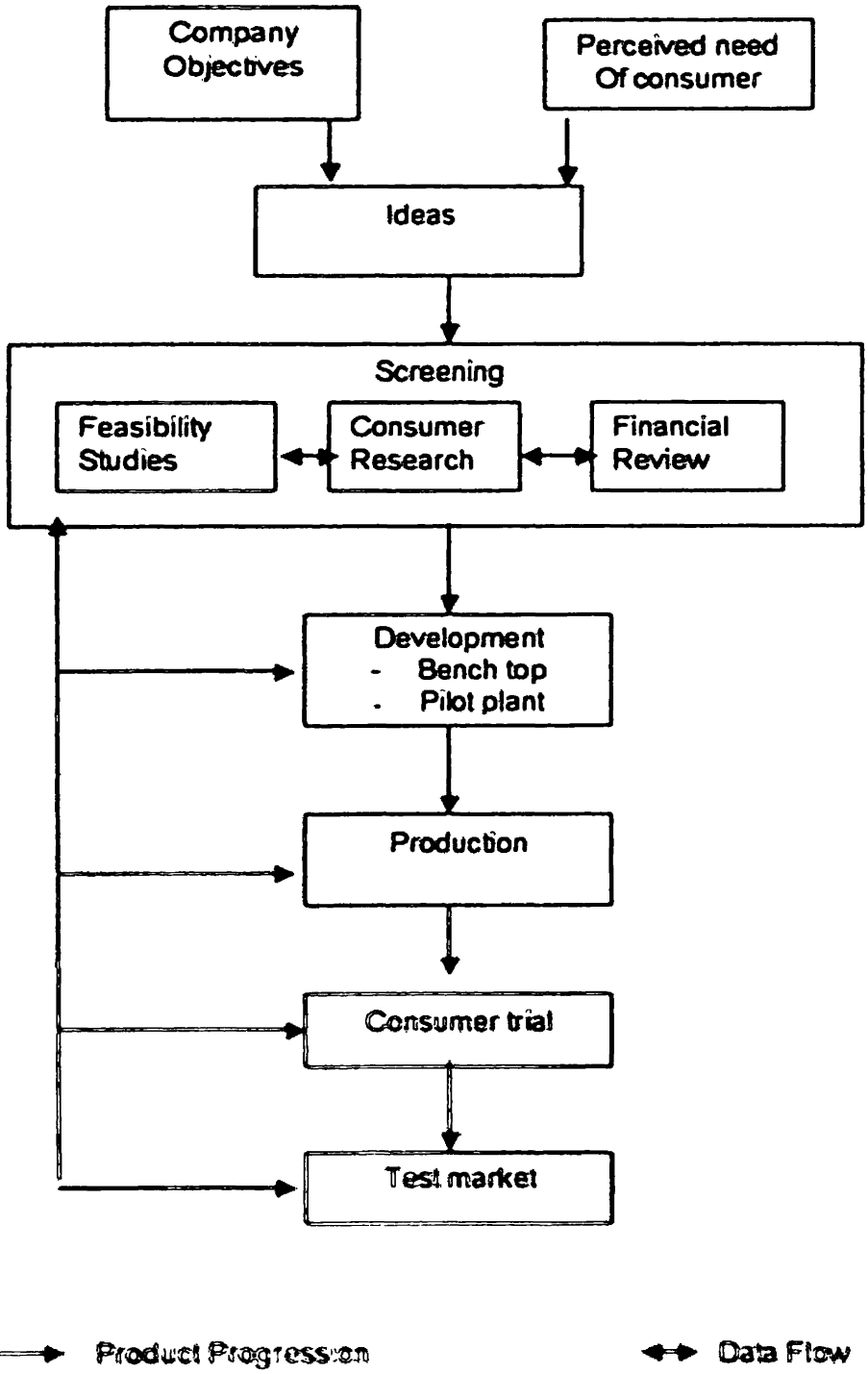
2.4.1. Why go in to new food product development

The need for new food product development can be seen to be driven by five dominant forces
- All products have life cycles. That is they enter the market place, for an indeterminate time, then die, and must be replacing.
- A company's management may adopt a policy that requires an aggressive growth program to satisfy long - range business goals.
- The market place may change, requiring new products more suited to responded to the changes
- New technology may make new food products available and new knowledge may tailor new food products more suited to the lifestyle of today's consumers.
- Changes in government legislation, health programs, agricultural policy, or agricultural support programs may dictate that development of new food products be pursued
(Fuller, 1994).

