Development of natural Nelli cordial

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Declaration

I carried out the work described in this thesis at the KelaniVelli Cannaries Ltd, and the Faculty of Applied Sciences, under the supervision of Mrs. Indira Wickramasinghe and Mr. T D. Samarakoon.
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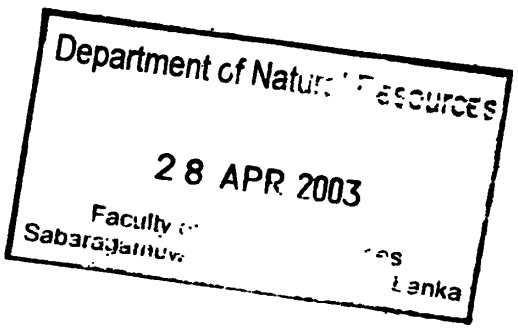

DEDICATION

LOVINGLY DEDICATED

TO MY FAMILY MEMBERS

AND ALL OF MY TEACHERS

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Abstract

Nelli (*Phyllanthus emblica*) is one of the important species in the patana land in Sri Lanka. It is a edible fruit with a therapeutic value, which is commonly used in indigenous medicine.

But most of these ripe fruits are wasted during the season without much use. Thus processing of the fruit is beneficial, which will minimize the wastage. On the other hand , the production of fruit juice in Sri Lanka is very limited. Therefore Nelli has a very good potential for that purpose due to its indigenous medicinal value.

This study was conducted to develop a fruit cordial from Nelli fruits. The juice was extracted with different extraction time (8,16,24 hrs with 1: 1) ratio of water and pH, Brix and titrable acidity were determined. Three cordials (about 1% acidity and 52 ^{0} Brix) were formulated, and they were analyzed chemically. (pH, Acidity, Brix) and organoleptically. There after the analysis was carried out once a week, while analysis was done in one month storage at room temperature. Additionally Vitamin C content was analyzed of all three samples.

All three formulated cordials were chemically, organoleptically and microbiologically acceptable up to one month storage period. Cordial with 24 hrs extraction time is the most Acceptable beverage in terms of sensory attributes.

Development of fruit cordial from Nelli fruit, not only will minimize the wastage and but also will provide nutritional and medicinal benefits of the people.

Contents

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Abbreviations

Et al ; And others

Hrs ;Hours

TSS ; Total soluble solids

CMC ;Caboxymethylcellulose

SMS ;Sodium metabisulphite

RTS ;Ready to serve drinks

App. ;Appendix

CHAPTER 01

INTRODUCTION WITH OBJECTIVES

1.0 Introduction

Fruits and vegetables are among the most important food of mankind as they are not only nutritive but also indispensable for maintenance of health. In the world of soft drink market fruit juices have an important place. They are rich in essential minerals, vitamins and other nutrients, which in turn make them popular. Now people are looking about natural food products and there is a good possibility to substitute the real fruit juices for synthetic, artificial flavoured beverages. That would be a boon to the consumer as well as the fruit grower.

In Sri Lanka the production of fruit is limited mostly to small scale production and the fruits generally grown are mango, papaya, pineapple, orange and passion fruit. Fruits such as Nelli and Anoda, which are generally classified as under exploited fruits are not subjected to the fruit juice production though they have very good potential for that purpose. Among other fruits Nelli has a very good potential due to its indigenous medicinal value.

It (*Phyllanthus emblica*) is an important arid zone fruit crop and it has acquired valuable therapeutic role from times immemorial. A decoction of the fruits with steam of *Tinospora cordifolia* (veniwall) is a well-known remedy for various urinary diseases. As a tropical tree it can be grown in Sri Lanka in most places on patana lands. Pest and disease problems are not very common with Nelli. This fruit is a rich source of ascorbic acid. Content has been reported about 300-1000 mg /100 g by a number of workers. (Kalra,1988).The fruit also contains tannins and many Polyphenolic substances.

Nelli is a rare example of an edible material, which is rich in tannin as well as ascorbic acid. (Kalra- 1988) . Fruits are mainly used in the form of murabbas, dried amla, triphala and chayvan prasha etc.... in India. In our country, using of Nelli in industries is very limited. Nelli are use in the decoction and preparation of thripala in indigenous medicine. The major problems faced by the industries are that the fruits are available only for a short period (October to January) and also good quality of the same in adequate quantity

is not available.Sufficient amount of fruit juice beverages are not available in our local market and to fill this gap Nelli juice can be used. Nelli being known by most our people that as a medicinal fruit have so many advantage.

1.1 Objectives

1. To develop a better extraction method with potable Organoleptic properties and minimum loss of vitamin c

2. Reduce enzymatic browning and non-enzymatic browning.

3. Removal of the bitterness and astringency in the cordial.

4. Sensory evaluation to select the best product.

5. Analyses the vitamin C content of final product

CHAPTER 02

LITERATURE REVIEW

2.0 Classification

Family	:Euphobiaceae
Botanical names	:*Phyllanthus emblica . L*
	:*Emblica officinalis*

2.1 Vernacular Names

Sinhala-Ambulu, Awusada Nelli, Nellica,; Tamil-Amalagam, Nellikkai; Hindi- Amla, Aonala ; English- Emblic myrobalan tree, Indian goosbery, Anola.

2.2 Varieties in Sri Lanka

Phyllanthus reticulates

2.3 Origin and Distribution

Nelli (*Emblic myrobalan*) is indigenous to a large area ranging from the southern Himalayas of Nepal and northern India to the south of the Indian subcontinent, Sri Lanka Burma, Thailand and Indo-china to southern china and Malaysia (Lemmens et al 1991).In Sri Lanka it is very common in exposed places on patina land in the moist regions up to 1300-m altitude.

