READY TO SERVE CARBONATED FRUIT BEVERAGES

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Re. No.02/AS/A/047

The thesis submitted practical fulfillment of the requirements for the degree of

Bachelor of Science

Department of Food Science and Technology

Faculty of Applied Science

Sabaragamuwa University of Sri Lanka

2006/August

DECLARATION

The research work described in this thesis was carried out exclusively by me at CBL fruit and beverages (pvt) ltd and faculty of Applied Sciences, under the supervision of Mr. Aruna Sri Wanasinghe and Mrs. Deepika Priyadarshani. A report on this thesis has not been submitted to any other university, for another degree.

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ABSTRACT

Carbonation (saturation of fruit beverage with CO_2) of fruit beverages has become one of the most applicable methods to add an extra value to the traditional fruit beverage. Coupling carbonation with the production process of ready to serve fruit beverages will result in increased consumer acceptability through a better mouth feel, taste and fizziness. Therefore this study was carried out to find out most suitable temperature of carbonation that is able to bring up the optimum carbonation level and to find out suitable fruit beverage types that can be effectively carbonated.

Limejuice filled into 160g bottles, were carbonated at the temperatures of 0.0°C, 4.2 °C, 7.4 °C, 10.0°C and 15.5°C. After 7 days of storage at ambient conditions beverages were evaluated for its colour, taste, fizziness, mouth feel and overall acceptability using 5-point Hedonic scale with trained sensory panel. Both the fruit juices carbonated at 0.0°C were used to assess the effectiveness of carbonation; their organoleptic properties were evaluated against non-carbonated juices.

Sensory evaluation tests results reveals the samples which are carbonated at 0°C possess most desirable colour, taste, fizziness, mouth feel and overall acceptability at 95% level of significance. Carbonated lime juice possessed better organoleptic qualities when compared to noncarbonated lime juice and the appearance, odour, flavour of carbonated mix fruit juice was lower than those of non carbonated mix fruit juice. So the study reveals that mixed fruit juice is not suitable for carbonation.

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ABBREVIATIONS

App.	Appendix
et. al	and others
e.g.	for example
etc	and so on or forth
fig.	Figure
RTS	Ready to serve
Temp	temperature

CHAPTER 1
INTRODUCTION

1.1. Introduction

The human body is composed of 100% matter in either a solid, liquid or gas form. Water makes up 2/3 of the body content and most of the water yield to body functions. This loss of fluid stimulates thirst so, that have to renew the moisture balance. Drinking fruit beverages is one of the options available to quench the thirst.

Fruit beverages are the products range from pure fruit juice to highly diluted artificially coloured and flavoured drinks that contain little or no fruit ingredients (Ensminger, *et al.*, 1994). And also they are easily digestible, highly refreshing, thirst quenching, a peptizing and nutritional far superior to many synthetic and aerated drinks. Ready to serve fruit drinks are one of the highly demanded fruit beverage types in Sri Lanka. In order to fulfil the above demand several reputed organizations in the food industry are involved in the manufacturing of Ready to serve fruit beverages. As a consequence an intense competition is been developed among those manufacturers and several strategies are being used to win the above competition and stabilize in the market. Value addition and product diversification have become widely implemented strategies for that purpose.

Carbonation of fruit beverages is one of the strategies that can be employed to add value to the traditional fruit beverage. Although several brands of carbonated soft drinks are available in the market still the carbonated fruit beverages are not introduced to the market. The use of fruit juices increase the nutritive value of carbonated beverages.

Carbonation is the process of saturating the beverage with CO_2. Carbonation result unique taste zest and sparkle imparted by the CO_2. Carbonation play role in inhibiting bacteria. Coupling carbonation with the production process of ready to serve fruit beverages, will result in an increased consumer acceptability to seek the optimum temperature to adding CO_2 through a better mouth feel, taste and fizzy.

1.2 Objective

- To find out the ability of lime juice and mix fruit juice for the carbonation.

- To find out the optimum temperature of carbonation that is able to bring up the optimum level of carbonation which results in most desirable colour, taste, fizzeness, mouth feel, overall acceptability.

CHAPTER 2

LITERATURE REVIEW

2.1. Beverages

Beverage industry is highly growing and popular in world wide. Beverages are any liquid used or prepared for drinking (Ensminger, *et al.*, 1994). Still numerous beverages have invented, but most of them can be include one of the following categories.

1. Aromatic and stimulating infusions such as herb, tea, coffee and roasted grain drinks.
2. fruit juices including lemonade and fruit flavored
3. Fermented beverages such as beer and wine
4. Distilled liquors
5. Soft drinks or carbonated beverages
6. water

Some of this consumed by people for their food value others are consumed for their thirst-quenching properties, for their stimulating effects or simply consumption is pleasurable.

2.2. Fruit beverages

Fruit beverages are products range from pure fruit juices to highly diluted artificially coloured and flavoured drinks that contain little or no fruit ingredients (Ensminger, *et al.*, 1994). So it can take beverages which produce by the fruits or fruit flavoured drinks as the chart below.

2.3. Unfermented Fruit beverages

These products are becoming in the market due to their nutritive and refreshing qualities. Also these drinks are quite cheap in artificial drinks, which were predominating in the marked.