2.4.2. Phases in new food product development

Most authors divide new food product development in to several distinct phases. Very few agree on the numbers, the order, or with the name of the phases (figure 2.3.1)

Figure 2.4.1 Phases In New Food Product Development



Source Modified from Fuller, 1994

CHAPTER III

MATERIALS AND METHODS

3.1 Materials for

3.1.1 Marketing survey

Sauce consuming middle class consumers and questionnaire papers

3.1.2 Sauce preparation

Tamarind purchased from the collectors at Buttala area

Ginger, garlic, cinnamon, chilli, powder cardamom, pepper and onion, which were purchased from Buttala, market

Commercially available powdered salt

Commercially available packaged date

Pumpkin available at Buttala market

Sodium benzoate

Electronic balance

Measuring cylinder

Sterilized ready to serve (RTS) bottles and lids

Beakers and petridishes

Stainless steal saucepan

Gas cooker

Bottle sealer

Hand refracto meter

3.1.3 Sensory evaluation

Question paper which was prepared according to Lamand 1977

Yoghurt spoons

White porcelain plates

Cream cracker biscuits

Water glasses

Panelists who were selected from the faculty

3.1.4 Chemical analysis

3.1.4.1 Determination of total solids

Moisture cans
Oven
Analytical balance

3.1.3.2 Determination of total soluble solids

Petridishes
Oven
Analytical balance
Filter papers
Buchner funnel
Hot water

3.1.4.3 Determination of acidity

Phenolphthalein
50% ethanol
Sodium hydroxide
Glass wears require for titration

3.1.4.4 Determination of total sugar

Anhydrous dextrose
Copper sulfate ($CuSo_4$ $5H_2o$)
Concentrated sulfuric acid
Rocheller salt (potassium sodium tartarate)
Sodium hydroxide
96%v/v ethanol
Methylene blue
Calcium carbonate
Lead acetate
Potassium oxalate
Glass wears require for titration

Steam bath
Other glass wears in a chemical laboratory
Gas burner

3.2 Method

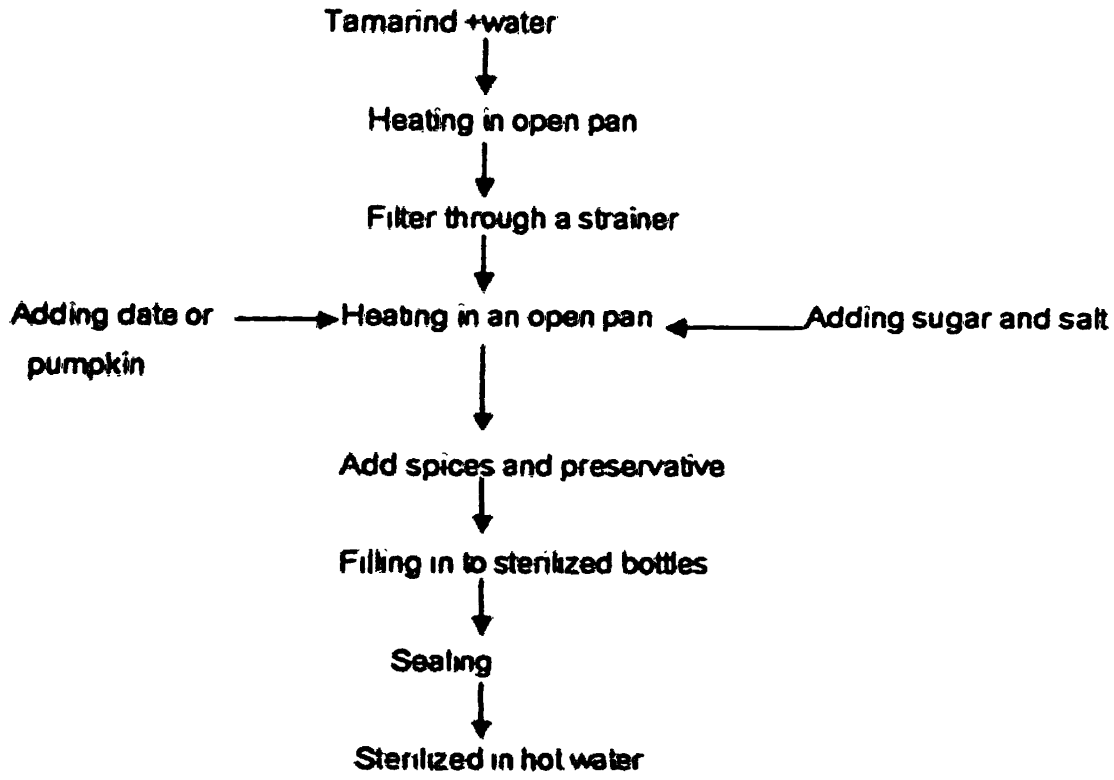
3.2.1 Method of marketing survey

Questionnaire was prepared with both open end and close end questions (Appendix 1). Target consumer group (refer 3.1.1) was consisting of 15 members and questionnaire was filled personally by speaking with them.

