# DEVELOPMENT OF GARCINIA SAUCE

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99/AS/045

A research report submitted in partial fulfillment of
the requirements for the degree of
Bachelor of Sciences
in Food Sciences and Technology
Sabaragamuwa University of Sri Lanka
Buttla
Sri Lanka

2003

*Affectionately Dedicated*
*To*
*My loving Parents*
*And*
*Teachers*

# ACKNOWLEDGEMENT

First and foremost wish to express my deepest gratitude to my internal supervisor Mrs. I. Wikramasinghe lecture, 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 Mr. N. Padmasiri, manager, Negmast Chemical Bay for providing me this opportunity.

I wish to express my sincere thank to Prof. M. Rupasinghe, Head, Department of Natural Resources, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka for his valuable advises. Also I would like to thank Dr.K.K.D.S. Ranaweera, senior lecturer, former Dean of the Faculty of Applied Sciences and Dr. M. Wicrkamaratna, Dean of the Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka.

Tanks also extended to food science laboratory technical staff 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 evaluations.

# ABSTRACT

*Garcinia cambogia* grows in a wide range the of the Sri Lanka and considerable portion of garcinia is wasted during the harvesting season. To prepare a value added product from garcinia here a study was carried out and determined the best ingredients and ingredient levels for the gacinia sauce. Nine sauce varieties were prepared by changing ingredients and ingredient levels. In three occasions consumer ideas were taken for the sauce development. Sensory evaluation was done three times. All sensory evaluations were done with thirty judges.

Total solids, total soluble solids, acidity and total sugars of the sauce sample that was selected as the most preferable sample, were analyzed quantitatively. Microbiological analysis of a fresh sample was carried to detect the safety of the product and the efficiency of heat treatment.

Garcinia sauce with high level of pumpkin, low level of spices, low level of corn flour and Brix value of 39 was selected as the best sample. When microbial colony count was done no detectable colonies seen on plates. For the completion of the sauce recipe development, further studies should be done on the shelf life of the sauce and on stabilisers.

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# CHAPTER I

# INTRODUCTION

Garcinia tree is an exotic tree growing all over the wet zone of the country. Garcinia is named as Goraka and Kodakkapuli in Sinhala and Tamil respectively. In Sri Lanka garcinia tree does not cultivate as a crop and mostly it grows as a wild plant. India is the only country in which garcinia cultivate as a crop. Garcinia tree is popular in Sri Lanka where the fruit is used as a condiment for flavouring curries in place of tamarind or lime.

In Sri Lanka garcinia tree is largely found in Western, Southern and Sabaragamuwa provinces. Garcinia can be harvested in June, July and August months. In garcinia season, a considerable portion of harvest is being wasted due to difficulties in harvesting, post harvest handling, low price, poor market, fungal attacks in stores and lack of developed products.

If preserved properly to develop new food products with scientific methods, garcinia can be more useful in day today use. For instance garcinia paste, powder and drinks are already available in Sri Lanka as well as in other countries. Garcinia pulp is suitable for sauce preparation. Roux sauces, starch thickened sauces, egg based sauces, meat, poultry, and vegetable gravies are the main sauce categories (Foote *et.al*, 1993). These days sauces are made in less traditional ways to satisfy consumer needs. For example Barbecue is one of the most popular types of sauce in America. Likewise Barbecue a sauce, which can be prepared using garcinia pulp, may different from traditional sauces.

Garcinia pulp contains good quality pectin. When sugar, acid, salt and water are present pectin can form a jelly. That jell can retain the liquid and give a good consistency to the sauce. Garcinia pulp has several medicinal values and is an extra benefit, that can be obtained from garcinia sauce. Ripen fruit pulp of garcinia is fairly rich in free sugar constitutes such as D-glucose, D-mannose and D-arabinose. It also contains tartaric, citric, oxalic and succinic acids .Those are the nutritional benefits which can be gained from garcinia sauce. Garcinia has its own 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 meat consumer desires for new flavours and aromas.

**Objectives**

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

# CHAPTER II
# LITERATURE REVIEW

## 2.1 Garcinia

*Garcinia cambogia* is a ever green dioeciously tall growing tree with rounded crown and horizontal or drooping branches; leaves dark green and shining, elliptic or obovate,2-5 inches long and 1-3 inches broad. The tree grows up to height of 30-50 ft.

### 2.1.1 Origin and Distribution

Garcinia is native to tropical Asia and now it is found in tropical Australia too.

### 2.1.2 Climatic Requirements

The tree is well adapted to wet regions with well drained soil.