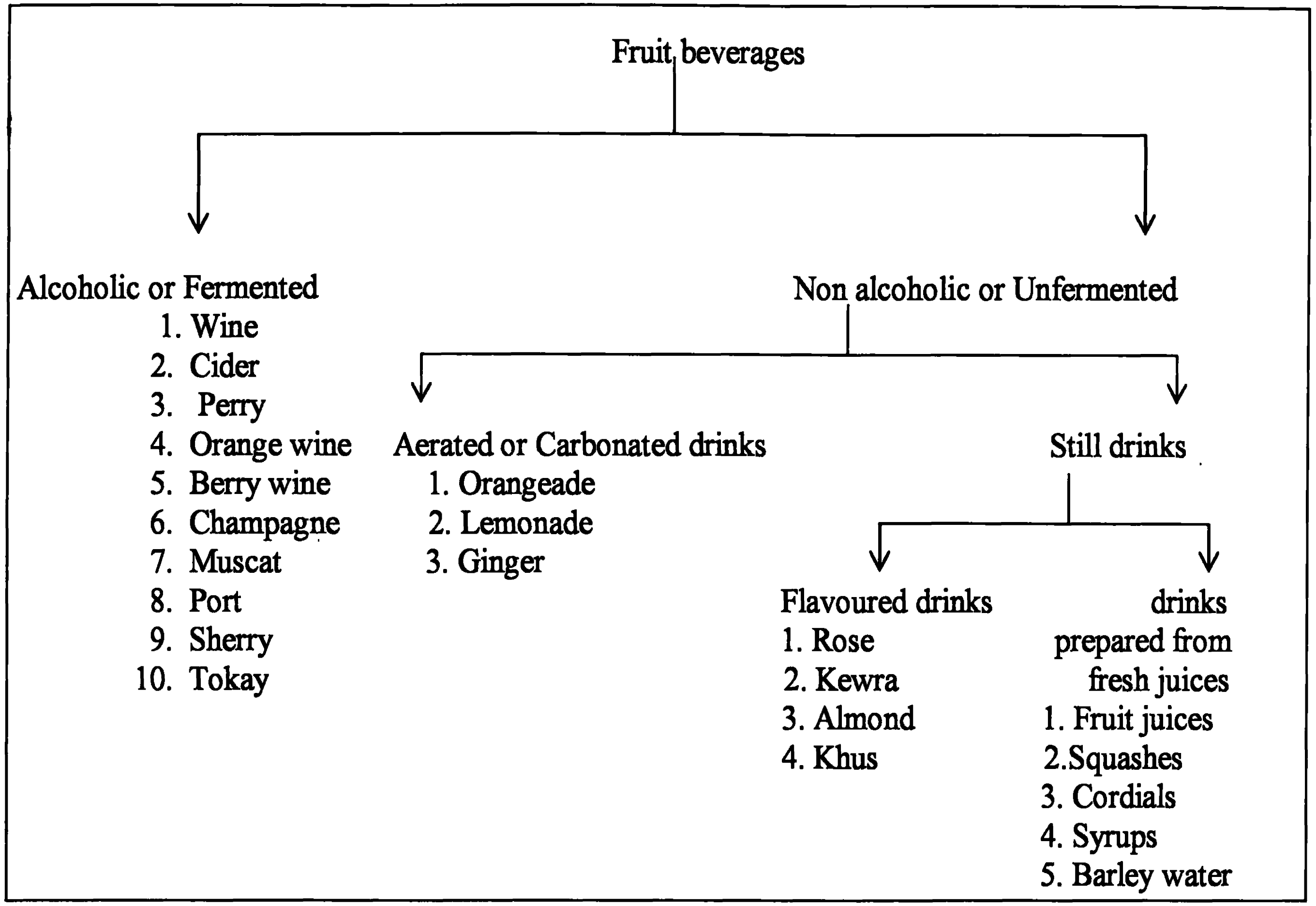

Figure 2.1. The types of fruit beverages

2.3.1. Fruit juices

Fruit juices, as defined in the UK by the fruit juice and fruit Nectars Regulations 1977 as amended are 100% pure fruit juices made from fresh fruits or fruit concentrates. Only the flesh of the fruit can be used in the juice production, and not the pith or peel.

2.3.2. Squashes and drinks

The UK soft drinks Regulations 1964 divided compound products containing fruits into two distinct categories. Squashes are products intended for dilution and must contain a minimum of 25% by volume of juice. Ready to drink beverages containing minimum of 5% by volume of the juice are normally described as " crushes" product make from commented fruits are described as "drinks" .and must contain minimum of 10%, W/V potable fruit it concentred , or 2% W/V potable fruit if ready to drink.

2.3.3. Preparation and preservation of unfermented Fruit beverages

There are processes which of preparation and preservation fruit beverages have many steps to manufacturing.

2.3.3.1. Selecting of fruit

All fruits are not fit for the make fruit juice, because there have lot of impurities, not only poor quality but also maturity, variety, and locality of cultivation influence the flavour and keeping quality of fruit..

2.3.3.2. Sorting and washing

Diseased, damaged, or decayed fruits are rejected or decayed fruits are rejected or trimmed. Fruits are washed truly to remove dirt and spray residues.

2.3.3.3. Juice extraction

The method of extraction fruit juice differs from fruit to fruit. Citrus fruits, the fruits are cut in to halves and was pressed halves giving little pressure. Before, cut in to halves, removed rind carefully. Other fruits are removed peel, cut in to pieces, if had seed is removed and is ground to extract juice.

2.3.3.4. Deareation

Most of the air contains fruit juice present of the juice and some is dissolved, are removed by subjecting the fresh juice to a high vacuum. This is not usually used in most of Sri Lanka food industry.

2.3.3.5. Straining or filtration

Fruit juices always contain various amount of suspended matter consisting of broken fruit tissues, seed, skin, gums, pectic substances and protein in colloidal suspension. In this, suspended matters which adversely effect to the quality of juice are removed by straining using sieve.

2.3.3.6. Clarification

Completely removed all suspended matter from juice, which is closely related to the quality appearance and flavour of the juice. The methods of clarification are used settling, filtration, freezing, cold storage, heating to high temperature, chemicals such as gelatine and etc.

2.3.3.7. Adding sugar

All juices are mostly sweetened by adding sugar. Sugar also acts as preservative for the flavour and colour and prolongs the keeping quality.