2.4 Description

plant; A small or middle sized tree about 10 m high, with a crooked trunk and spreading branches, bark thin, gray with numerous bosses whence arise the leaf – bearing branch lets young parts pubescent.

Leaves; Simple, alternate_very numerous, closely placed distichously, overlapping spreading, nearly_sessile, about 1.2cm long, linear strap-shaped, rounded at base, sub acute, glabrous paler beneath.

Flowers; unisexual , small ,greenish yellow, monoecious, apetalous and auxiliary; male flowers very small, numerous on slender pedicels in auxiliary fascicles; female flowers few nearly sessile; flowers during October.

Fruit; Globose, 1.2-1.6 cm diameter, fleshy, pale green or yellow of 3 sub dehiscent, 2 seeded, crustaceous cocci enclosed in a thin fleshy coat; seed 6 trigonous (Jayaweera,1980).

Seeds ; Nelli stones, which are tightly, embedded in the flesh are hexagonal and contain six small seeds. It is reported that seeds cotain a fixed oil, Phosphatides and small quantity of essential oil with a characteristic odour.(kalara,1988).

2.5 Uses of plant parts

Immature fruits are used for tannin in India and Thailand. The fruits are used to prepare black ink and hair dye. The astringent and sour ripe fruits are edible. They are rarely eaten raw. More commonly they are used in cooked food or a sweet meat and pickle. And also made in to jelly and syrup. It has a numerous medicinal uses. The fruits are one of the important ingredients of a famous medicine of the Aurwedic system. In fact the fruits are applied for an enormous variety of complaints. The bark and roots also serve as a local medicine. The leaves are used as fodder and as green manure. Trees are planted with others to conserve soil. The timber is used for implements and sometimes for building. It can be used to build wells, as it is durable under water. The wood is excellent firewood and provides charcoal of good quality. (Lemmens etal,1991).

2.6 Cultivation

2.6.1 Ecology, propagation and planting

Nelli is a light demanding species.In the past propagation was usually by seeds. For extensive production and selection, vegetative propagation is necessary. A

high rate of rooting (84%) has been reported from semi hard and cuttings collected from the middle portions of invigorated shoots of young trees and planted in beds at a temperature of about 33^0C.

2.6.2 Harvesting

The fruits are ready for harvesting about seven months after flowering. They can be retained on the tree for about three months without considerable loss in quality yield.

Table 2.1 Chemical changes in Nelli (*Phyllanthus emblica*) during growth and maturity

	Picking Dates							
characters	Aug 30	Sept20	Oct.10	Oct.30	Nov.20	Dec.10	Dec.30	Jan20
	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6
T.S.S.OB	15.00	15.00	15.00	15.00	15.20	15.60	15.60	15.70
%Acidity(as citric acid	0.70	2.73	2.90	2.94	2.98	2.59	2.58	2.49
Ascorbic acid(mg/100g)	57.6	117.2	230.5	340.5	414.1	500.5	512.9	564.0
%reducing sugar	1.90	2.02	3.07	3.70	4.32	4.10	4.02	2.90
%non-reducing sugar	0.81	0.78	0.76	0.72	0.33	0.45	0.39	0.65
%Total sugar	1.84	2.80	3.83	4.42	4.65	4.55	4.41	3.58
Tannin%(gall: acid)	4.68	4.26	3.18	1.39	1.27	1.09	0.97	0.52
Colour	Green	Light green	Cream –ish green	Cream –ish green	Cream -ish green	Cream -ish green	Cream -ish green	Cream -ish green

Source: Indian food packer v.37, No. 4.

2.6.3 Storage

The storage life of the fruit is dependent on the initial quality and stage of maturity harvest The available information on the storage behavior of Nelli is very limited Nelli fruits are hard and yielding to touch and as such well suited for long distance transportation .The fruits may be kept well in cold storage for 7-8 days at 32-35^{0}F and RH 85-90%.(kalra, 88).

Table 2.2 Changes in chemical composition of Nelli (*Phyllanthus emblica*) fruits (var. Desi and Banarasi) during storage at different condition.

variety	storage condition	storage period (days)	moisture (%)	acidity	ascorbic acid mg/100 (g)	sugar (%)	
						Total	Reducing
		0	83.92	2.14	492.61	4.99	3.88
		3	82.71	2.16	486.69	4.95	3.85
		6	82.68	2.16	481.12	4.92	3.8
DESI	LT	9	81.68	2.18	474.92	4.9	3.78
		12	79.7	2.21	470.44	4.84	3.76
		15	77.82	2.22	464.59	4.8	3.72
		0	83.92	2.14	492.61	4.99	3.88
		3	80	2.17	478.11	4.89	3.81
		6	78.01	2.2	466.49	4.8	3.74
DESI	A.T	9	75.82	2.22	451.12	4.72	3.68
		12	75	2.26	439.19	4.6	3.59
		15	-	-	-	-	
BANAR ASI	L.T.	0	85.23	2.06	416.26	5.29	4.18
		3	84.49	2.09	412.24	5.16	4.14
		6	82.82	2.09	408.12	5.1	4.1
		9	81.98	2.11	402.19	5.07	4.07
		12	80.12	2.11	395.91	5.02	4.03
		15	78.09	2.13	392.53	4.98	3.98
BANAR ASI	A.T.	0	85.23	2.06	416.26	5.19	4.18
		3	82	2.1	402.19	5.08	4.11
		6	79.78	2.12	389.42	5	4.04
		9	77.6	2.16	376.51	4.89	4.93
		12	76.51	2.2	361.89	4.77	3.82
		15	-	-	-		

L.T. low temp. (2-5^{0}c) A.T. ambient temp.(24-29^{0}c source: Indian food packer ,V.33, No.1.

