COMPARATIVE STUDIES OF SOME NON-CARBONATED SOFT DRINKS

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D E C L A R A T I O N

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been submitted in any form elsewhere for award of any other degree or certificate.

Information obtained from the published and unpublished works of others has been acknowledged by means of references.

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D E D I C A T I O N

TO MY WIFE AND CHILDREN.

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ABSTRACT,

This analytical study was carried out on some of the common non-carbonated soft drinks manufactured by various food industries in Nigeria. Among those analysed, shelf-life studies of five commonly consumed brands namely Juicy Orange, Apple, Tutti frutti, and Cola all of Saladel Enterprises Ltd., Products, Kano and Lima Orange juice of Lima Services Ltd., Kano, were carried out on storage for three months at room temperature (23° - 25°C).

For the shelf life study the following parameters were envisaged; specific gravity values, Brix values, refractive index, pH, Acidity, Ascorbic acid, total solids, crude protein, saccharin, colour and preservative used.like free sulphurdioxide, sodium benzoate and sorbic acid if present. These analysis were carried out on the freshly bottled samples, which served as the control (standard) while the storage samples were analysed periodically after 4, 8, and 12 weeks storage. For the colour determination, analysis was done periodically after two weeks. However, in comparison with the control, results showed a constant increase in pH, total solids and some other parameters with time while ascorbic acid (Vit. C), preservatives and crude protein values, decreased.

Slight changes were recorded in the colour, taste and flavour of the camples on storage. The titratable acidity values remained virtually constant throughout the period of investigation although it varied from one drink to the other.

Other parameters studied but not included for the storage study were ash content, alkalinity of ash, moisture content, average liquid content, head space, major and trace elements. Other ready to drink types purchased from the market were also analysed, they were Fruits O r a n g e made at Ogbomosho in Oyo State, VIP Apple drink from Lagos, Essdee grapefruit from Lagos, Fruit Maid Pineapple from Jos, Caprisonne Orange from Kaduna and Okin pure apple drink also from Kaduna. The last two samples analysed were the concentrated drinks (Dilute to taste types) namely:-

Tree Top Orane drink produced by Lever Brothers Limited, Lagos and Rola Extra Strong Lemon-lime by Alro Ltd., Kano.

From the data collected, an attempt has been made to:

(a) enumerate how the various non-carbonated soft drinks analysed compared to each other; and

how they measure up to the stipulated quality standards required of soft drinks in agreement with the food Laws of Nigerian Standard Organisation (N.S.O.), and Food and Drug Administration Standards (F.D.A).

(b) detect any adulteration and estimate the contaminants.

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ABBREVIATIONS

J.O.	-	Juicy Orange
J.A.	-	Juicy Apple
J.T.F.	-	Juicy Tutti frutti
J.C.	-	Juicy Cola
L.J.	-	Lime Orange Juice
F.O.	-	Fruito Orange
V.A.D.	-	VIP Apple Drink
Ess.	-	Essdee grape fruit
F.M.P.	-	Fruit Maid Pineapple
C.O.	-	Caprisonne Orange
O.P.J.	-	Okin Pineapple Juice
T.T.O.	-	Tree Top Orange drink
R.L.L.	-	Rola Lemon Lime
R.T.D.	-	Ready to drink
D.T.T.	-	Dilute to taste
N.S.O.	-	Nigerian Standard Organisation
F.D.A.	-	Food and Drugs Administration
B.A.	-	Benzoic acid
Vit.	-	Vitamin
S.A.	-	Sorbic acid
SO_2	-	Sulphur dioxide
Brix	-	% sugar content
A.V.	-	Acidity value
Sacc.	-	Saccharin
C.P.	-	Crude protein.

CHAPTER ONE

1.0 I N T R O D U C T I O N

1.1 NON-CARBONATED SOFT DRINKS:

A soft drink is defined from a legal point of view (1) as: Any liquid intended for sale as drink for human consumption, either without or after dilution and includes mainly:

i. any fruit drink, and any fruit juice squash, crush or cordial;

ii. any sweetened artificially carbonated water whether flavoured or unflavoured.

iii. cereal products containing alcohol, which are not intoxicating liquors.