2.3.3.8. Pasteurization

Pasteurization is most common method to preservation of ready to serve drinks. The process of heating at boiling temperature or slightly below it for a sufficient length of time to kill the micro organism, which cause spoilage, is called pasteurization (1994, Srivastav et al). Pasteurization does not kill the all micro organisms present in juice. Some spores and spores forming bacteria like *Bacillus subtilis* can survive and multiply later. However, generally too small in number cause any spoilage. Mould spores are destroyed by heating for 5 to 10 minutes. Yeast and acid tolerant bacteria are readily killed if the juice is heated for few minutes at about 66^0 C.

2.3.3.9. Bottling

Bottles are truly washed with hot water and filled leaving 1.5-2.5 cm head space, then sealed with crown corks by crowing machine.

2.4. Fermented beverages

Fruit juices which have undergone alcoholic fermentation by yeasts include wine, Champaigne, Port, Sherry, Tokay, Muscat, Perry, orange wine, berry wine, nira and cider (Sanjeev,2002).

2.5. Carbonated non-alcoholic beverages (soft drinks)

Their origin goes back to Greeks and Roman times when naturally occurring mineral waters were prized from "medicinal" and refreshing qualities. Carbonated non-alcoholic beverages are generally sweetened, flavoured, acidified, colourd, artificially carbonated and some time chemically preserved beverages.

An early method of obtain the carbon dioxide was by acidification of sodium bicarbonate, and form the use of these sodium salts came the name "soda" which remains today although most carbon dioxide is no longer generated in this fashion, with the addition of the carbon dioxide to render the product "sprinkling" or "fizzy", the manufacturer would have a Lemonade or similar product.

There can be found various fruit flavour types. Such as Grape, Pineapple, Apple, Black Cherry, Lemon, Strawberry, Cola, Orange, Ginger ale and etc. This variety and availability of soft drinks are reasons for the fantastic popularity of soft drinks as food item.

2.5.1 Main ingredients of soft drinks

1. **water**
2. **sugar**
3. **acid**
4. **flavour**
5. **colours**
6. **preservatives**
7. **carbonation**
8. **fruits**

2.5.1.1. Water

Water is the main ingredient consists of 92% by volume. It is essential that the water be as a nearly chemically pure as is commercially feasible, since trace of impurities reacts with other constituents of the drink.

The control of the Chlorine is essential to protect the flavour profile and stability of the soft drink, also removed stale or muddy off flavours caused by organic compounds.

Sand filtration will removed suspended particles that will show the filling speed. The water may also treat on site to change the mineral balance and alkalinity, because higher alkalinity produces a dull product.

2.5.1.2. Sugar

The sugars are the traditional sweeteners for soft drink formation with sugar itself (sucrose), whether derived from cane or beet, being the most important. When used as a sole sweetener, they form 8-12% of the product. Sucrose is highly refined after being extracted from plant sources. It provides energy.

Finished beverage was content about 8-14% sugar. Sugars are invariably a major cost component of the soft dink formulation but they are stable, provide aboard of sweetness profile, full mouth feel and contribute a texture to the product that changes little with time when stored at ambient conditions (Ashurt, 1998).

2.5.1.3. Acid

Acid provide sharpness, bite and brightness to the soft drinks. They contribute to the preservative system by lowering the pH to make the environment unfavourable to most pathogen bacteria. The lowering of the pH to below 4-0 is critical for effective pasteurisation and for the effective discolouration of sorbates and benzoates.

The most common used as citric acid. Citric acid and sugar have been traditionally accepted taste profiles; here the slow, smooth sweetness delivery of sugar is balanced by the relatively high. Similar profiles gain with non-nutritive sweetener from malic acid, lactic acid and tartaric acid in soft dinks. Ascorbic acid is naturally added to provide acidity or flavour but either an antioxidant to protect beta-carotene or flavouring from oxidative degradation or provide enough vitamins to make a label claim for health benefits (Ashurt, 1998).

2.5.1.4 Flavours

Flavouring materials are usually produced by specialist companies and supplied to the beverages manufacturer as a finished material to be used as an ingredient. The raw materials for flavouring are sourced from around the world in order to support the vast range of flavouring profiles now required in soft drinks. The materials include fruits, spices, herbs, etc, for extracts or fine specialist chemicals. They are processed, blended and compounded to produce the exact profile required for the formulation. This task is achieved between the flavourist, formulator and the customer.
For the formulator there are three main flavour groups:

- natural
- nature identical
- artificial

Natural flavours are those obtained by extraction from natural sources, such as fruit, vegetables, spices, herbs, or from biotechnology. Natural identical flavours are those produced from synthetically prepared materials that have been identified as occurring in nature. Thus a flavour profile can generally be constructed that is superior to that of the natural flavour in price, desired flavour profile, delivery and stability and lower in added quantity. Artificial flavours are chemical materials that are not found in nature (yet) but which have a flavour contribution. They represent a small number of materials.

2.5.1.5 Colours

In parallel with he flavours it is convenient to consider the colour in three groups:

- artificial
- natural
- nature identical

The artificial colours most based on azo-dyes. Those remaining on the permitted list have a long history of use and a wide usage. The colours are usually supplied in granular form to particular dye content. To the consumer the colour is important to support the flavour and make the product interesting. Natural colours are extracted from natural sources. The major natural colour is anthocynin, a red/purple colour. The colour intensity may be weak and more material may be needed to achieve a similar effect. Stability usually less than in artificial colours and further complicated because break down products are usually coloured (Ashurt, 1998).

2.5.1.6 Preservatives

There are chemicals added to control low levels of micro-organisms that may de introduced to the product (Ashurt, 1998). They work as part of a "hurdle" system with pasteurisation, acids and carbonation. Sulphur dioxide and benzoic acid are permitted preservatives use in the Sri Lanka by 183:1997, UDC 663.86 Sri Lanka standards.