3.2.2 Sauce preparation method

Tamarind and water were mixed in 1.3 ratios by weight. Tamarind pulp was extracted by heating for about 15 minutes and filtered through a stainer.
Extracted tamarind pulp was weighed and as a percentage of that weight other ingredients were added. Sugar and salt were mixed with tamarind pulp and was heated while stirring. Spices were grounded using a grinding stone by adding small portion of vinegar. When tamarind pulp was reached about Brix® 35, The grounded spices were suspended in a masking cloth bag and dipped in to the boiling tamarind pulp. Then sodium benzoate was added, when mixture was reached about Brix® 42 heating was stopped. Then heated sauce was filled to RTS bottles and bottles were sealed. Bottle sterilization was done by keeping the bottles in 100° c hot water for 30 minutes

Figure 3.2.2 Sauce preparation procedure



Nine sauce varieties were prepared by combining ingredients as follow

Table 3.2.2 Ingrediant combination method

	Pure tamarind pulp	tamarind + 10% pumpkin	Tamarind +10% date
Without corn flour and low spice content*			
2%corn flour and low spice content* 2% corn flour high spice content**			

*		**	
Salt	1.5%	salt	1.5%
Ginger	0.5%	ginger	1%
Chile	0.5%	Chile	1.5%
Cinnamon	0.25%	cinnamon	0.5%
Pepper	0.25%	pepper	0.5%
cardamom	0.05%	garlic	1%
		onion	1.5%
		cardamom	0 05%

All percentages were calculated on the weigh basis of the tamarind pulp

Two sets of nine sauce varieties were prepared with 450 ppm sodium benzoate and without sodium benzoate

3.2.3 Sensory evaluation method

Each panelist was separated by using cardboard Sensory evaluation was done only in the morning and nine sauce varieties were provided to each panelist in porcelain plates Aim of the sensory evaluation and basic things involve with a sensory evaluation was known to each panelist (Appendix 3) Yogurt spoons were provided with each sample Seventeen panelists were parecipated for the sensory evaluation Ballot papers for sensory evaluation were prepared (Refer appendix 3) and sensory evaluation data was analyzed according to ranking method of Larmand,1977

3.2.4 Method of chemical analysis

Sample which got lower rank sum (Refer Table 4.3.1) was selected from the sensory evaluation and following chemical analysis were done to that sample.

3.2.4.1 Method of total solids determination

Sample was weighed in to a moisture can and was distributed thinly in an even layer over the bottom. Sample was dried at 70° c in an oven and weighing was made at two hour intervals and do not vary more than 1mg.

Calculation

$$\text{Total solid} = \frac{\text{sample weight-weight loss}}{\text{Sample weight}}$$

3.2.4.2 Method of total soluble solid determination

First the insoluble solids were determined. Sample of 20.0014g was weighed and washed repeatedly with hot water. Clear supernatant liquid was filtered through a weighed filter paper, placed in a Buchner funnel. After washing for times remaining insoluble matter was transferred through filter papers and was dried in a covered dish for two hours at 100° c. Weight of dry matter was taken

Calculation

Insoluble solids percentage, m/m = $\frac{m_2 - m_1 \times 100}{m_0}$

Total soluble solid percentage by mass = total solid percentage - insoluble solid percentage

Where

m_0 = Mass in grams of the test portion

m_1 = Mass in grams of the dried filter paper

m_2 = Mass in grams of the filter paper with residue after drying

3.2.4.3 Method of acidity determination

Standard sodium hydroxide solution (0.1N) was prepared. Indicator was prepared by dissolving 0.5g of Phenolphthalein in 200 ml of 50% ethyl alcohol by volume. Sauce sample of 5.0067g was weighed and was transferred to a conical flask with 150 ml of recently boiled and cooled distilled water. One milliliter of Phenolphthalein indicator solution was added and was titrated with standard Sodium hydroxide solution

Calculation

Acidity (as tartaric acid) present by mass = $\frac{15nv}{m}$

Where

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

3.2.4.4 Method of total sugars determination

Standard dextrose solution, Methylene blue indicator, Fheling's A solution, Fehling's B solution were prepared according to S L S 581 1982 method Standardization of Fehling's solution, preparation of sample solution were done according to the above method (appendix 1).