Definition (i) - (iii) excludes many drinks which are commonly thought of as 'soft drink'. The word beverage, is permissible in this context. A "beverage" is defined in the Concise Oxford Dictionary as a drinking liquor (2).

Initially soft drinks are generally considered harmless and not usually promoted on the grounds of doing you good. Today, more and more attention is being given to the formulation of soft drinks which can be advertised as nutritionally beneficial because of some particular ingredients added.

The term 'non-carbonates' are sometimes used for squashes and fruit juices e.g. "Still lemonade" (lemonade without carbonation). Generally, soft drinks are non-alcoholic drinks, produced from ripe fruit juice, from which the names "fruit juice drinks" are coined, and known currently as natural or organic drinks, and if held for one or more days, they partially ferment. Juice varieties of various fruits are used. Non-carbonated soft drinks are usually prepared from a concentrated syrup containing sugar (and possibly saccharin), fruit juice (or flavouring essence), citric acid and preservative (usually sodium benzoate). Artificial colouring matter is added to some drinks' products (4). In the manufacturing, a specific volume of the syrup is measured into the bottle and capped for sale. Some orange juices, (ready-to-drink) are widely sold in places such as cinemas, local markets, departmental stores and theatres. Legislation (1) now divides soft drinks into those 'for consumption without dilution and those for consumption after dilution', but they are also described in the trade as 'unconcentrated' and 'concentrated' (specially for consumption after dilution, by babies and young children). The present day industries deal, then with products of apparently considerable variety, but simply, they can be considered as fruit and vegetable juices, squashes and cordials.

1.2 RESEARCH JUSTIFICATION AND OBJECTIVE:

With the alarming increase in the population of soft drink producers and the rate at which the drinks are consumed in Nigeria and the World as a whole, the ultimate pending consequences of the side effect of the chemicals, synthetic flavours and artificial food colours added when compounding the drink syrup, seem to bid the imagination of every rational citizen. The need to search for the composition of these beautifully coloured drinks is highly obvious and mandatory. On this justifiable ground, an intensification of research in carbonated and non-carbonated soft drink has been, and is still going on with other research centres. In Nigeria, large amount of soft drinks' ingredients are imported or formulated with imported ingredients to suppliment our megre sources. The foreign exchange involved here could be better channeled to other pressing projects, if the knowledge of the nutritional sources of our environment is a bit more widened.

Non-carbonated soft drinks have food value that depends largely on distinct and measurable characteristics, hence the desire for quality assurance leads to analysis of the measurable parameters, because if food is prepared for sale, with a major motive of maximising profit, it would be adulterated to a greater or lesser degree. Most of the

consumers are attracted by the beautiful colours of soft drink, while some go for taste especially, children feel happy when served with beautifully coloured drinks, without knowing exactly what are contained in them. And unfortunately, soft drinks are served as refreshment items in places like national seminar's centre, conferences, parties and other social gathering centres.

The objective of this work is to study the physical properties and to determine quantitatively the composition of non-carbonated soft drink, so as to shed more light on its nutritional value, if any, and to what extent the food value can last on storage. Efforts have also been made to compare the results obtained with some data, to the maximum permissible level of ingredients, adulterants and contaminants in agreement with the Food Laws of Nigerian Standard Organisation (N.S.O), and Food and Drug Administration Standards (F.D.A.).

1.2.1 Nutritional Consideration.

Non-carbonated soft drink is among the food and beverages produced by various food manufacturing industries in Nigeria. The taking of soft drink is a way of making available more vitamins, minerals and natural sugars to the body of infants, invalids and senior citizens. The chief nutritional contribution of fruit drinks, other than

the caloric value supplied by their natural sugar content, is vitamin C (the Antiscurvy Vitamin). Some manufacturers add vitamin C to the products, others do not, although none of the products approach the vitamin concentration of fresh fruit juice drink.