Sulphur dioxide is a traditional preservative for soft drinks. It has a preservative effect in the body of the drink and in the head space. In addition it is an effective antioxidant and has a noticeable flavour effect.

In most soft drinks Sulphur dioxide exists in two forms: the free form, which is effective as a preservative, and the bonded form, which has reacted with other ingredients. The two together form the total Sulphur dioxide. Sodium benzoate is the free, undissociated acid that has the preservative, inhibitory action and thus it is most effective at low pH.

2.5.1.7 Carbonation

2.5.1.7.1 Carbon dioxide

Carbon dioxide is a colourless, non-toxic gas with slight pungent or biting odour produced by (a) burning carbon compounds, such as coke, oil, gas; (b) heating limestone to form lime and carbon dioxide, (c) fermentation to produce alcohol and carbon dioxide, and (d) trapping from gas wells. It distributed (a) as a liquid in a cylinders under high pressure, (b) as a liquid in a tank trucks or rail cars under low pressure, or (c) solid in insulated containers or tracks at atmospheric pressure. It dose not support combustation. It is heavier than air and has specific gravity, compared to air, of 1.529. Carbon dioxide condenses to a colourless, refractive liquid at 20°C when subject to 50 atmospheres of pressure.

2.5.1.7.2. Carbon dioxide volume

The volume of carbon dioxide in the finished beverage is the most important factor, for it is the quantity of carbon dioxide dissolved in the beverage that give its sparkle and governs the length of time, along with other factors, such as temperature, that the beverage will continue to effervesce.

Henry's low states that the amount of the gas dissolved by a given volume of a solvent at constant temperature is directly proportional to the pressure of the gas with which it is in equilibrium according to the gas low, the amount of carbon dioxide dissolved by water at the given temperature is proportional to the pressure of the carbon dioxide on the water. This low is, however, conditioned by the nature of the molecule as it exists in the gaseous state and as it exists in the solution. In the instance of carbon dioxide, as far as carbonated drinks are concerned variations from Henry's low are not large.

At atmospheric pressure, the amount of carbon dioxide dissolved by water will depend solely on the temperature. It has already been pointed out that this solubility is greater at lower temperatures than at higher temperatures. The unit of measurement that has been adopted by the beverages and bottling industry as standard is the volume.

This is defined the amount of gas in millilitres. That a given volume of water will absorb at atmospheric pressure, namely 760 millilitres of mercury and 60°F (15.5°C). These are arbitrary points set by agreement. This condition registers as zero on the scale gage commonly used to measure the volume of carbon dioxide absorbed in carbonated beverages.

Thus at 60°F(15.5°C) beverage water will absorb 1 volume of carbon dioxide, represented as zero on carbon dioxide volume gages. If the carbon dioxide is supplied to the water under pressure of 2atm the water will absorb 2 volumes. For each additional 15 pisg, 1 additional volume of gas is absorbed by the water.

Reducing the temperature of the water to 32°F (0°C) increases the absorption by the water to 1.7 volumes. Data on the relationship of pressure and temperature to the volume of water was presented in (App.03).

2.5.1.7.3. Carbonation

Carbonation is the process of saturating the beverage with carbon dioxide. Popularity of carbonated drinks is due to the unique taste, zest, and sparkle imparted by the carbon dioxide. The dissolved gas also plays a major part in inhibiting and/or destroys harmful bacteria.

Carbonation is achieved by dissolving carbon dioxide gas in water to form carbonic acid. The gas is sparingly soluble and thus is released slowly, forming bubbles that provide the characteristic mouth feel and flavour effects when consumed. Lightly carbonated products will contain around 2.0-3.0 volume of the gas, moderate carbonation usually refers to about 3.5-4.0 volumes and high carbonation levels are around 4.5-5.0 volumes.

2.5.1.7.4. The Carbonation test

Various carbonation test procedures have been devised to minimize or correct the error caused by the presence of air in bottled carbonated beverages.

One test extensively used in the brewing industry and canned carbonated beverages employs and apparatus which makes possible the measurement of pressure and actual air content of the bottle under test.

This is accomplished by first measuring the equilibrium pressure of the test bottle. After the pressure measurement, the head space gases are released in to a burette filed with a sodium or potassium hydroxide solution. This solution absorb all of the CO_2, leaving only air in the burette. Nearly all the air present in the test can or bottle can be transferred to the burette by repeated shakings and release of gas in to the burette. The air content of the burette is then measured and the total pressure value is corrected for the amount of air present (Phlips, *et al.*, 1974).

2.5.1.7.5. Fizz

"Fizz" is a word that is used to describe the action or sound of gas bubbles moving through and escaping from a liquid, or the formation of an emulsion of this gas and liquid at the top of the liquid's container. The word itself is an example of group of words, derived from the sound the multiple bubbles make together as they "pop" when they escape. A carbonated beverage, such as cola or beer, will form bubbles when the dissolved carbon dioxide is depressurized to form emulsions at the top, and it will make "fizzing" sounds when it is opened or poured into a container.

2.5.1.7.5. Effervescence

Effervescence is the escape of gas from a aqueous solution. The term is usually used to describe the foaming or fizzing that results from gas. In the lab a common example of effervescence is the addition of hydrochloric acid(HCl) to a block of limestone. If you put a few pieces of marble or an antacid tablet in hydrochloric acid in a test tube fitted with a cork, you can witness the effervescence of CO_2. Carbonate and dilute acid also produces effervescence which contains carbon dioxide.

This process is generally represented by the following reaction, where water and gaseous carbon dioxide react to form a dilute solution of carbonic acid.

$$H_2O \quad + \quad CO_2 \longrightarrow H_2CO_3$$

Effervescence is the cause of bubbles in fizzy drinks (carbon dioxide escaping water), beers and sparkling wines.