2.6.4 Diseases

Blue mould-caused by *Penicillium islandumin.*In this disease brown patches with water soaked areas are formed and finally the whole fruit is covered with bluish green pustules.

.Anthracnose - caused by *Glomerella cingulata.* This disease manifests as small soaked circular depressed lesion, Which later turns black in the center.

Fruits rot caused by *Phoma putamium*, *Cytospora sp.*The soft rot caused by *P.phyllnthi*_may be controlled by difolantan, Dithane M-45 or Bavistin. (Kalara.1988).

2.6.5 Nutritional value

Nelli is a rare example of an edible material which is rich tannins as well as ascorbic acid. The fruit is a rich source of pectin .The total sugar content in Nelli fruit varies from 7.0 to 9.6%. The presence of fructose, glucose, sucrose and myoinsitol has been identified. Nelli contains about 0.9% protein on fresh wet basis. In juice contains 600-1300 mg of ascorbic acid. Vitamin C is present in a stable form.

Nelli fruit is reported to contain 1.1-4.45%tannins on fresh weigh basis .The fruit contain many polyphenolic substances and the presence of tannic acid, gallic acid, phloroglucinol, pyrogallol and catechol.

The exact nature of action of tannin in the human system is not clearly known. However it is believed that tannins have protein precipitant action and hence causes smoothening effect in case of diarrhea. And also contains oxalic acid (126.9 mg/100 g) alkaloids (0.08%) auxins and minerals (total ash 0.7%) which comprises ca, P and Fe. (Kalra,1988).

Table 2.3 Chemical composition of Nelli fruit

Particulars		Reference Number anon[27] 1960	teotia et al [8]	shivastava [28]
T.S.S.	%	-	9.0-15.0	-
Moisture	%	81.2	-	-
Protein	%	0.5	-	0.91
Fat	%	0.1	-	-
Acidity	%	-	2.17-2.58	-
Total sugars	%	-	7.00-9.60	-
Reducing sugars	%	-	1.04-4.09	15.57
Non-reducing sugars	%	-	3.05-7.23	absent
Starch	%	-	-	3.46
Acid: sugar ratio	%	-	-	1.60
Fiber	%	3.4	-	-
Total ash	%	0.7	-	-
Calcium	%	0.05	-	-
Phosphoõũrus	%	0.02	-	-
Iron	(mg/100g)	1.2	-	-
Vitamins				
Ascorbic acid	(mg/100 g)	600	450-665	682
Nicotinic acid	(mg/100 g)	0.2	-	-
Vitamin B1	(ug/100 g)	30	-	-
Tannin	%	-	-	4.45

Source: Indian food packer, V. 42 , No.6.

2.6.6 Therapeutic value

The fruits have diuretic, laxative and purgative activity and also show molluscicidal and antimicrobial properties.The pericarp of the fruit is often use in decoctions along with other ingredients and externally on boils with cow ghee to promote suppuration .The juice of the bark with honey and turmeric is given for gonorrhea. An infusion of the leaves with fenugreek seed is given for chronic diarrhea. A decoction of the fruit with stems of *Tinospora codifolia* a well known remedy for various urinary diseases. The expressed juice of the fruit along with other ingredient is used to cure hemorrhage, anemia, colic acute, leprosy fits, instanity joundice, cough, indigestion dyspepsia, asthma and other diseases. (Jayaweera,1980). Anti oxidative properties ;The tannin in the fruit prevents or retard the oxidation of the vitamins.

2.7 vitamin C

2.7.1 Description of vitamin C

Vitamin C (L-Ascorbic acid) plays a important role in human nutrition as well as in food processing. L-ascorbic acid occurs naturally in fruits and vegetables. The west Indian cherry is reported to be the richest source of L-ascorbic acid .100g of edible portion contain 1000-300mg of ascorbic acid (chauhan et al,1998). L-ascorbic acid is the trivial name for L-threo -2-hexenono –lactone. (chauhan et al,1998). It is a six – carbon, white crystalline solid with properties such as molecular weight 176, melting point 192^{0}C and optical rotation (α) +22^0 in water. (Bavernfeind,1982).It is soluble in water (33% w/v at 25^{0}c) but slightly soluble in ethanol (2%) acetone (0.05%) and acetic acid (0.2%). (chauhan et al,1998). Its enantiomer is D –ascorbic acid.

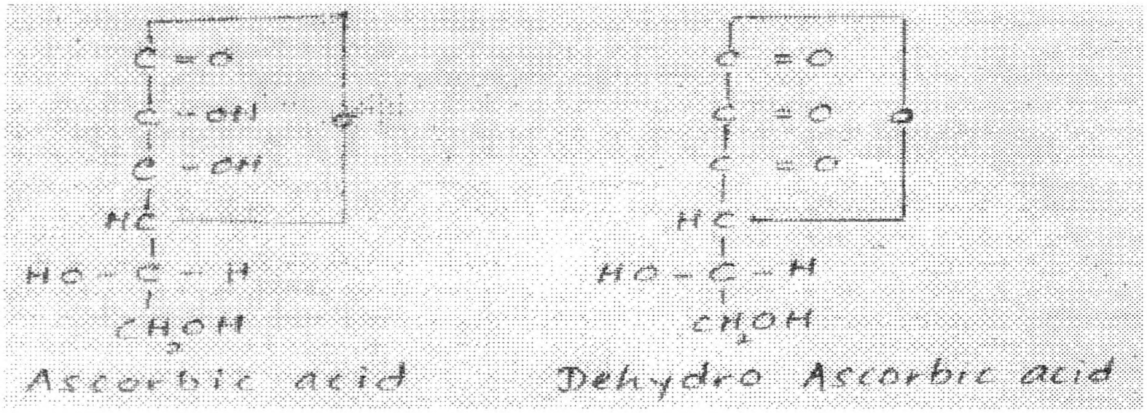

Figure 2.1 Chemical structure of ascorbic acid
Source: Properties of ascorbic acid.(1988)