### 2.1.3 Harvesting

The tree flowers from February to April and fruit ripens during June –July. Fruits are picked at both ripe and unripe stages. The unripe fruits are picked by using a picking pole. The well ripen fruits are blown off and are picked up.

### 2.1.4 Fruit

The fruits are ovoid or spherical in shape and may vary in size weighing 50-180g and the fruit rind is grooved in to 7-10 segments. Green colour immature fruits turn to yellow or red when ripe. The fruit is a source of hydroxy citric acid, amount varying from 20-30% per berry.

**Table 2.1.1 Composition of the fruit**

| Composition | Percentage |
|---|---|
| Moisture | 71 |
| Proteins | 0.5 |
| Fat and oils | 0.1 |
| Tartaric acids | 10.6 |
| Total sugars | 15 |

Sauce: modified from Perera and Padma, 1986. Tables for Food Composition.

### 2.1.5 Medicinal Value of the Fruit

The fruit is rich in acids and possesses marked antiseptic properties. It is used as an appetite suppressant to inhibit the absorption and synthesis of fat, cholesterol and triglycerides. In other words, it is a dietary aid.

### 2.1.6 Food Products from Garcinia

Several food products have been developed from Garcinia in these days.

#### (a)Garcinia Extract

Garcinia cambogia extract is the calcium salt of hydroxyl citric acid, which is obtained from water extract of garcinia fruit. It is tasteless, odourless powder and found to be very effective herbal medicine for controlling obesity and cholesterol by inhibiting lipogenesis in the body. It is a well established fat burning agent all over the world (Lowenstein, 1971).

#### (b)Garcinia Powder

Drum dried garcinia powder has been produced in Sri Lanka. Although it is not available in the market, It is found to be used in culinary preparations.

#### (c)Garcinia Paste

Dried garcinia rind is ground with water to make a paste. It is used to flavour curries especially the fish curries.

#### (d)Dried Garcinia Rind

Dried garcinia rind is the widely available form of garcinia in the 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 now have a much more important part to play as they are used to complement the flavour, texture and appearance of foods. A sauce should never over power the dish it accompanies but bring harmony and balance(Foote *et.al.*,1996).

Sauces are generally of two types, thick sauce and thin sauce. Thick sauce consists of suspension of very finely divided fruit and vegetable particles in a thickened

spiced, acid syrup. It should contain at least 3% of acetic acid, So that it has good keeping quality. The acidity should not exceed 3.4%, otherwise the sauce would taste sharp. The sugar content may vary from 15% - 30% according to the kind of sauce made. The refractometric solids of the finished product are normally of the order of 35 – 40% (Srivastava and Kumar,1994).

Thin sauces are, in effect, hot highly spiced and flavoured vinegars or vinegar/acid liquors with no added stabilizer or insoluble particles (Srivastava and Kumar, 1994).

### 2.2.1 Sauce preparation techniques

Sauces are prepared from fruit or vegetable pulp or juice that is made following washing, sorting, grading and pulp or juice extraction. After pulp or juice extraction, pulp or juice is sieved to give smooth consistency to the final product. Sauces are prepared by cooking fruit pulp or juice with other ingredients.

High quality sauces are prepared by maceration of spices, herbs, fruits and vegetables 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 fruits separately and blends them suitably.

Some sauces develop a characteristic flavour and aroma on storing in wooden barrels. Freshly prepared products often have a raw and harsh taste and therefore should be matured by storing for certain period. Some times a filing material is added to avoid this harsh taste. Filling material may be fruits like dates, plumps or vegetables like pumpkin, ash pumpkin etc.

Sauce usually thickens slightly on cooking. Thickening agents are also added to the sauce to prevent sedimentation of solid particles. Gum tragacanth , modified starch, or corn flour is used as thickening agents (Gupta *et.al*,1969 ).

Hot filling of cooked sauce is done leaving a 2 cm of headspace at the top of the bottle and bottles are sealed or cooked at once. The neck of the bottles, when cold; is dipped in paraffin wax for air tight sealing. It is advisable to pasteurize sauce after bottling since there is always a danger for fermentation. For this purpose bottles are kept in boiling water for about 30 minutes (Srivastava and Kumar, 1994).

### 2.2.2Commonly Used Ingredients in Sauce

#### Sweetening agents

Sweetness is derived from fruits like date, sultanas, and apple and partly from sugar. The most widely used sweetener is the sugar. Sugar also important for the colour, appearance, moisture and buffering power(Gupta *et.al*,1969 ).