A balanced diet includes any one from 2360 - 3800 calories a day depending on age and amount of activity. About 200cm^3 of soft drink should contain about 100 calories, and because they are in the form of sugar, they convert almost instantly into energy. Soft drinks consist of about 90% purified water and because of that, medical practitioners recommend soft drinks to patients with cold and virus infection to prevent dehydration. Sometimes soft drinks help to settle upset stomach, especially if carbonated.

1.2.2 Quality control of soft drinks.

At present, there is high competition and great demand of soft drinks, so, the quality control function is necessarily becoming more complex than ever before and it assumes an increasingly vital role in the economy of production, as well as ensuring that only product of the desired quality reaches the market. The function of quality control is to achieve a high and consistent standard of quality in the product and to check the

formulation and the ingredients of soft drinks. The quality control also takes care of the control of the quality of water and its treatment before use for soft drinks manufacture.

Quality is generally accepted as the degree of excellence (5), and may be defined as its conformity to a given level of excellence which represents particular standards or specifications with minimum cost to the producer. The proper balance of ingredients in the soft drink's syrup must be maintained and quality control tests are run continously.

1.3 Analysis of ingredients in soft drinks.

Chemical research of soft drinks helps to develop and improve new soft drink ingredients leading to better products and more efficient plant operations. Most of the drinks could be fortified with vitamins, colours or flavours blended with one another and may be preserved with chemicals. Chemical analysis is the detailed examination of materials used in compounding the syrup, as well as for nutrient determination if any. Some of these materials do not have any significant effect on the quality of the finished product. For the determination of materials where complex method of analysis could not easily be carried out, lesser analytical technique could be used, e.g. taste, flavour, odour and colour additive's test.

Non-carbonated soft drink consists of a large number of chemical substances, however, the main constituents are nutritionally useful e.g.

i. soluble carbohydrates e.g. glucose, sucrose, dextrose which are the total sugars (nutritive sweeteners).

ii. non-nutritive sweeteners e.g. saccharin and sorbitol.

iii. proteins with a variable amounts of inactive substance;

iv. inorganic salts and trace metals;

v. vitamin C (the antiscurvy vitamin) and the preservatives.

vi. materials that contribute to the colour, odour and flavour of the drinks.

For the proximate analysis of soft drink, it involves determination of the percentage of the natural occuring parameters, e.g. moisture content, ash value and alkalinity of ash.

1.4 SHELF LIFE STUDY OF SOFT DRINKS

The period between manufacture and retail purchase of a food product during which the product is of satisfactory quality is commonly referred to as the shelf life (5, 29 - 31). Apart from soft drinks, all food products have a definite and variable shelf life under different environmental conditions e.g. temperature, relative humidity and light intensity. There are very slow chemical changes that take place during storage. The changes lead to deterioration in nutritional value, flavour, colour and taste of the product. The rate of loss depends on the formulation, light and amount of handling. Apart from environmental and physical means of spoilage, there are microbiological means, due to growth of micro-organisms. Some food colours e.g. tartrazine yellow fade off quickly in sunlight.

Heats promote chemical reactions and will therefore hasten loss of freshness. The chemical changes possibly taking place in soft drinks are oxidation, reaction of free chlorine, saponifications of esters, hydrolysis and other chemical reactions of flavouring ingredients. There is also the break down of complex molecules of caramel by reactions of acids and minerals (12). Oxidation may be due to air containing oxygen which is introduced into the product as a foreign gas, this

oxygen alters many flavours, and spread changes brought about by light, heat, micro-organisms and other chemical products of the soft drinks. Alkaline water used causes off-odour due to its reaction with the drinks flavours. Caramel becomes insoluble after standing for a few days (13). The insolubility of caramel is due to the break down of the complex molecule under the actions of the acids, and in some cases, the mineral salts.