Calculation

Milligrams of Anhydrous dextrose present in one

Milliliter of the prepared solution = $m = \frac{\text{Dextrose factor}}{\text{Titre}}$

Total sugars (as invert) present by mass = $200 \times \frac{m}{m_1}$

Where

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

m_1 = Mass in g. of the prepared sample used for making 250 ml of solution

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Results of marketing survey

Figure 4.1.1 Preference levels of sweet taste

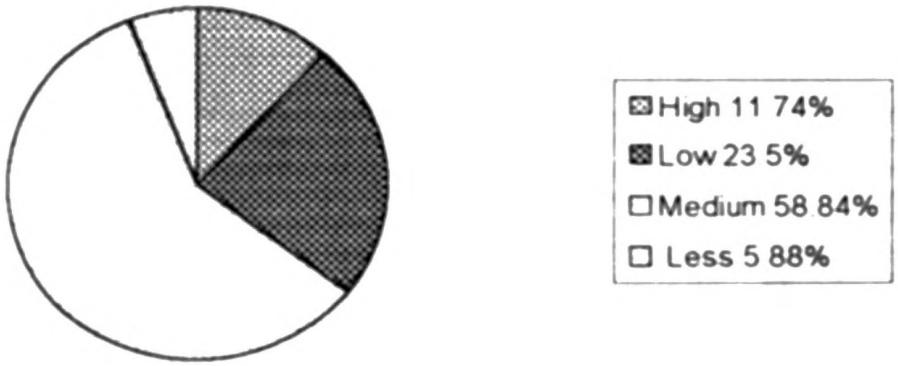


Figure 4.1.2 Preference levels of sour taste

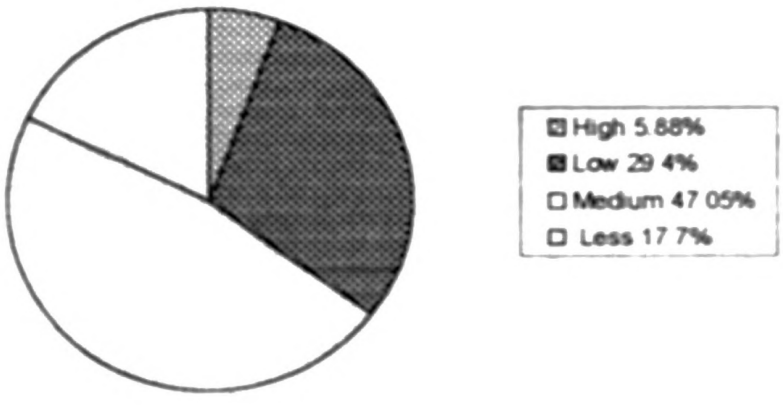


Figure 4.1.3 Preference levels of spicy taste

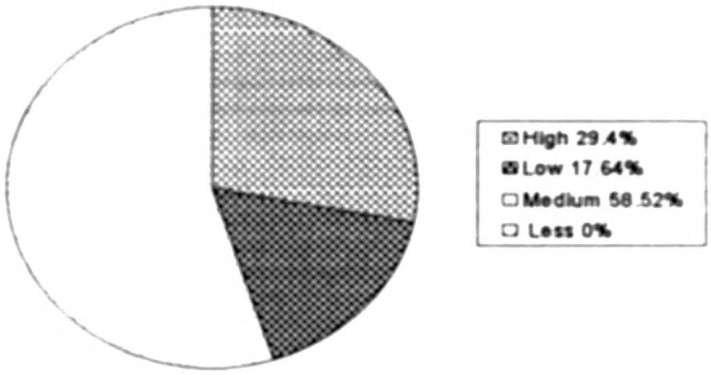


Figure 4.1.4 Consumer preference on the colour of the sauce

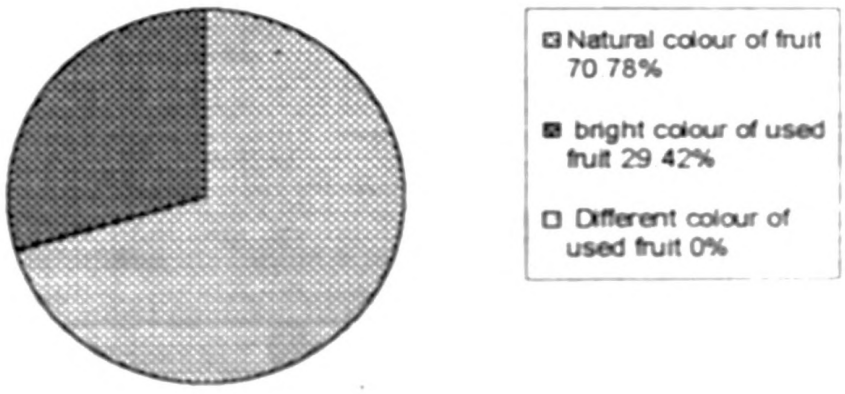


Figure 4.1.5 Consumer preference on the thickness of the sauce

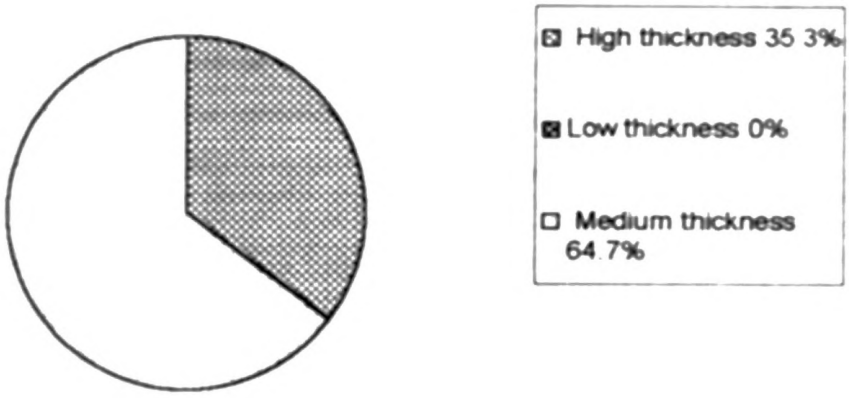


Table 4.1.1 Ranked characteristic according to consumer preference

Rank (according to rank sum)	Characteristic
1	Thick ness
2	Colour
3	Sour taste
4	Spicy taste
5	Sweet taste

(For ranking methods refer appendix 4)

More consumers prefer medium level of sweet, sour and spicy taste in a sauce. When we consider colour of the sauce more consumers like natural colour of the fruit. But anyone do not like different colour of used fruit. Many consumers prefer medium thicken sauce. In table 4.1.4 characteristics were arranged by using total rank sum. Characteristic, which got lower rank sum, arrange as first and characteristic, which got highest rank sum, arrange as fifth.

Seventeen sauce consumers were used for this marketing survey. (When we consider the sauce consuming population in Sri Lanka the sample size of 17 is not enough). For my marketing survey I used only a certain area and middle class consumers. Here I did not do a complete and systematic marketing survey. Because it is time-consuming process and as

well as it requires expert in that field and trained personals Aim of my marketing survey is to look at sauce through consumer eye and to collect ideas about consumer preferring characteristics and level of the characteristics etc about sauce

Questions were included to the questionnaire about colour, taste, thickness, and size of the package Other than the mentioned characteristics consumers consider below characteristic too. These facts were known from the eighth question in the questionnaire.