#### Salt

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

#### Vinegar(acetic acid)

This act as a preservative and spices extracting agent. Its preservative action is mainly due to the undissociated acetic acid molecules.

#### Spices

Spices and herbs give pleasant odour and flavor to sauces. e.g. Garlic.

### 2.2.3 Problems in the Preparation of Sauce

Sauces may deteriorate or get spoiled due to various reasons. Some of these are mentioned below .

Deterioration due to metallic contamination:

Trace metal, particularly copper , accelerate oxidative rancidity in various products . Traces of Zink result in sulphide blackening of vegetable , by reacting and tannins derived from ingredients . e.g. certain whole or ground spices especially cloves (Gupta *et.al.*,1969).

Growth of yeast, moulds or bacteria:

Because of their low pH correctly formulated sauces have no risk of microbiological food poisoning. The problem of microbiological spoilage in unpasteurised packs is mainly one of microorganisms capable of tolerating acetic acid . Apart from pasteurization and preservatives the only real safeguard against this type of

spoilage is, strict hygiene spoilage by a wide range of microorganisms may occur at intermediate stages of handling and processing due to incorporation of some ingredients which may spoil the finished product .

Deterioration due to enzymes:

Enzymes naturally present in vegetable , and elaborated by microorganisms are responsible for reactions causing various forms of deterioration such as darkening and flavour deterioration.

Deterioration through oxidative reactions:

Browning of sauces is taken place due to oxidative reaction .

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.

Contamination with foreign matter:

To avoid this defect the raw materials should be properly inspected and decontaminated. Containers should be inspected and during processing care should be taken to prevent contamination. Before filling product should be properly tested.

Gelling of the product:

Sauces may separate with a layer of clear liquid at the top. Gelling may result from the use of an unsuitable thickener, or from incorrect processing or both. Decreasing viscosity on storage may result from the gradual acid hydrolysis of some types of thickeners.

Deterioration due to unsatisfactory packaging:

Imperfect sealing of closures, or defect closures, or incorrect capping machine adjustment, or the trapping of the particles between the glass and the closure may lead to spoilage.

Deterioration due to poor storage conditions:

Higher temperature of store reduce shelf life of the product due to faster deterioration rate. Displacing in shop windows where direct sun light is falling on the

container is particularly dangerous as colour fading and oxidative deterioration is accelerated.

### 2.3 Microbiological Analysis of Foods

Different types of microorganisms are growing in foods. They may be bacteria, yeast or moulds. Microorganisms of interest in analytical food microbiology can be subdivided in to indicators, pathogens and spoilage organisms.

The indicator microorganisms such as *E.coli* , coliforms and faecal streptococci are supposed to indicate unhygienic handling of foods including possible presence of certain pathogens. They are widely used in the microbiological quality of foods and water.

The pathogenic microorganisms are those organisms that cause food-borne infections or intoxications as for example *Salmonella* species, *Clostridium botulinum* and *Staphylococcus aureus*.

The spoilage microorganisms include bacteria, yeasts and mould that cause undesirable changes of the appearance, odour, texture, taste or smell of food.

Indicator organisms are bacterial groups whose presence in foods, above certain numerical limits, is considered to indicate exposure to conditions that might introduce hazardous organisms and/ or allow proliferation of pathogenic or toxinogenic species. They have value in assessing both the microbiological quality and safety of foods.

#### 2.3.1 Aerobic Plate count

The aerobic mesophilic bacteria plate count is one of the most useful indicators of the microbiological status of a food. A high viable count often indicates contaminated raw materials, unsatisfactory sanitation, unsuitable time or temperature / time combination during production or storage, or a combination of these.

This method is based on the assumption that the microbial cells present in a sample mixed with an agar medium each form visible, separated colonies. This obtained by mixing decimal dilutions of the food sample homogenate with the medium. After incubation of he plates at $30^{0}$c for 72 hours the number of mesophilic aerobic bacteria per gram of food sample is calculated from the number of colonies obtained in selected petri dishes at levels of dilutions giving a significant results (Rfai, 1979).

## 2.4 Sensory Evaluation of Foods

### 2.4.1 Definition

Sensory analysis is the identification, scientific measurement, analysis and interpretation of the properties(attributes) of a product as they are perceived through the five senses of sight, smell, touch and hearing. (Roland *et.al*, 1999).

### 2.4.2 Types of tests .

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

**(a)Discrimination or difference tests**

In discrimination or difference testing, assessors compare two more product indicating whether any difference is perceived.

**Types of discrimination Tests:**

(i) Paired comparison (difference ) test

(ii) Duo-trio test.