In simple terms, it is the result of a chemical reaction occurring in a liquid which produces a gaseous product.

2.6. Ready to serve fruit juice

This is a type of beverage which contains at least 10% fruit juice and 10% total soluble solids beside about 0.3% acid. It is not diluted before serving; hence it is known as ready to serve (RTS) (Srivastav, *et al.*, 1994).

2.6.1. Lime Juice

This is specie of citrus. Limes are typically grown in humid tropical climates region. It came into cultivation in Europe from Southeast Asia during the crusades. Limes have thinner skin.

Entrepreneurs planning on processing either lime need to make provision to extract the oil from the peel. Lime oil is valued at many times the value of the juice.

2.6.2. Mixed fruit Juice

Mixed fruit juice contains mainly papaya, pineapple and lime juice. So it contains high nutritive value and it has high demand. It is one of the most popular fruit drink in Sri Lanka.

2.7. Sensory Analysis

Sensory analysis is the identification, scientific measurement, analysis and interpretation of the properties(attributes) of product as they are perceived though the five senses of sight, smell, taste, tough and hearing(Carpenter, *et al.*,2000).

Sensory analysis has to do with measurement. However, there is nothing in this definition to indicate , whether the measurement is qualitative or quantitative nor does the definition stipulate whether trained assessors or untrained consumers making the assessments, although this is just one of the important decision that must be made when planning sensory study. There are 3 main types of testing.

1. Discrimination tests
2. Descriptive tests
3. Acceptance tests

2.7.1. Discrimination tests

In discrimination or difference Testing assessors compare 2 or more product indicating whether any differences are perceived. They may also be asked to describe are difference and estimate how large they are. As these tests involve side by side comparative judgments, they can be very sensitive and capable of detecting quite small difference between products.

2.7.2. Descriptive tests

In sensory descriptive testing, the assessors develop descriptors for the sensory characteristics of a product and then use these descriptors to quantify difference between products. The set of rating for the sensory characteristic of appearance, odour, flavour, texture and after taste constituent what is often referred thus sensory profile product.

2.7.3. Acceptance tests

Acceptance tests are used to evaluated product acceptability or liking or determine which of a series of products is the most acceptable or the most preferred. It should however be expressed that acceptability and preference are not the same thing. There are two main types of acceptance testing.

1. Measurement of acceptability or liking
2. Comparison of acceptability or preference

A number of sensory measurement scales have already been described and several of these are also appropriate for the measurement of acceptability or liking. In addition there are special hedonic scales for the measurement of liking.

Comparative assessments of acceptability or preference can be under taken using the paired or by the ranking test.

2.7.3.1. Hedonic Rating

In this test assessor is asked to record the extent of liking for a product usually by selecting a category on a "hedonic" or liking scale "Like very much" to dislike very much a number of different scales have been used. In this assumption, the data can be summarized by recording average "liking scores.

2.7.3.2. The requirements of the sensory test

It is important to ensure that all the necessary equipment is at hand, particularly if the products require some preparation prior to serving.

The test area also to be done the test, depend upon a number of factor, such as the frequency, such as the frequency of testing, the need to lay out large number of samples and the requirement of to store samples under control condition prior to testing.

The allocated area should be comfortably accommodate a panel of around 10-12 assessors, plus the panel leader. Segregating assessor and reducing bias due to group interaction. The test area should be well ventilated in order to maintain constant temperature and to remove product odour.

Sensory laboratory have well lighting to assess the sample, better day lighted place or using artificial day light. During the sample assessment the equipment used for preparation and serving will vary depending of the nature of the product. All the serving containers, it is important to avoid use pen giving off strong solvent odours.

2.7.3.3. The panel of acceptance test

The number of assessors required to panel, to carry out a particularly sensory analysis test will depend on a number of factors. Including the purpose of the test, the test procedure and the amount of the assessor training it entails, the variability of the product, the repeatability and consistency of the assessor's results. If the panel is too small, the result may be depend on individual judgements. There are 3 main types of panels for acceptance test.

2.7.3.4. Consumer panels

The best group to use evaluation the acceptability or preference of product or range of products, because they can be recruited to a quota that match the profile of the target consumer population in terms of product usage, demographics, etc.

2.7.3.5. Untrained panels

An untrained panel of at least 50 people possibly drawn from an "in house" panel of company employees may on occasion be asked to evaluate the acceptability of a product or a range of product (Carpenter, *et al.*, 2000).

2.7.3.6Trained panels

Training encourages assessors to be diligent in focusing on objective measurement and generating information on the full range of product attributes. They can no longer be expected to behave as native consumers and provide simple subjective value judgements (Carpenter, *et al.*, 2000).

2.7.4. Sensory parameters

2.4.1. Colour

The colour of the product is important appearance factor. The colour of a food affects our perception. The colour is an important appearance factor. Colour used in to assessing of the food. The colour of a food affects our perception and evaluation by other senses. Consumer preference based on the colour of the food. Colour characteristics of food can result from both pigmented and originally nonpigmented compound (Carpenter, *et al.*, 2000).

2.7.2. Smell

Smell can detect many different odours when sniffed through the nose, but it also important for detecting volatile given off by food items in mouth.

2.7.3. Taste

The sensation of taste is a receptor is a result of the effect of water soluble molecules interacting with receptors on the tongue and in the oral cavity. It is now generally accepted that there are four basic tastes (Carpenter, *et al.*, 2000).

2.7.4. Texture

The attribute of a substance resulting from a combination of physical properties and perceived by the sense of though, slight, and hearing, physical properties may include size, shape, nature and conformation of constituent structural elements (Carpenter, *et al.*, 2000).