2.7.2 Role of ascorbic acid

During food processing operations, particularly heating, L-ascorbic acid degrades, leading not only to loss of vitamin but also to the formation of brown colour products or melanoidines. It was shown that the non-enzymatic browning of L-ascorbic acid could be responsible for the discolouration of fruit juices, dried products and other foodstuff. (Chauhan et al, 1998). As a consequence the stability of L-ascorbic acid during storage and processing of food is a major problem.

2.8 New food product development

2.8.1 Definition of new food product

A simple definition for a new product might be a product not previously marketed or manufactured by a company; however, this break down if one includes new packaging (shape or sized) or if one enters a product in to a new market niche- the food service sector, for example. The definition of new food product development and introduction of a product not previously manufactured by a company in to the market place or the presentation of an old product in to a new market previously explored by a

company. These definitions should not be applied too rigidly. They become a little shaky if pushed. (Fuller, 1994).

2.8.2 Why go to new food product development

New food products are the major avenues open to a food company to be profitable and to survive. 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 marketplace, flourish 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 – range business goals.
- The market place may change, requiring new products more suited to respond to the changes.
- New technology may make new food products available and new knowledge to the lifestyles of today's consumers.
- Changes in government legislation, health programs, agricultural policies or agricultural support programs may dictate that development of new food products be pursued.(Fuller,1994)

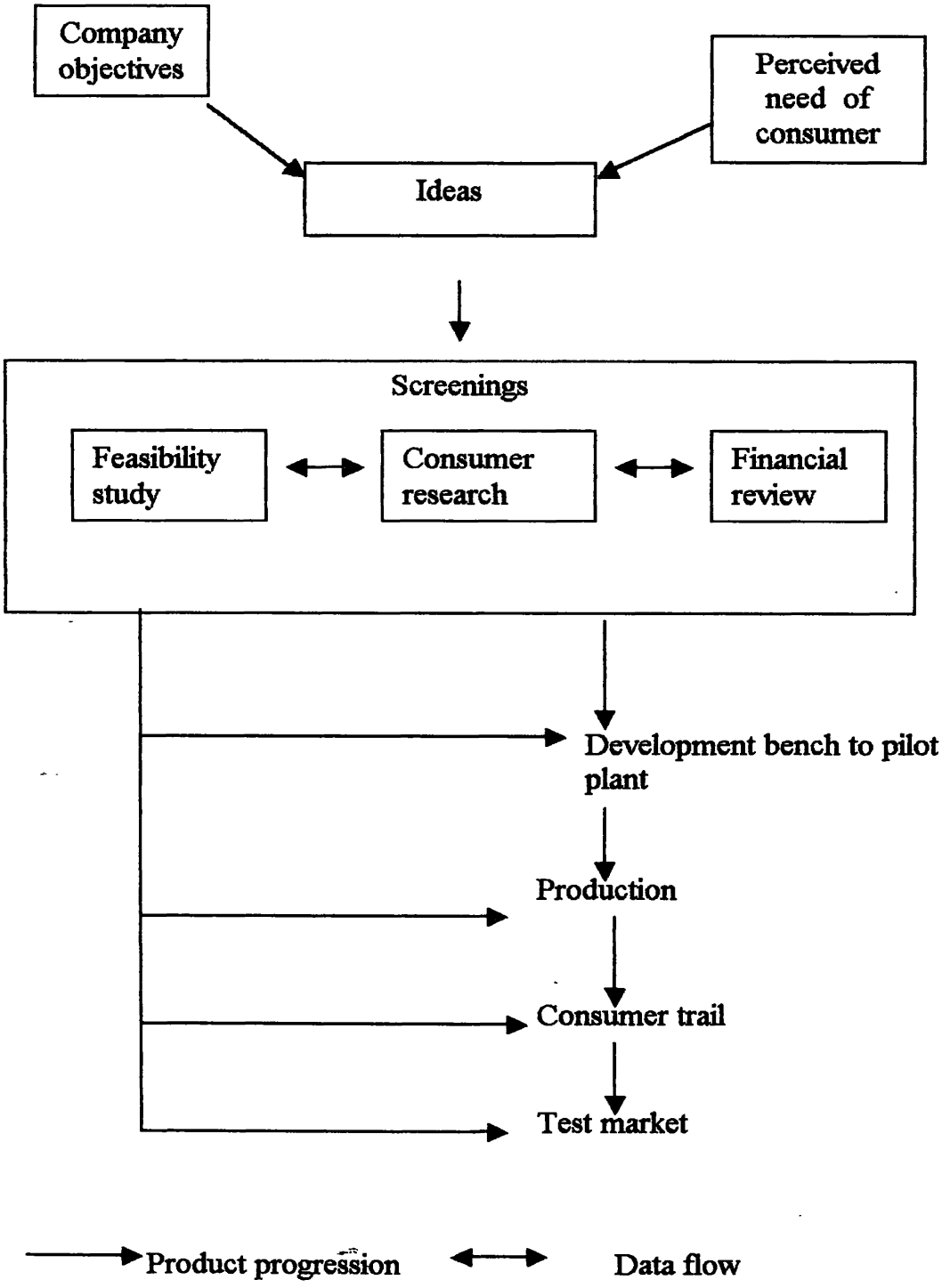

Figure 2.1 phases in new food product development

Source; Fuller (1994).