(iii) Difference from control tests

(iv) Triangle test

(v) Two-out- of- five test

(vi) Ranking test

**(b) Descriptive tests**

In sensory descriptive testing, the assessors develop descriptors for the sensory characteristics of a product and then use these descriptor to quantify difference between products.

Types of Descriptive tests:

(i) Consensus profiling.

(ii) Descriptive profiling.

(iii) Free- choice profiling.

**(C)Acceptance tests**

Acceptance tests are used to evaluate product acceptability or liking or to determine which of a series of product is the most acceptable or the most preferred.

Types of acceptance tests:

(i) Hedonic rating.

(ii) Paired comparison (Preference) test.

(iii) Repeat paired comparison (Preference) tests.

(iv) Multi- sample ranking for preference.

**2.4.3 Ranking**

**2.4.3.1 Definition**

Test in which a series of three or more sample 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.

**2.4.3.2.Application**

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

(a) as a screening test, to aid 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)

## 2.5 New Food Product Development

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

### 2.5.1 Necessity of Going 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. They enter the market place, for an indeterminate time, then die and must be replaced.
- A company's management may adopt a policy that requires an aggressive growth program to satisfy long-rang 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).

### 2.5.2 Phases In New Food Products Development

Most authors divide new food product development in to several distinct phases. Very few agree on the number, the order, or with the name of the phases (figure 2.1).