(i) Odour of the sauce

(ii) Characteristic of the package (bottle) likes attractive look, ability to consume whole content in the package etc.

(iii) Shelf life of the sauce at room temperature after opening the bottle.

(iv) Nutritional value of the sauce

(v) Cost of the sauce

4.2 results of sauce preparation

Table 4.2.1 Preservative action in tamarind sauce

Sauce varieties	With preservatives	Without preservative
A	O	O
B	O	O
C	O	O
D	O	X
E	O	O
F	O	O
G	O	O
H	O	X
I	O	O

A-Tamarind, pumpkin, high spice content, with 2% corn flour combination

B- Tamarind, date, high spice content, with 2% corn flour combination

C- Tamarind, high spice content, with 2% corn flour combination

D- Tamarind date low spice content with 2% corn flour combination

E- Tamarind date low spice content without corn flour combination

F- Tamarind only, low spice content with 2% corn flour combination

G- Tamarind only low spice content without corn flour combination

H- Tamarind, pumpkin, low spice content, without corn flour combination

I- Tamarind, pumpkin, low spice content, with 2% corn flour combination

O-Absence of mold patches after 3 weeks

X- Presence of mold patches after 3 weeks

Mould patches were present in 2 sauce samples, which were prepared without preservatives. Two sets of nine sauce varieties were prepared with preservatives and without preservatives. Actually only using these two sets of samples we can't get a clear idea about chemical preservative action on mold growth in tamarind sauce scientifically

Table 4.2.2 Brix° values of tamarind pulp and prepared sauce

Sauce variety	Brix° value of extracted pulp	Brix° value of prepared sauce
A	12	41
B	13	44
C	14	45
D	13	40
E	13	46
F	14	42
G	14	49
H	12	43
I	12	43

Letters donate to the samples as in table 4 2 1

Final Brix° value of the sauce varies within the range of 40° to 50°. My aim was to get the final Brix° value around 42° As I had prepared the tamarind pulp in 3 times I have got 3 values on the initial Brix° value of the tamarind pulp. To prepare the tamarind pulp, water and tamarind fruit was used in the same ratio (refer3.2). But the Brix° value of tamarind pulp can vary due to the heating time, tamarind variety etc