2. 9 Cordials

2.9.1 Definition

Cordials are sparking clear sweetened fruit juices from which all suspended matter has been eliminated. They are prepared by adding sugar to clarified juices, Acid, flavours, preservatives are added to the product according to the requirement and individual recipes. (Shadaksharaswamy and Manay, 2000).

2.9.2 Other ingredients

Sugar; Sugar is used as a sweetening agent and also it aids in the preservation of products. The high osmotic pressure of sugar creates conditions that are unfavorable for the growth and reproduction of most species of bacteria, yeasts and molds. Glucose, Fructose, Glucose syrup and invert sugar can be used.

Stabilizers; These compounds function to improve and stabilize the texture of foods, inhibit crystallization (sugar) stabilize emulsions and foams, encapsulate flavours. Substances used as stabilizers in cordial preparation are carboxmethylcelluloses (CMC) and pectin.

Acidulants; The most important functions of acid in foods are the contribution of sour taste and control the pH value. Acids also have the power of intensifying and modifying the taste perception of other flavour agents. Ascorbic acid, citric acid, tartaric acid, lactic acid, fumaric and malic acid can used as a acidulant. (SLS 221,1985).

Preservatives; Capable substances of inhibiting, retarding or arresting the growth of microorganisms, of any deterioration of food due to microorganisms, or of masking the evidence of any

such deterioration. SO_2 or benzoic acid can be used. (SLS 221, 1985).

Table 2.4 SLS requirements for natural/synthetic, artificial drinks and beverage.

Characteristics	Requirements
Sugar content (as Sucrose)% by mass Minimum	5
SO_2 mg/kg maximum	7
Benzoic acid mg /kg	120
Acidity (as anhydrous citric acid) % by mass	1

Source: SLS. 221. (1985)

2.10 Spoilage

2.10.1 Discoloration due to browning reaction

Two type of browning reaction can be seen.

1. Enzymatic
2. Non enzymatic

2.10. 1.1 Enzymatic browning

Enzymatic browning occurs whenever fruits are injured. The parts of injured fruits or vegetable, which is exposed to air, undergoes a rapid darkening. Today most evidence suggests that oxidation of phenol reaction in enzymatic browning. Enzymes are the principle reaction in enzymatic browning. Enzymes are called "polyphenoloes" which act as substrate for the phenol complexes includes catechol, tyrosine, caffeic chlorogenic gallic and numbers of anthocyanins and flavonoids.

2.10. 1.2 Prevention of enzymatic browning

Use of an antioxidant during processing time (ascorbic acid) heating destroys the enzyme. The concentrate sugar solutions inhibit or depress the activity of plant oxidase. Preservative such as SO_2 is an effective browning inhibitor. Prevent the contamination of Cu, Fe, in processing time, can be use brine solution.

2.10.1.3 Non Enzymatic Browning

Three mechanisms can be seen.

I. The reaction that occur between carbohydrates and amino acids result in the formation of brown pigments. (Millard reaction)

II. Ascorbic acid undergoes oxidation wich the formation of a compound with produces brown colour pigments.

III. Caramalyzation of sugars with or without catalytic action.

The temperature of storage, the amount of moisture and exposes of the fruits or fruit juices to oxygen either during processing or storage is influential in the development of browning. Non enzymatic browning occurs some fruits are processed. The compound undergoing changes may be ascorbic acid or some reducing sugars.

2.10.1.4 Prevention of non enzymatic browning

Refrigeration is reduced the rate of browning reaction. SO2 will reduce the millard browning and also can have effect on ascorbic acid degradation. Lowering concentration of final products using sucrose instead of the sugars.

2.10.1.5 Contamination of juice with metals

The cheap sources of contamination with metals are the water, pipes, pans and other utensils used in the various manufacturing processes

2.10.1.6 Prevention of metal contamination

The water should tested whether it is free from irons. It should also be softened. If hard, since deposit of Ca or Mg phosphates.

Oxalate or other insoluble salts of these metals occasionally cause turgidity in syrups. Ordinary iron pipes or gutters should not be used for conducting any; liquids of and acid nature. They should be made of stainless steel or other relatively non- corrodible metals.

2.10 Package

The product shall be packed in suitable clean containers under strict hygienic conditions and the container shall be sealed at airtight. Glass bottles are more suitable packing materials for cordials.(SLS 221,1985).

2.11 Shelf life evaluation

During storage and distribution, foods are exposed to a wide range of environmental condition. Environmental factors such as temperature, relative humidity, O2, light can trigger several reaction mechanisms that may lead to food degradation. As a result of that foods may be altered to such an extent that the consumer either rejects them or they may harmful to the person consuming them. Chemical, physical and microbiological changes are the leading causes of food deterioration.

2.12 Sensory evaluation of foods

Sensory evaluation consists of judging the quality of food by a panel of judges. The evaluation deal with measuring, analyzing and interpreting the qualities of food as they are perceived by the senses of sight, taste, touch and hearing.

2.12.1 Types of tests

The tests are grouped in to four types. They are difference (discrimination) tests, rating (quantitative difference) tests, sensitivity tests and descriptive tests. The selection of a particular test method will depend on the defined

objective of the test, accuracy desired and personnel available for conducting evaluation.

2.13.2 The hedonic scale

This test is used to measure the degree of pleasurable and unpleasurable experience of the food product on a scale of point from "like extremely" to "dislike extremely". (Shadaksharawamy &Manay, 2000).