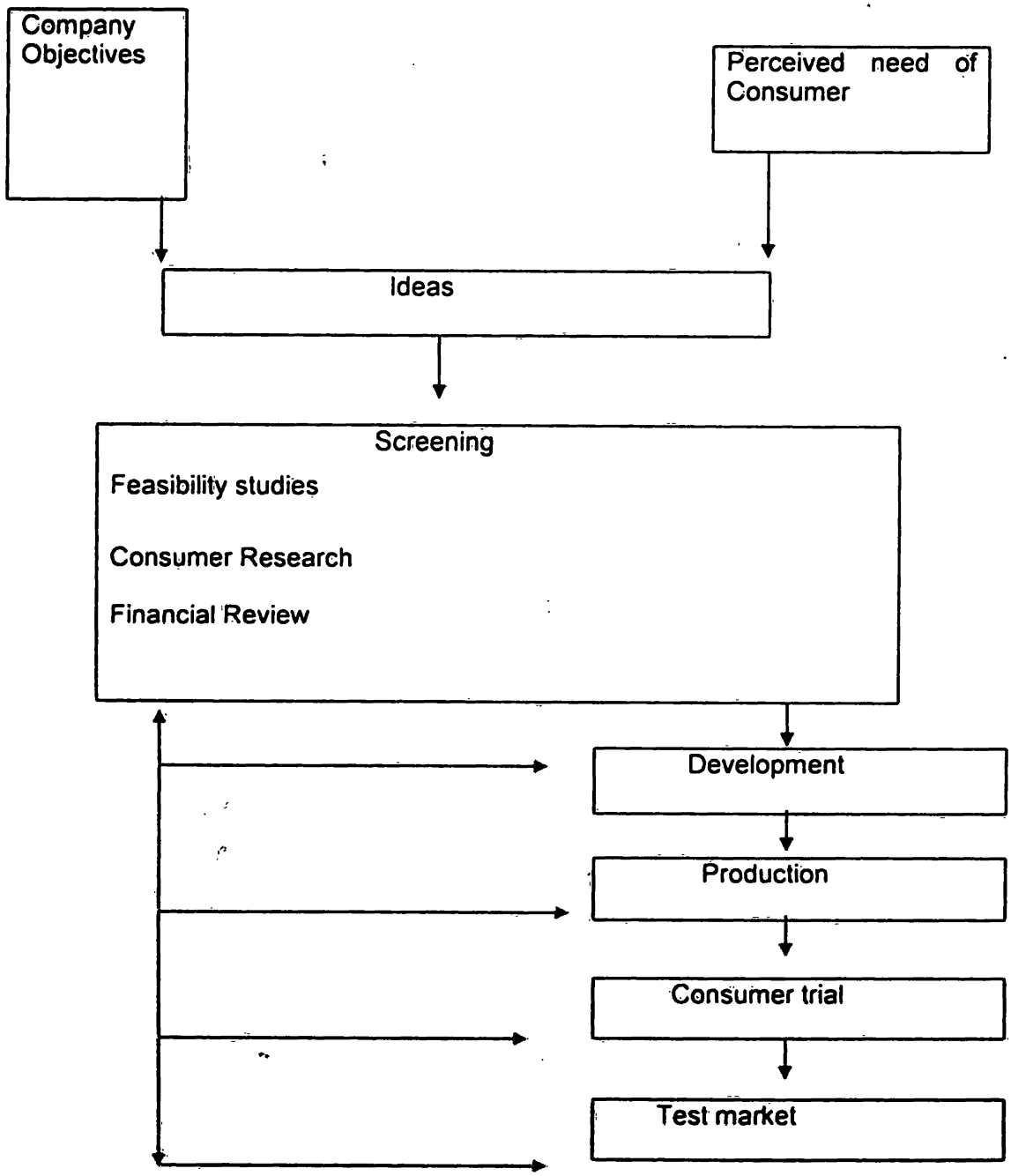


**Figure 2.1 Phases In New Food Product Development**

**Source: Modified from Fuller, 1994**

# CHAPTER III

# MATERIALS AND METHODS

## 3.1 Materials

### 3.1.1 Sauce Preparation

**Raw materials**

Ginger , garlic ,cinnamon, chili , powder ,cardamom , pepper and onion , which were purchased from the market

Commercially available powdered salt

Pumpkin available at the market

**Chemical agents**

Sodium benzoate

**Equipments**

Electronic balance

Measuring cylinder

Sterilized ready to serve( RTS) bottles and lids

Beakers and Petri dishes

Stainless steal saucepan

Gas cooker

Bottle sealer

Hand refractometer

### 3.1.2 Sensory Evaluation

Question paper, which was prepared according to Larmand, 1997

Yoghurt spoons

white porcelain plates

Cream cracker biscuits.

water glasses

panelists who were selected from the faculty

### 3.1.3 Chemical Analysis

#### 3.1.3.1 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

**3.1.3.3 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 (CuSo4. 5H2o)

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

**3.1.4 Aerobic Plate Count**

Petri dishes

Pipettes

Water bath,

Incubater

Colony counter

Peptone water

Agar

### 3.1.5 Enumeration of yeasts and moulds

Petri dishes

Pipettes

Water bath

Incubator

Colony counter

Peptone water

Potato dextrose agar

## 3.2 Methods

### 3.2.1 Sauce Preparation Method

Garcinia fruits were cut in to slices and seeds were removed. Slices were blanched immediately by dipping in hot water at $80^{0}$c for five minutes. Slices were crushed with water in 1:4 ratio by weight to extract garcinia pulp.

Extracted garcinia pulp was weighed and as a percentage of that weight other ingredients were added. Sugar and salt were mixed with garcinia pulp and was heated while stirring. Spices were grounded using a grinding stone by adding little volume of vinegar. When garcinia pulp was reached about $Brix^{0}$ 35, the grounded spices were suspended in a cloth bag and dipped in to the boiling garcinia pulp. Then sodium benzoate was added and when mixture reached to a $Brix^{0}$ value of 38, heating was stopped. Then heated sauce was filled in to sauce bottles and bottles were sealed. Bottle sterilization was done by keeping the bottles in 80 $^{0}$C hot water for 30 minutes.

### 3.2.2 Ingredient Combination Method

For the purpose of selecting the best level of filler (pumpkin) three sauce samples were prepared by changing the percentage of pumpkin, as in following table and sensory evaluation ($1^{st}$ sensory evaluation) was done to select the best level of filler.

**Table 3.1: Levels of pumpkin**

| Other ingredients | 20% pumpkin + Garcinia pulp | 10% pumpkin + Garcinia pulp | Pure Garcinia pulp |
|---|---|---|---|
| 0.5% Corn flour<br>0.5% Spices | B | A | C |

Sauce sample with 20% pumpkin (sample B) was selected by the panelists in the sensory evaluation.

To select the best levels of spice content three sauce samples were prepared with 20% pumpkin ( best level of filler). Then changed the spice content as in the following table and the sensory evaluation (2nd sensory evaluation) was done.

**Table 3.2: Levels of spices**

| Other ingredients | 0.5% spices | 1% spices | 2% spices |
|---|---|---|---|
| 20% pumpkin<br>0.5% spices<br>— | D | E | F |

Sauce sample with 1% spice content (E) was screened by panelists as the best sample.

To select the best level of thickener three sauce samples were prepared with 20% pumpkin and 1% spices. Then changed the corn flour content as in the following table and sensory evaluation (3rd sensory evaluation) was done.