4.3 Result of sensory evaluation

Table 4.3.1 Ranking of samples

Judges	Samples								
	A	B	C	D	E	F	G	H	I
1	8	3	9	2	6	1	5	4	7
2	8	7	3	5	6	2	9	4	1
3	7	2	8	1	5	3	6	4	9
4	5	7	4	1	3	9	2	6	8
5	2	1	4	7	3	6	9	8	5
6	6	1	4	9	8	3	5	7	2
7	6	1	3	2	4	9	8	5	7
8	9	7	8	4	3	6	5	1	2
9	5	4	3	7	6	8	9	2	1
10	4	3	7	9	8	6	5	2	1
11	2	3	1	5	9	8	6	4	7
12	9	6	1	2	8	5	7	3	4
13	7	4	1	5	8	2	6	3	9
14	3	9	8	2	1	6	4	7	5
15	8	4	9	7	1	5	2	3	6
16	1	7	3	9	4	8	6	5	2
17	1	7	6	4	8	5	9	3	2
Total rank sum	91	76	82	81	91	92	103	71	78

Letters donated to the samples as in table 4.2.1

The rank totals are compared with the values in appendix 5. When there are nine samples and seventeen judges (reps), the tabular entries are 58-112, the lowest insignificant rank sum is 58 and the highest insignificant rank sum is 112. If one or more rank sums are higher than the upper left value in the block (58) or higher than the upper right value in the block (112) statistical significance at the 5% level of significance is indicated. But rank totals in table 4.3.1 are laid within 58-112. The conclusion is that there is no significance difference between samples.

According to Elesabath Laman 1977, sensory evaluation panels can be grouped in to three types, highly trained experts, laboratory panels, and large consumer panels. According to this categorization, in here a laboratory panel was used. This panel should be a trained one. But judges used for the above sensory evaluation were not trained personnel. Also nine sauce samples were used for this sensory evaluation at a time. So errors can be occurred. For this situation best thing is to use a consumer panel consisting about 100 panelists as I couldn't use a trained panel. Here aim of the ranking test is to screen the best sample or samples for further development.

4.4 Result of Chemical analysis

Table 4.4.1 Characteristics of sauce, which got lower rank sum

Characteristic	Results (per cent by mass)
Total solids	42 56
Acidity expressed as tartaric acid	5.3633
Total soluble solids	38.77
Total sugars (as invert sugar)	26.347

(For the calculation refer appendix 6)

Tamarind sauce is not available in Sri Lankan market. So there are no SLS standards for tamarind sauce. Comparison of the above results with SLS requirement for Chile sauce as follows.

Table 4.4.2. Comparison of tamarind sauce with Chilli sauce requirement

Characteristic	Requirement for Chilli sauce (as per cent by mass)	Tamarind sauce (as per cent by mass)
Total solids	25 min	42.56
Total soluble solids	20 min	38.707
Acid	1 2 min (as acetic acid)	5.3633 (as tartaric acid)
Total sugars (as invert sugar)	10 min	26 347

When comparing with chilli sauce standards the prepared tamarind sauce has far better values

CHAPTER V

CONCLUSION

Tamarind sauce with pumpkin, low spice content and Brix° value of 43 got the lower rank sum Ingredient combination level of this sauce is: pumpkin 10%, sugar 20%, salt 1.5%, ginger 0.5%, Chilli 0.5%, cinnamon 0.25%, pepper 0.25%, cardamom 0.05%. Addition of chemical preservative is better otherwise mould patches can appear. But here there is no significant difference at 5% level between nine sauce varieties used. Statistically can't choose the sauce sample, which got lower rank sum, as the best one. Level of the four chemical parameters of the sauce which got lower rank sum are: total solids 42.56%, acidity expressed as Tartaric acid 5.363%, total soluble solids 38.703%, and total sugars (as invert sugar) 26.347%

In this project an untrained panel was used for the sensory evaluation, which apply for the ranking of the samples. Errors can be occurred because of the Unitarian personnel. In such an occasion by using a large consumer panel consisting about 100 panelists errors can be minimized.

Further studies and recommendation

Here I studied only about ingredient combination and levels of the ingredients in sauce recipe. By this, sauce recipe cannot be completely developed. Below studies can be recommended further

- Studying about the shelf life of the sauce
- Studying about the best stabilizer and the levels of it
- Studying about tamarind pulp extracting methods and conditions

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APPENDIX 1

Marketing survey about sauce

1. How often do you buy sauce per year? (Belong to any brand)

2 You buy sauce for (Under line your answer)

(i) Special occasions (Arms giving, wedding etc.)