CHAPTER 03

MATERIALS AND METHODS

3.1 Materials

3.1.1 Materials for disinfecting of fruits and extraction of fruits juice

Mature Nelli fruits, *(Phyllanthus emblica)*

Crushing machine (Ms-100, India)

Muslin clothes

Stainless steel knife

Saucepan

Plastic jugs and trays

Potable water

Electric balance (yamato, Japan)

3.1.2 Materials for cordial preparation

Extracted fruit juice

Ground sugar

Citric acid (AR, England)

Sodium metabisulfite (AR, England)

Potable water

Carboxymethylcelllose

Sterilized glass bottles with caps

Gas cooker

Chemical balance (Ms-100)

Thermometer

3.1.3 Materials for sensory evaluation

Thirty untrained panelist

White glasses

Cracker Biscuits

Potable water

Prepared cordials

Ballet papers (see App.1)

Expert sensory panelist of Kalani Velli Canneries Ltd. Staff

3.1.4 Materials for chemical analysis

3.1.4.1 Determination of pH

Digital pH meter (pH scan 2, Singapore)

3.1.4.2 Determination of Total soluble solid

Hand Refracto meter (Japan)

Dropper

Thermometer

3.1.4.3 Determination of Acidity

Burette (25 ml)

Conical flask (250 ml)

Measuring cylinder

Chemical balance (Ms-100, Japan)

NaOH (AR, England)

Phenolphthalein

3.1.4.4 Determination of Vitamin C

Standard thiosulphate solution

I_2 solution

Starch solution

Other normal laboratory equipment and reagents

3.2 Methods

3.2.1 Methods for preliminary studies

A series of samples were prepared as follows

Sample was prepared by blending fruits. Second sample was prepared by giving heat treatment to the fruits, 3 minutes at 90^0 C (Gunarathne, 1993) and then crushed and the cordial was prepared. Other samples were prepared by crushing fruits and water was added in the ratio of 1:1, 1:2, 1:3. Allowed to extract fruit juice with 8 hrs, 16 hrs and 24 hrs intervals. All the prepared samples were sensed by expert sensory panelist of Kalani Velli Canneries Ltd.

3.2.2 Disinfecting of fruits and extraction of fruit juice

Mature fruits were brought from Rathnapura city market and then sorted out and washed with running chlorinated water, Fruits were pricked manually by using a knife and dipped in SMS solution. (200 ml water/ 50 mg of SMS), after pricking fruit slices were crushed and weighed out. Again the prepared SMS solution was added and filled rest of water amount to get 1:1 ratio in sealed plastic bottles. Those were kept 24, 16, 8 hrs. After the extraction period juice was extracted by using muslin cloth and determined the pH, Brix and Titrable acidity.

3.2.3 Preparation of cordial

All the ingredient required for a fruit cordial of brix 52^0 and 1% acidity were calculated.Three lots of cordials (3 replicates of in each) having different extraction time (8,16,24 hrs)were prepared in the following way.First half of the extracted juice were measured out and added all the SMS into that. Then a higher quantity from the measured ground sugar, measured citric acid and rest of the juice were mixed in a saucepan and heated until the sugar was completely dissolved. Then rest of the sugar and CMC were mixed and added step by step and stirred well while heating the mixture up to about 85^0C. Then the remain portion of the juice and SMS mixture was added back and mixed thoroughly. Finally hot filling of sterilized bottles was carried out immediately in order to minimize the loss of the added preservatives.

3.2.4 Sensory evaluation

Three samples of cordials were labeled randomly. (see app.1) One part of the fruit cordial was mixed with four parts of cooled water. This was done separately to all three samples of cordials prepared. Then for each panelist, 50 ml of each reconstituted cordials were served in three separate labeled white glasses and was asked to evaluate five point hedonic scale in the given ballet paper. Thirty untrained panelists (KVC staff) were

participated in the evaluation. The sensory data were statistically analyzed using Minitab statistical software package (release 8.21).

3.2.5 Chemical storage studies of the cordials

Storage studies were carried out in all three types of cordials separately by measuring pH, acidity and TSS as soon as they were prepared and weekly during the one month storage period.

3.2.5.1 Determination of pH

The samples of the extracted juice and the cordials were taken in beakers and pH was measured using the pH meter.

3.2.5.2 Determination of TSS

Two to three drops of the extracted juice and the prepared cordials were placed on the refractor meter and the reading was taken. Then the reading was corrected, with temperature.

3.2.5.3 Determination of acidity

About 10 ml of juice was mixed with 50 ml of distilled water and three drops of the indicator were added to it. Then this solution was titrated with 0.1N NaOH solution until a permanent pale pink colour persisted. Finally the burette reading was taken and acidity was calculated. (See app.2) (SLS 214:1985).

3.2.5.4 Determination of Vitamin C

I_2 solution was standardized with standard thiosulphate solution. Then 25 cm^3 portion of prepared cordials were titrated using standard I_2 solution using starch as the indicator. Firstly the deep blue colour was appeared at the end point it was persisted.

CHAPTER 04

RESULTS AND DISCUSSION

4.1 Preliminary Studies

The cordial prepared from blending of fruits was very bitter and astringent. On the other hand they were turn deep brown within one week. Second sample that was prepared from giving heart treatment had undesirable odour and bland in flavour. Other samples that were prepared from giving 1:1, 1:2, 1:3,ratio of water and 8, 16, 24hrs of extraction time rather bland in flavour.