Table 3.2.3: Levels of corn flour

| Other ingredients | 0.5% corn flour | 1% corn flour | 2% corn flour |
|---|---|---|---|
| 20% pumpkin<br>0.5% spices | G | H | K |

### 3.2.3. Method of Sensory Evaluation

Each panelist was separated by using a cardboard. Sauce samples were provided for each panelist in porcelain plates. Each panelist was guided with the aim of the sensory evaluation and with the basic things involve in the sensory evaluation (Appendix 1). Yogurt spoons were provided with each sample. Fifty panelists were participated for 1$^{st}$ and 2$^{nd}$ sensory evaluations. Thirty and twenty panelists were participated for 3$^{rd}$ and 4$^{th}$ sensory evaluations respectively. Ballot papers of the sensory evaluation were prepared (Appendix 2) and sensory evaluation data was analyzed using Kruskal-Wallis test.

### 3.2.4 Method of Chemical Analysis

Sample which was selected as the best sample from the sensory evaluation, was subjected to the following chemical analysis.

#### 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 105$^{0}$c in an oven and weighing was done at two hour intervals and final weight was taken when it comes to a constant level.

Calculation

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

### 3.2.4.2 Method of Total Soluble Solid Determination

First insoluble solids were determined. A sample of 20. 0011g 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 certain period of time remaining insoluble matter was transferred through filter papers and was dried in a covered dish for two hours at 105$^0$c. Weight of dry matter was taken.

**Calculation**

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

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 It 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**

$$\text{Acidity[ as tartaric acid] present by mass} = \frac{15nv}{m}$$

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 Sugar Determination

Standard dextrose solution , Methylene blue indicator, Fehling'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 solutions was done according to the above method (Appendix 3).

**Calculation**

$$\text{[Milligrams of Anhydrous dextrose present in one milliliter if the prepared solution]} = \frac{\text{Dextrose factor}}{\text{Titre}}$$

$$\text{Total sugars( as invert) present by mass} = \frac{200 \times m}{m1}$$

Where,

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

m1=mass in g, of the prepared sample used for making 250 ml of solution.

### 3.2.5 Method of Aerobic Plate Count

One millilitre of prepared sauce was mixed with 9 ml of the peptone water.1 ml of that dilution was passed in to a tube containing 9 ml of the peptone water. From that dilution, 1 ml was transferred into the tube containing 9 ml of peptone water. All dilutions were shaken well.

1 ml of the sauce and each dilution of the sauce was pipetted into each appropriately marked duplicate dishes. 15 ml of the agar was poured in to each Petri dish. Prepared dishes were incubated at 30°c for 72 hours.

**Calculation**

$$\text{Bacterial count per g or ml} = \frac{\text{number of colonies}}{} \times (\text{dilution factor})^2$$

### 3.2.6 Method of Enumeration of Yeast and Moulds

Dilutions of sauce samples were prepared as in aerobic plant count. 1 ml of each dilution was pipetted in to each approximately marked duplicate petri dishes.15 ml of melted PDA was poured in to each petri dish. Plates were inverted and incubated at $30^0$c for five days.

### Calculation

| | |
|---|---|
| Yeast or mould Count per g or ml | = number of x (dilution factor) $^2$ colonies |

# CHAPTER IV
# RESULTS AND DISCUSSION

## 4.1 Results of the sauce preparation

**Table 4.I .1: Brix$^0$ values of the garcinia pulp and the prepared sauce**

| Sauce variety | Brix$^0$ value of extracted pulp | Brix$^0$ value of prepared sauce |
|---|---|---|
| A | 10 | 38 |
| B | 10 | 39 |
| C | 10 | 37 |
| D | 9 | 38 |
| E | 9 | 38 |
| F | 9 | 37 |
| G | 11 | 37 |
| H | 11 | 38 |
| K | 11 | 39 |

Final Brix$^0$ value of sauce varies within the range of 37 to 39. Objective was to get the final Brix$^0$ around 40$^0$. Since garcinia pulp was prepared in three times three different initial Brix$^0$ values were obtained. Although the same ratio of garcinia fruit and water was used in the preparation of pulp, Brix$^0$ values of prepared pulps was different.

## 4.2 Results of Sensory Evaluation

### 4.2.1 1$^{st}$ Sensory Evaluation

When data were analyzed with Kruskal-Wallis test, P value of the test was 0.000. It is les than 0.05. Therefore $H_0$ was rejected at 5% significance level(Appendix 5).So there was a significance difference between samples.

Where,

$H_0$ : There is no difference between samples.

$H_1$ : There is a difference between samples.

Z values of A,B,C, treatments were – 4.69, - 1.95, 6.65 respectively. Sample B got the least Z value. Therefore it was selected as the most preferable sample. This means sauce sample with added 20% pumpkin, was selected as the preferable level of pumpkin.