2.8 Spoilage in preserved food and its prevention

Spoilage is brought about by the activity of micro organisms, physical and the factors, faulty techniques, rough handling, poor storage etc. A spoiled food is simply a food that is unacceptable to a consumer for reasons of smell, taste, appearance, texture, or the presence of foreign bodies (Garbutt, 1997).
The main causes of spoilage of canned other preserved products can be classified as three main groups.

- Chemical and physical spoilage
- Microbiological spoilage
- Enzymatic spoilage

2.8.1. Chemical and physical spoilage

Generally the bottles or a canned food, due to improper treating chemical and physical spoilage occurs. Therefore it shows many changes in food. Such as swell, rust, discolouration, undesirable textures and etc.

2.8.2. Microbiological spoilage

Canned food spoilage can be due to, under processing, survival of theomorphic bacteria and leaker spoilage. Even mild heat treatment will kill vegetative cells of bacteria, yeasts and moulds so that spoilage of this type is caused by spore forming anaerobes or facultative anaerobes. Low acid canned product can be spoiled by mesophilic spores formers. The organisms produce spoilage symptoms that consist of putrid off odours and gas (CO_2 and Hydrogen (H_2)) that causes the can sell or eventually burst (Garbutt, 1997).Yeasts need sugar and plenty of water for their normal growth and in suitable conditions the sugar converted in to alcohol and gas is evaluated. This reason that forms the food materials spoiled by yeasts gas evolves due to fermentation and bumps out the corks from the bottle with great force (Srivastav, 1982).

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1. Experiment 1-: Carbonation of fruit juices

3.1.1Materials-: Lime juice
Mixed fruit juice
Liquid carbon dioxide

3.1.2. Equipments-: Mr.Buttler soba maker
Thermometer
Freezer
Glass wares
Autoclave

3.1.3. Method-:

Carbonation principle

Carbon dioxide (CO_2) gas is readily soluble in cool or cold water. At 60°F and under 1atm (14.7 lb pis) of pressure, a given volume of water will absorb an equal volume of CO_2 gas. The solubility of CO_2 gas in water decreases with increasing temperature. The CO_2 gas is relatively insoluble in boiling water.

Pre prepared fruit juice

↓

Pasteurization (80°C-15min.)

↓

Freezing

↓

Thawing (using tap water at ambient temperature)

↓

Separate in to 5 samples having same volume

↓

Bring temperature up (using tap water at ambient temperature)

↙ ↙ ↓ ↘ ↘

0.0°C 4.2°C 7.4°C 10.0°C 15.5°C

↓

Fill in to sterilized bottles (160g for each bottle)

↓

Closed the bottles using cotton buds

↓

Open the cotton buds

↓

Carbonation

↓

Keeping for 7 days

(Observation the changes of appearance in bottles daily)

↓

Sensory evaluation was done at the 7th day.

Fig.3.1. Flow chart of carbonation of fruit juices

10kg of pre prepared lime juice obtained from Cecil factory was pasteurized for 15 min. at 80°C. Then it was filled in to polythene bag and closed tightly using rubber bands. Then fruit juice mass packed in the polythene bag was frozen until it become a solid mass (-14°C). Frozen solid mass was then thawed, until it become to liquid again using tap water at ambient temperature. The liquid fruit juice was then separated in to 5 samples having same weight. Those fruit juice samples were then again warmed using tap water at ambient temperature to bring the temperature of those 5 samples having same weight up to 0.0°C(32°F), 4.2°C(40°F), 7.4°C(45°F), 10.0°C(50°F) and 15.5°C(60°F) separately((App.03).

The lime juice sample at 0.0°C was filled in to 10 prior sterilized bottles, 160g each and closed with prior sterilized cotton buds. The same procedure was followed for all the 4 other samples in 0.0°C, 4.2°C, 7.4°C, 10.0°C and15.5°C.the bottles were then carbonated using carbonation machine. The carbonation bottles were lading and sealed and stored at ambient temperature for 7 days. Changes in the appearance of fruit juice were observed daily and compared with non carbonated lime juice bottle. On the 7Th day the bottles were opened and samples from bottles carbonated at each temperature were presented to sensory evaluation test (fig.3.1.).

3.2. Experiment -: Evaluation of the sensory qualities in carbonated lime juice at different temperatures

3.2.1. Materials and equipments-: Coded Carbonated Lime juice bottles
Water
Specimen evaluation sheet
Glasses
Tray
Non carbonated lime RTS

3.2.2. Method-:

Sensory evaluation was done by 10 trained panellists of CBL fruit and beverages (pvt) Ltd, with use of specimen evaluation sheet (see App.01).

Firstly coded 5 glasses were arranged to tray with glass of water. Then after the panellist came, the bottles were opened and put in to the coded glasses. The 5 samples were evaluated using 5 points hedonic scale, and were ranked as below.

Like Very Much	5
Like Slightly	4
Neither Like Not Dislike	3
Dislike Slightly	2
Dislike Very Much	1

Results were analyzed using computer aided Minitab software package statically analyzed, according to the nonparametric Freedman test at α=0.05 level of significant.

Table3.1.Codes of the samples

	The temperature of added CO_2	Sample code
1.	0.0	S_1
2.	4.2	S_2
3.	7.4	S_3
4.	10.0	S_4
5.	15.5	S_5

CHAPTER 4

RESULT AND DISCUSSION

At atmospheric pressure, the amount of carbon dioxide dissolved by water depends solely on the temperature since the solubility of gases is increased with the decreasing temperature. So in this experiment the temperature was altered and controlled at different levels in order to change the amount of CO_2 added to the product (App.03).

4.1. Result of the sensory evaluation for determination of optimum amount of CO_2 to be added in pretreated Lime juice

The result of sensory evaluation conducted to determine the amount appropriate CO2 amount was given below. According to the analyzed data of sensory evaluation the level of preference for each sensory attribute in all the five samples were identified.