Table 4.1 pH, Brix and Acidity of extracted juice with different extraction time

Character	8 hrs	16 hrs	24 hrs
pH	3.0	3.0	3.0
Brix	3.0	3.0	3.1
Acidity	2.1	2.0	2.1

4.2 Disinfecting and extraction of juice

Sorting and washing with chlorinated water of fruits before juice extraction is essential. Plucking of fruits was carried out without damaging or bruising them. The seed removed fruits were dipped in SMS solution to prevent the growth of undesirable microorganism during juice extraction period and to prevent enzymatic browning. One to one ratio of water was added. Because fruits were very fibrous. The same water that was used in basic step was used throughout the procedure. It is important to maintain the desirable colour in cordial. About 80% of seed recovery ratio were found. Kalra (1988) reported similar observation.

Table 4.2 Ingredients used for preparation of sample

Sample	Extracted juice With water (g)	Sugar (g)	Citric acid (g)	CMC (g)	SMS (mg)
1	760	700	2.5	12	260
2	590	550	2.5	10	200
3	830	775	2.5	15	260

Sample 1- with 8 hrs extraction time

Sample 2- with 16 hrs extraction time

Sample 3- with 24 hrs extraction time

Table 4.3 Sum of ranks for Sensory attributes.

Sample	colour	flavour	cooked odour	Overall acceptability
1	63.5	60.5	64.5	62.5
2	48.5	48.0	59.0	52.5
3	68.0	71.5	56.5	65.0

Table 4.3 shows the differences in sensory attributes of three samples with different extraction time. According to the panel of judges cordial 3 gave the best result in terms of flavour, colour. But cooked odour was less in sample 1. This may be due to less extraction time. The results of statistical analysis showed that there was no significance difference in sensory attributes the overall acceptability of the three samples. But panelist mostly preferred cordial 3 among the three. This may be due to its high extraction time, When compared with other two,which result in more

pleasant and mild sensation in mouth. Hasan and Ahamed (1998) reported similar trend for mango pulp beverage.

Table 4.4 Effect of storage sensory attribution of cordials.

Cordial	Storage week											
	1			2			3			4		
	1	2	3	1	2	3	1	2	3	1	2	3
Flavour	60.5	48.0	71.5	60.5	48.1	71.5	60.4	48.1	71.4	60.4	48.1	63.8
Colour	63.5	48.5	68.0	63.2	50.5	70.0	60.0	49.0	68.5	63.4	48.4	69.7
Cooked odour	56.5	59.0	64.5	56.4	58.9	65.5	57.5	58.4	64.3	55.0	57.0	64.5
Overall Acceptability	62.5	52.5	65.0	65.0	55.4	63.7	60.0	61.4	64.5	62.8	54.3	

Effect of storage on sensory attributes of the three samples was shown in the table 4.4. Although sum of ranks during the storage shows some irregular variation, statistical analysis data showed no significant change of sensory attributes, ($p>0.05$) among the samples as well as within the samples during the one month storage period. But Hassan and Ahamed (1998) reported that there was a significant change in quality attribution of mango milk beverage after 3 months storage period. The contrasting result in this study may due to the short storage period considered. Generally fruit cordials available in the

market have shelf life around one year. This longer storage study is important as it may produce different result.

Table 4.5 Chemical storage studies of the Cordials.

Storage Week	Sample 1			Sample 2			Sample 3		
	pH	TSS	Acidity %	pH	TSS	Acidity %	pH	TSS	Acidity %
0	3.2	52	1.08	3.2	51	1.06	3.1	52	1.09
1	3.2	52	1.07	3.2	51	1.06	3.1	52	1.09
2	3.2	52	1.07	3.2	51	1.06	3.1	52	1.00
3	3.2	52	1.08	3.2	51	1.08	3.1	52	1.00
4	3.2	52	1.08	3.2	51	1.07	3.1	52	1.00

According to the table 4.5 no significant change in pH, acidity and total soluble solid (TSS) has been observed in any of the samples during the one month storage period. Srivastava (1998) reported similar trend for RTS Drink prepared from Baganpalli mangoes. Thakur and Barwel (1997) also reported that no significant change had been taken place in TSS and pH for kiwifruit squash during its two-month storage period. Generally in fruit beverages pH and acidity change during storage mainly due to microbial action which provides organic acid. (Hassan &Ahamed, 1998). TSS changes mainly due to degradation of starch in to simple sugar. In this cordial prepared from containing SMS as a Chemical preservative, It inhibits microbial action of molds, bacteria and yeast. (ICMSF,1974), which may lead to the changes in pH and acidity and in the present study considered storage period seems to be too short to observe any undesirable microbial and chemical reaction. So in the long run, it is possible that these undesirable changes may take place even for lesser extent.

Some variation in initial acidity of the samples has been resulted, even through 1% has been expected at the preparation of the cordials. The values obtained were 0.9-1.07. This may be due to personal errors involved in manual operation such as improper mixing and loss of the acidulant during preparation.

Table 4.6 Vitamin C content of prepared cordials.

	Vitamin C (%)
Sample 3	0.036
Sample 2	0.031
Sample 1	0.023

Table 4.6 shows the vitamin percentage of prepared cordials. It was very less. Because vitamin C degrade very rapidly during processing. In cordial preparation, cordials were heated up to 85^0 C. On the other hand this results may include other reducing agents, eg; other acids.

CHAPTER 05

CONCLUSION AND SUGGESTIONS

5.1 Conclusion

The formulated cordial with 24 hrs extraction time and half addback is the most acceptable beverage in terms of sensory attributes.

All three formulated beverages with different extraction time are chemically, organoleptically and microbiologically acceptable during the study period of one month at room temperature.

Development of a fruit cordial from Nelli not only will minimize the wastage and provide nutritional and medicinal benefits to the people.

5.2 Suggestions

Should conduct a extended storage study of the developed fruit cordial at least for one year.