### 4.2.2 2nd Sensory Evaluation

When data was analyzed with Kruskal-Wallis test, P value of the test was 0.000.It is less than 0.05. Therefore $H_0$ was rejected at 5% level of significance (Appendix 6).
Z values of C,D,E treatments, were – 1.03, -5.39, -6.42 respectively. Sample E got the least Z value. Therefore it was selected as the most preferable sample. This means sauce sample with 1% spice content was selected as the preferable level of spices.

### 4.2.3 3rd Sensory Evaluation

When data was analyzed with Kruskal-Wallis test. P value of the test was 0.000. It is less than 0.05. Therefore $H_0$ was rejected at 5% level of significance(Appendix 7). We accepted $H_1$. So there was a significance difference between samples.
Z values of G,H,K treatments were 0.77, -3.85, -3.08 respectively. Sample H got the least Z value. Therefore it was selected as the most preferable sample. This means sauce sample with 1% corn flour content was selected as the preferable level of thickener.

## 4.3 Results of Chemical Analysis

**Table 4.3.1: Characteristics of sauce that got the lowest average rank**

| Characteristics | Results (percent by mass) |
|---|---|
| Total solids | 42.59 |
| Acidity as tartaric acid | 5.45 |
| Total soluble solids | 38.04 |
| Total sugars (as invert sugar) | 26 |

(For the calculations refer appendix 3)

Garcinia sauce is not available in Sri Lankan market. So there are no SLS standards for garcinia sauce. Comparison of the above results with SLS requirements for chili sauce as follows.

**Table 4.3.2: Comparison of garcinia sauce with chili sauce requirements**

| Characteristic | Requirement for chili sauce(as percent by mass) | Garcinia sauce (as percent by mass) |
|---|---|---|
| Total solids | 25 min | 42. |
| Total soluble solids | 20 min | 38 |
| Acid | 1.2 min (as acetic acid) | 5 |
| Total sugars(as invert sugar) | 10 min | 26 |

**4.4 Results of Microbiological Analysis**

Aerobic plate count = less than $1x10^1$ / g

Yeast and mould count = less than $1x10^1$ / g

# CHAPTER V
# CONCLUSION

Garcinia sauce with high level of pumpkin, low level of spices, low level of corn flour and Brix$^0$ value of 39 got the lowest average rank and lowest Z value. Therefore it was selected as the best sample. Ingredient combination levels of this sauce is, pumpkin 20%, sugar 30%, sat 1.5%, ginger 0.5%, chili 0.5%, cinnamon 0.25%, pepper 0.25%,and cardamom 0.05%.

When microbiological analysis was done to a freshly prepared sauce sample, no detectable microbial colonies are seen on plates. Absence of microbial colonies indicates either absence of microbial cells or unfavourable growth conditions or inability of cells to grow due to weakness of cells. Therefore can conclude that, the heat treatment provided for the product is sufficient.

**Further studies and recommendation**

Here I studied only about the ingredient combination and the levels of ingredients in sauce recipe. Following studies can be recommended further.

- Study on the shelf life of the sauce
- Study on the best stabilizer and the level of it
- Study on garcinia pulp extracting methods and conditions

REFERENCES

Foote, Roland, Coulthard, Philip, Groves, Tony, Kenyon, Bob, Klasen, David Rbone, Pam, Stevenson, Danny, Tolon, Harry and Ware, Malcom (Ed), (1992) Catering and Hospitality, Stanley Thornes Ltd, Cheltenham. pp. 176 – 198.

Fuller, Gordon W. 1994. New Food Product Development from Concept to Marketplace, C.R.C. press, London. pp.236.

Gupta, R.K.(1969) Hand Book of Export Oriented Food Processing Projects. C.I.S.R. New Delhi, pp. 332 – 336.

Jayasinghe, S.D(1998). Value Addition in Green Chili, B.Sc.thesis, Sabaragamuwa University of Sri Lanka.

Kumar,N. (1989).Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, Sunil Printers, New Delhi, pp.4.21.

Larmond, E. (1977). Laboratory Methods for Sensory Evaluation of Foods, Canada, Department of Agriculture, Ottawa.

Lowenstine, J.(1971). The Journal of Biological Chemistry, pp.246, 629, 632.

Perara, W.D.A., Padma, M.(1986).Tables of Food Composition for Use in Sri Lanka.UNISEF, pp. 32.

Refai, M.K.(1979). Microbiological Analysis, FAO, pp.D-1, D -32, D -33.