4.1.1. The effect of CO_2 amount on the colour of the lime juice.

The highest sum of rank value for colour was obtained by sample S_5 which was carbonated at 0.0°C. According to the data analysis, there was not a significant different between the sample since probability P= 0.174 of the test is higher than the minimum probability value P= 0.05. Therefore the colour of the lime juice was not changed after carbonation when compared to natural lime juice (see App.01).

Table4.1.The effect of amount CO_2 on colour.

Sample code	N	Estimated median	Sum of rank
S_1	10	4.000	28.3
S_2	10	4.000	33.0
S_3	10	4.000	28.0
S_4	10	4.000	25.5
S_5	10	4.000	35.5

(Like Very Much 5, Like Slightly 4, Neither Like Not Dislike 3, Dislike Slightly2, Dislike Very Much1)

4.1.2. The effect of CO_2 amount on the taste of juice

The result of the effect on the taste of the carbonated lime juice show highest rank for the S_5 sample which added CO_2 at 0.0°C.According to the analysis there is a significant difference between the samples, since probability value P = 0.022 of the test is less than the minimum probability value 0.05. According to the data S5 sample which added CO2 to 0.0°C gained the highest median for taste. Therefore this sample comes under category "like slightly" according to the 5 point hedonic scale (see App.01).

Table 4.2 the effect of amount CO_2 on taste

Sample code	N	Estimated median	Sum of rank
S1	10	2.900	28.0
S2	10	3.000	27.5
S3	10	2.700	22.0
S4	10	3.400	32.0
S5	10	4.000	40.5

(Like Very Much 5, Like Slightly 4, Neither Like Not Dislike 3, Dislike Slightly2, Dislike Very Much1)

4.1.3. The effect of CO_2 amount on the Fizzness of juice

According to the data analysis there is a significant difference between the samples, since probability value P=0.000 of the test is less than minimum probability value P=0.05. So the sample which added CO_2 at 0.0°C gain the highest sum of rank value with the highest estimated median for the fizzness. Therefore this sample comes under the category of "like Slightly" according to the 5 point hedonic scale(see App.01).

Table 4.3 the effect of amount CO_2 on fizzness

Sample code	N	Estimated median	Sum of rank
S1	10	2.450	20.0
S2	10	2.850	25.5
S3	10	2.950	25.0
S4	10	3.050	31.0
S5	10	3.950	48.5

(Like Very Much 5, Like Slightly 4, Neither Like Not Dislike 3, Dislike Slightly2, Dislike Very Much1)

4.1.4. The effect of CO_2 amount on the mouth feels of juice

The sample which added CO_2 in 0.0°C shows highest sum of the rank to the sensory evaluation test. The Probability value of test is 0.013. It's lower than the minimum value of 0.05, so the mouth feel is significantly difference each other samples. Also the highest median is given by the S_5 sample (see App.01).

Table 4.4 the effect of amount CO_2 on mouth feel

Sample code	N	Estimated median	Sum of rank
S1	10	3.050	26.7
S2	10	3.050	27.0
S3	10	2.950	21.0
S4	10	3.750	37.5
S5	10	3.950	38.5

(Like Very Much 5, Like Slightly 4, Neither Like Not Dislike 3, Dislike Slightly2, Dislike Very Much1)

4.1.5. The effect of CO_2 amount on the overall acceptability

The result of the effect on the overall acceptability of the carbonated lime juice show highest rank for the S_5 sample which added CO_2 at 0.0°C.According to the analysis there is a significant difference between the samples, since probability value P =0.003the test is less than the minimum probability value 0.05. According to the data S5 sample which added CO2 to 0.0°C gained the highest median for overall acceptability. Therefore this sample comes under category "like slightly" according to the 5 point hedonic scale (see App.01).

Table 4.4 the effect of amount CO_2 on overall acceptability

Sample code	N	Estimated median	Sum of rank
S1	10	2.400	18.0
S2	10	3.200	31.0
S3	10	2.600	24.0
S4	10	3.500	36.0
S5	10	3.800	41.0

(Like Very Much 5, Like Slightly 4, Neither Like Not Dislike 3, Dislike Slightly2, Dislike Very Much1)

4.2. Discussion

The juice can be easily transported as solid form than it is in liquid form. That was the reason for freezing before transportation.

The solid mass was thawed using tap water. If any other heat source is used, the flavour and chemical changes could be occurring due to its high thermal activities. Accessibility of water is easier than other heat source and save energy too. That is the reason for choosing tap water to thaw the frozen juice.

Carbonated mix fruit has been fermented which might due to the processing in open environment. The abnormal foamy appearance and sedimentation are the evidences for fermentation. Those observations even match with literature information, which proves the fermentation of juice.

The lime juice has not been fermented as mix fruit and, the above mentioned observations have not been seen in the lime juice because, lime is acidic in nature. So, less accessibility is provided for microbes. But, mix fruit is a low acidic juice which provides a better medium for microbes.

Pressure is a critical parameter of bottling. The bottles could be able to crack in the excess pressure. To avoid the cracking, a considerable volume of head space was kept.

The bottles were sterilized before filling, and finally it was covered by a cotton wool as soon as possible, to prevent the contamination.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The highest desirable organoleptic parameters was given by lime juice at 0.0°C.
Lime juice carbonation was succeeded.

5.2. Recommendations

- A shelf life evaluation is to be done at ambient conditions.
- The carbon dioxide amount of bottled juice should be measured.
- The mix fruit carbonation should be carried out again, by changing its formula.
- Head space optimization should be carried out in further trials.

REFERENCES

- Ashurt, P. R. (1998) The chemistry and technology of soft drinks and fruit juices. Sheffild academic press, Bocaraton, pp258.