(ii) Daily use

(iii) Both of those occasions

3 Different sauce tastes are mentioned below (Under line your choice)

(i) Sweet taste

- High sweet taste
- Low sweet taste
- Medium sweet taste
- Sweet less

(ii) Sour taste

- High sour taste
- Low sour taste
- Medium sour taste
- Sour less

(iii) Spicy taste

- High spicy
- Low spicy
- Medium spicy
- spicy taste less

4 What is your preference about colour

- Natural colour of the used fruit (Without adding colourings)
- Bright colour of that natural colour (By adding colouring)
- A different colour (Adding a different colour)

5. Your preference is

- High thickness
- Low thickness
- Medium thickness

6. Renumber the below characteristics according to your preference

(i) Colour

(ii) Sweet taste

(iii) Sour taste

(iv) Spicy taste

(v) Thickness

Appendix 2

Instructions for sensory evaluation

Following instructions were given to the judges

(1) Ask from judges do not smoke, consume chewing gum, eating and drinking for at least 30 minutes before start testing Because above factors can affect taste feelings of judges

(2) Forget every thing, which you know about the sample preparation and used ingredients Because it can affect to the ranking

(3) Before start tasting and between tasting two samples eat piece of cream cracker biscuit and drink some water Cream cracker biscuit can neutralize mouth from other tastes

(4) Tell to judges if it is difficult to get idea about thickness colour like characteristics from given amount of sample, ask the sample bottles

(5) When panelists participating to the sensory evaluation ask to do not speak with other panelists and do not look at others ballot papers

Appendix 3

Questionnaire Fo: Ranking

Name.

Product

Please rank these samples for preference. Rank the sample you like best as first and sample you like least as ninth. Taste the sample in following order.

156 235 852 123 431 362 675 593 249

First .....

Second .....

Fourth .....

Fifth .....

Sixth .....

Seventh .....

Eight .....

Ninth .....

Comments

HELP

Colour
Sweet taste
Spice taste
Aroma
Thickness

Appendix 4

Calculation of rank sum

Table A.4.1. Preference of the characteristics

Consumers	Colour	Sweet taste	Sour taste	Spicy taste	Thickness
1	3	4	1	5	2
2	5	2	3	1	4
3	2	4	3	5	1
4	5	3	2	1	4
5	2	3	5	4	1
6	5	1	2	4	3
7	5	4	1	2	3
8	1	4	3	5	2
9	1	5	3	4	2
10	4	2	5	3	1
11	4	5	3	1	2
12	2	5	4	1	3
13	1	4	5	2	3
14	1	3	4	5	2
15	3	1	2	5	4
16	1	5	2	3	4
17	2	5	3	1	4
Total	49	60	51	52	45

Appendix 5

Statistical Chart

Rank Totals

Rank totals required for significance at the 5% level (P<=0 05) The four figure blocks represent, lowest insignificant rank sum, any treatment-highest insignificant rank sum, any treatment Lowest insignificant rank sum, predetermined treatment-highest insignificant rank sum predetermined treatment