S.L.S. 581: 1982. Methods of Chemical Analysis of Foods.Sri Lanka Standards Institution, Colombo.

S.L.S. 931: 1991. Methodology of Sensory Analysis of Foods General Guidance, Sri Lanka Standards Institution, Colombo.

# Appendix 1

**Instructions for sensory evaluation**

Following instructions were given to the judges.

(1) Do not smoke,do not consume chewing gum. Stop eating and drinking at least 30 minutes before testing. Because above factors can affect your taste feelings.

(2) Forget every thing, that 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) If it is difficult to get idea about thickness, colour like characteristics from given amount of sample, ask more from the sample bottles.

(5) Do not speak with other panelists. Do not look at others ballot papers.

# Appendix 2

## Questionnaire for Ranking

Product :

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

| | 236 | 421 | 342 |
|---|---|---|---|
| First | ..... | ..... | ..... |
| Second | ..... | ..... | ..... |
| Third | ..... | ..... | ..... |

Comments:

Help

Colour:
Sweet taste:
Spice taste:
Aroma:
Thickness:

# Appendix 3

**Calculation of Chemical Analysis**

Total solids

Weight of the moisture cane = 19

Weight of the sample = 8.26

Final weight of the moisture cane +dried residue = 22.51

Total solids $= \frac{3.51}{8.26} \times 100$

$= 42.49\ \%$

Acidity

Weight of the sauce = 5.0019

Required NAOH = 18.2 ml

Acidity $= \frac{15\ nv}{M}$

$= \frac{15 \times 0.1 \times 18.2}{5.0019}$

$= 5.4501\ \%$

Total soluble solids

Weight of the sauce sample = 20.0029

Weight of the filter papers = 0.9127

After the drying residue + filter paper = 44.9398

Weight of the insoluble solids = 44.9398 – 43.1561 – 0.9127

= 0.871

Insoluble solid percent $= \frac{0.871}{20.0029} \times 100$

$= 4.35\ \%$

Total soluble solids = total solids – insoluble solids

= 42.49 – 4.45

= 38.04 %

Total sugars

Standardization of Fehling's solution and find correction factor

Concentration in mg/ 100 ml, of anhydrous dextrose = 167
in standard dextrose solution

Titre in ml, obtained by direct titration = 29.1

Dextrose factor for 29.1 ml of standard dextrose solution = 29.1 x 1.67

= 48.59

Dextrose factor for 29.1 ml of standard dextrose solution= 50.00

Correction to be applied to dextrose factor derived from table= 48.59 – 50.00

= - 1.41

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

Dextrose factor = 50 – 1.41

= 48.59

Required sample solution = 35.5

M = $\frac{48.59}{36.5}$

= 1.331

Total sugars (as invert), percent by mass = 200 x $\frac{1.331}{10.01}$

= 26.59 %

# Appendix 4

Invert Sugar Table

| Ml of sugar solution required | Dextrose factor | Mg of dextrose per 100 ml |
|---|---|---|
| 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: S.L.S. 581:1982

# Appendix 5

Kruskal-Wallis Test

Kruskal- Wallis Test on Response

| Factor | N | Median | Ave.rank | Z |
|---|---|---|---|---|
| A | 30 | 2.000 | 68.5 | -1.95 |
| B | 30 | 1.000 | 54.5 | -4.69 |
| C | 30 | 3.000 | 112.5 | 6.65 |
| Overall | 90 | | 78.5 | |

| | | |
|---|---|---|
| H = 46.68 | DF = 2 | P = 0.000 |
| H = 52.51 | DF = 2 | P = 0.000 |

# Appendix 6

Kruskal – Wallis Test

Kruskal – Wallis Test on response

| Factor | N | Median | Ave. rank | Z |
|---|---|---|---|---|
| C | 30 | 2.000 | 41.5 | -1.03 |
| D | 30 | 1.000 | 24.5 | -5.39 |
| E | 30 | 3.000 | 70.5 | 6.42 |
| Overall | 90 | | 45.5 | |

H = 47.56 DF = 2 P = 0.000

H = 53.50 DF = 2 P = 0.000

# Appendix 7

Kruskal-Wallis Test

Kruskal-Wallis Test on response

| Factor | N | Median | Ave.rank | Z |
|---|---|---|---|---|
| G | 30 | 2.000 | 48.5 | 0.77 |
| H | 30 | 1.000 | 30.5 | -3.85 |
| K | 30 | 3.000 | 57.5 | -3.08 |
| Overall | 90 | | 45.5 | |

H = 16.62 DF=2 P=0.000

H = 18.69 DF=2 P=0.000