Should develop a vitamin C preservation technique.

Analyzing of the vitamin C content using standard analyzing methods.

Developing a colour enhance technique.

Conducting a market survey to find out the consumer acceptability of the new product

Further studies on the medicinal values of Nelli (*Phyllanthus emblica*)

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Appendix 1

SENSORY EVALUTION BALLET PAPER FOR THE FIVE POINT HEDONIC SCALE

NAME DATE

PRODUCT

INSTRUCTION

- Please taste the samples given here
- Give the score for each characteristics such as follows

Like very much	5
Like slightly	4
Neither like, no dislike	3
Dislike slightly	2
Dislike very much	1

Characteristics	sample code		
	322	348	532
Colour			
Flavour			
Cooked odour			
Overall acceptability			

COMMENTS

Appendix 2

Calculation for acidity

(acidity was calculated as citric acid %)

Percent acid in the sample = Z

$$Z = \frac{V \times N \times \text{meq wt} \times 100}{Y}$$

Z = % of acid in sample

Y = Weight of juice sample

N =Normality of NaOH (0.1N)

V = Volume (ml) of NaOH used for titration

Meq wt = 0.064 (concentration factor for citric acid)

Appendix 3

Ascorbic acid undergoes oxidation as,

I_2 + ascorbic acid ⟶ Dehydro ascorbic acid + $2H^+$ + $2I^-$

Calculation,

Weight of the cordial sample = W g

Volume of I2 solution consumed = V Cm3

Amount of I used = $\frac{V \times [I_2] \text{ mol}}{1000}$

Amount of equivalent ascorbic acid = $\frac{V \times [I_2] \text{ mol}}{1000}$

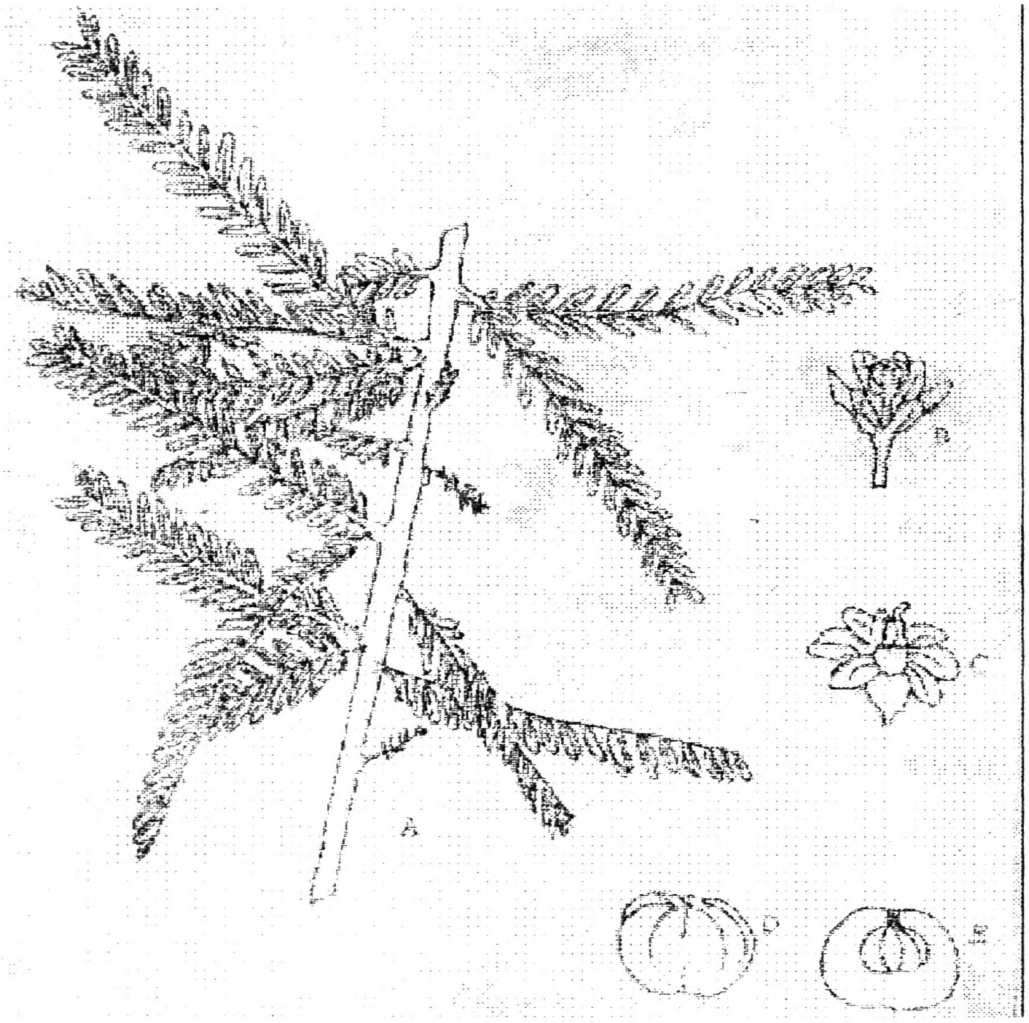
Relative molecular mass of ascorbic acid = 176

Weight of ascorbic acid (g) = $\frac{V \times [I_2] \text{ mol} \times 176}{1000}$

% of ascorbic acid in vitamin C = $\frac{V \times [I_2] \text{ mol} \times 176}{1000 \times w}$

Appendix 4

Morphology of Nelli (*Phytllanthus emblica*)



(A) Branch (B) Male flower

(C) Female flower (D) Fruit

(E) Longitudinal section

source; Traditional food plants in Sri Lanka

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