No of reps.	Number of treatments or samples									
	2	3	4	5	6	7	8	9	10	11
2				3-9	3-11	3-13	4-14	4-16	4-18	5-19
3				4-14	4-17	4-20	4-23	5-25	5-28	5-31
		4-8	4-11	5-13	6-15	6-18	7-20	8-22	8-25	9-27
4		5-11	5-15	6-18	6-22	7-25	7-29	8-32	8-36	8-40
		5-11	6-14	7-17	8-20	9-23	10-26	11-29	13-31	14-34
5		6-14	7-18	8-22	9-26	9-31	10-35	11-39	12-43	12-48
	6-9	7-13	8-17	10-20	11-24	13-27	14-31	15-35	17-78	18-42
6	7-11	8-16	9-21	10-26	11-31	12-36	13-41	14-46	15-51	17-55
	7-11	9-15	11-19	12-24	14-28	16-32	18-36	20-40	21-45	23-49
7	8-13	10-18	11-24	12-30	14-35	15-41	17-46	18-52	19-58	21-63
	8-13	10-18	13-22	15-27	17-32	19-38	22-41	24-46	26-51	28-58
8	9-15	11-21	13-27	15-33	17-39	18-46	20-52	22-58	24-64	25-71
	10-14	12-20	15-25	17-31	20-36	23-41	25-47	28-52	31-57	33-63
9	11-16	13-23	15-30	17-37	19-44	22-50	24-57	26-64	28-71	30-78
	11-16	14-22	17-28	20-34	23-40	26-46	29-52	32-58	35-64	38-70
10	12-18	15-25	17-33	20-40	22-48	25-55	27-63	30-70	32-78	34-86
	12-18	16-24	19-31	23-37	26-44	30-50	33-57	37-63	40-70	44-76
11	13-20	16-28	19-36	22-44	25-52	28-60	31-68	34-76	36-85	39-93
	14-19	18-26	21-34	25-41	29-48	30-55	37-62	41-69	45-76	49-83
12	15-21	18-30	21-39	25-47	28-56	31-65	34-74	38-82	41-91	44-100
	15-21	19-29	24-36	28-44	32-52	37-59	41-67	45-75	50-82	54-90
13	16-23	20-32	24-41	27-51	31-60	35-69	38-79	42-88	45-98	49-107
	17-22	21-31	26-39	31-48	35-56	40-64	45-72	55-80	54-89	59-97
14	17-25	22-34	26-44	30-54	34-64	38-74	42-84	46-94	50-104	54-114
	18-24	23-33	28-42	33-51	38-60	44-68	49-77	54-86	59-95	65-103
15	19-26	23-37	28-47	32-58	37-68	41-79	46-89	50-100	54-111	58-122
	19-26	25-35	30-45	36-54	42-63	47-73	53-82	59-91	64-101	70-110
16	20-28	25-39	30-50	35-61	40-72	45-83	49-95	54-106	59-117	63-129
	21-27	27-37	33-47	39-57	45-67	51-78	57-87	63-97	69-107	75-117
17	22-29	27-41	32-53	38-64	43-76	48-88	53-100	58-112	63-124	68-136
	22-29	28-40	35-50	41-61	48-71	54-82	61-92	67-103	74-113	81-123
18	23-31	29-43	34-56	40-68	46-80	51-93	57-105	62-118	68-130	73-143
	24-30	30-42	37-53	44-64	51-75	58-86	65-97	72-108	79-119	88-130
19	24-33	30-46	37-58	43-71	49-84	55-97	61-110	67-123	73-136	78-150
	25-32	32-44	39-56	47-67	54-79	62-90	69-102	76-114	84-125	91-137

Source Modified from Larmond, 1977

Appendix-6

Calculation of chemical analysis

Total solids

Weight of moisture cane = 22.8619
Weight of the sample = 7.05
Final weight of the moisture can + dried residue = 25.862
Total solids = $\frac{3.001}{7.05} \times 100$
= 42.56%

Determination of acidity

Weight of the sauce = 5.0067
Required NaOH = 17.9 ml
Acidity = $\frac{15 \text{ nv}}{M}$
= $\frac{15 \times 0.1 \times 17.9}{5.0067}$
= 5.3633%

Total soluble solids

Weight of the sauce sample = 20.0014
Weight of the filter papers = 0.4342
After the drying residue + filter paper = 43.5797
Weight of the insoluble solids = 43.5797 - 42.3746 - 0.4342
= 0.7709
Insoluble solids per cent = $\frac{0.7709}{20.0014} \times 100$
= 3.853%
Total soluble solids = total solids - insoluble solids
= 42.56 - 3.853
= 38.707%

Total sugars

Standardization of Fehling's solution and find correction factor
Concentration, in mg/ 100 ml, of anhydrous dextrose in standard dextrose solution = 167.0
Titre in ml, obtain by direct titration = 28.7
Dextrose factor for 28.7 ml of standard dextrose solution = Titre in ml x number of mg of anhydrous dextrose in 1 ml of standard dextrose solution
= 28.7 x 1.67
= 47.929
Dextrose factor for 28.7 ml of standard dextrose solution = 50.00
Correction to be applied to dextrose factor derived from table = 47.929 - 50.00
= - 2.071

Milligrams of anhydrous dextrose present in 1 ml of the prepared solution = m = $\frac{\text{dextrose factor}}{\text{titre}}$
Dextrose factor = 50.57 - 2.071

= 48 499

Required sample solution = 36.7

$$M = \frac{48\,499}{36\,7} = 1\,321$$

Total sugars (as invert), per cent by mass

$$= 200 \times \frac{1\,32}{10,023}$$

= 26.347 %

Appendix – 7

Dextrose table for 10 ml of Fehling's solution

Ml of sugar solution required (1)	Dextrose factor* (2)	Mg dextrose per 100 ml (3)
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	136.4
38	50.5	132.9
39	50.6	129.6
40	50.6	126.5
41	50.7	123.6
42	50.7	120.8
43	50.8	118.1
44	50.8	115.5
45	50.9	113.0
46	50.9	110.6
47	51.0	108.4
48	51.0	106.2
49	51.0	104.1
50	51.1	102.2

*mg of dextrose corresponding to 10 ml of Fehling's solution

Source SLS 581 1982

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