- Carpenter, P. R., Hasdell, A. T. and Lyon, D. H. (2000) Guidelines of Sensory analysis. Aspen publishers, Maryland, pp209.

- Ensminger, A.H., Ensminger, M. H., Konlande, E. J. and Robson, J. R. K. (1994) Food and nutrition Encyclopedia. 2nd end, CRC Press, v.2, pp 1208.

- Hotchkiss, H. J. and Potter, N. N.(1996) Food Science. 1st edn, CBS publishers and Distributors, pp608.

- Gardutt, J.(1997) Essentials of Food Microbiology. 1st edn, Arnold, a member of the Headline group, pp 251.

- Kumar, S. and Srivastava, R. P.(2002) Fruit and Vegetable Preservation principle and practices. 3rd edn, Army Printing press, pp 474.

- Phlips, G.F. and Woodroof, J.(1974) Beverages: Carbonated and Noncarbonated, 4th edn, Avi Westport,pp530.

- Srivastava, R. P. (1982) Preservation of fruit and Vegetable products. Siva printers, Dahra Dun, pp 142.

APENDIX 01

SPESIMAN EVALUATION SHEET FOR THE HEDONIC SCALE TEST

SCORE SHEET FOR ASSESMENT OF CARBONATED LIME RTS

NAME...

DATE...

Please indicate your preferences according to the five points hedonic scale starting from like very much (5), dislike very much (1) for the 5 samples given.

LIKE VERY MUCH 5
LIKE SLIGHTLY 4
NEITHER LIKE NOT DISLIKE 3
DISLIKE SLIGHTLY 2
DISLIKE VERY MUCH 1

QULITITY CHARACTERISTIC	S1	S2	S3	S4	S5
1.COLOUR					
2. TASTE					
3. FIZZENESS					
4. MOUTHFEEL					
5. OVERALL ACCEPTABILITY					

COMMENTSANDSUGGETION...
...
....
....

APENDIX 02

———— 7/26/2006 10:33:38 PM ————————————

Welcome to Minitab, press F1 for help.

Friedman Test: colour versus carbonated lime RTS blocked by Assessors

S = 2.70 DF = 4 P = 0.609
S = 6.35 DF = 4 P = 0.174 (adjusted for ties)

carbonated lime RTS	N	Est Median	Sum of Ranks
s1	10	4.0000	28.0
s2	10	4.0000	33.0
s3	10	4.0000	28.0
s4	10	4.0000	25.5
s5	10	4.0000	35.5

Grand median = 4.0000

Friedman Test: taste versus carbonated lime RTS blocked by Assessors

S = 7.54 DF = 4 P = 0.110
S = 11.42 DF = 4 P = 0.022 (adjusted for ties)

carbonated lime RTS	N	Est Median	Sum of Ranks
s1	10	2.9000	28.0
s2	10	3.0000	27.5
s3	10	2.7000	22.0
s4	10	3.4000	32.0
s5	10	4.0000	40.5

Grand median = 3.2000

Friedman Test: fizzeness versus carbonated lime RTS blocked by Assessors

S = 19.54 DF = 4 P = 0.001
S = 23.26 DF = 4 P = 0.000 (adjusted for ties)

carbonated lime RTS	N	Est Median	Sum of Ranks
s1	10	2.4500	20.0
s2	10	2.8500	25.5
s3	10	2.9500	25.0
s4	10	3.0500	31.0
s5	10	3.9500	48.5

Grand median = 3.0500

Friedman Test: mouthfeel versus carbonated lime RTS blocked by Assessors

S = 9.38 DF = 4 P = 0.052
S = 12.59 DF = 4 P = 0.013 (adjusted for ties)

carbonated lime RTS	N	Est Median	Sum of Ranks
s1	10	3.0500	26.0
s2	10	3.0500	27.0
s3	10	2.9500	21.0
s4	10	3.7500	37.5
s5	10	3.9500	38.5

Grand median = 3.3500

Friedman Test: ovarall Acceptibility versus carbonated lime RTS blocked by Asse

S = 13.52 DF = 4 P = 0.009
S = 15.72 DF = 4 P = 0.003 (adjusted for ties)

carbonated lime RTS	N	Est Median	Sum of Ranks
s1	10	2.4000	18.0
s2	10	3.2000	31.0
s3	10	2.6000	24.0
s4	10	3.5000	36.0
s5	10	3.8000	41.0

Grand median = 3.1000

——— 5/6/2006 8:01:49 PM ———

Welcome to Minitab, press F1 for help.
Retrieving project from file: 'F:\BEVERAGES\BEVERA.MINITAB.MPJ'

APENDIX 03

Volume of CO_2 gas absorbed in one volume of water

Pressure, in bottle, Pigs											
Temp,°F	0	10	20	30	40	50	60	70	80	90	100
32	1.17	2.9	4.0	5.2	6.3	7.4	8.6	9.7	10.9	12.2	13.4
40	1.45	2.4	3.4	4.3	5.3	6.3	7.3	8.3	9.2	10.3	11.3
50	1.19	2.0	2.8	3.6	4.4	5.2	6.0	6.8	7.6	8.5	9.5
60	1.00	1.7	2.3	3.0	3.7	4.3	5.0	5.7	6.3	7.1	7.8
70	0.85	1.4	2.0	2.5	3.1	3.7	4.2	4.8	5.4	6.1	6.6
80	0.73	1.2	1.7	2.2	2.7	3.2	3.6	4.1	4.6	5.2	5.7
90	0.63	1.0	1.5	1.9	2.3	2.7	3.2	3.6	4.0	4.5	4.9
100	0.56	0.9	1.3	1.7	2.0	2.4	2.8	3.2	3.5	3.9	4.3

(Phlips, 1974)

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