1.5 LITERATURE REVIEW

1.5.1 Historical Background: (5)

In 1865 in U.S.A, the following flavours for sodawater were advertised: pineapple, blackcherry, orange, apple, apricot and peach. The soft drink industry was on its way throughout its history, and endeavoured to produce high quality products for the public it served. The National Soft Drink Association (N.S.D.A), which represents bottlers producing about 90% of soft drinks sold in the country, works closely with all elements of the industry to assure that continous attention is given to product packaging and quality controls. Cola, lemon-lime, orange, ginger ale and grape are very popular flavours of soft drinks. Soft drinks manufacturers have produced every conceivable type of flavour from grape fruit, pineapple,

black cherry, peach, strawberry, creamsoda, and many other taste and eye appealing mixtures. These drinks are very popular and they are used as refreshment items.

Soft drinks are available in nearly every type of container from returnable bottle to paper cup. Most soft drink manufacturers are under Franchise agreements with companies that own the rights to formulae and trade names. In some cases the Franchise company actually provides the syrup or flavour concentrates. The ingredients of a typical soft drink are purified water, sugar, flavouring, edible acids and colouring. The finished products of soft drinks are usually dispensed in a cup through a vending machine or a soda fountain. Juices of fruits have been drunk since recorded history and juices of vegetables, as beverages, came during the current history e.g. tomatoes are the chief source of vegetable juice.

1.5.2 Vending and some types of non-carbonated soft drinks (4, 5).

Vending of soft drinks are in form of cups, cans, and various types of bottles whether plastic or glass types. Most of the brands of the non-carbonated soft drinks are served as wonderful punch. The soft drink products are advertised under a variety of trade names, e.g. fruit drinks, juice drinks, breakfast drinks, ades,

nectars, treats, cocktail mix, squashes, comminuted drinks, cordials, black currants, mineral water, tonic water and cola. Most of these types of drinks are found in different sections of the grocery displays.

1.6 NOTES ON SOME OF THE INGREDIENTS USED IN SOFT DRINKS.

1.6.1 Water in soft drinks.

Water is basic to the finished soft drink products. More than 85% of the total volume of soft drink is water (5). To produce a uniform and consistent high quality of soft drink, it is essential to use treated water according to specifications.

1.6.2 Flavours in soft drinks.

Flavour is not a single, sharply defined sensation, but the combination of many basic sensations such as sweet, sour bitter and burnt (5). Chemical analyses of the volatile components in foods, some of which may contribute to flavour, has recently become one of the most important areas of flavour chemistry (13). Several prominent orange beverages have lemon as a predominating flavour, but because they are coloured orange, the consumer associates the flavour with orange.

The natural raw materials used in preparing flavour bases take many forms e.g. essential oils, juices, oil resins, solid extracts and other materials like plant extracts. Synthetic flavourings are the largest group of flavouring materials which are composed of synthetic chemicals and they are isolated from natural materials. The synthetic chemicals consist of the aliphatic and aromatic terpene alcohols, aldehydes, ketones, acid esters, phenols, phenol esters, lactones and organic derivative of sulphur. Other types of flavour materials are essences, spices, emulsion and concentrates.

1.6.3 Sweeteners in soft drinks:

The major sweetener used for soft drinks is sucrose which is usually sold in form of dry sugars, invert sugars and other liquid sugars. The dry sugars are brown, medium brown and dark brown in colour and they are in granulated forms. The brown sugars are obtained when molasses are added to white sugars. Other types of sugars used in soft drinks are fructose (levulose which is fermentable and not often found in great quantity in nature. Sucrose, dextrose and lactose, when heated, loose water and darken in colour. The dark coloured product is called caramel which is used for colouring and flavouring of foods and beverages.

Saccharin is a non-nutritive sweetener usually added to soft drinks. It is about 500 - 700 times sweeter than sugar (sucrose) depending on amount taken. Saccharin is a non-food chemical synthesised in 1979 (5). Saccharin (O-Sulpho-benzimide, $C_7H_5NO_3S$) is an aromatic organic compound, usually available and used in form of its sodium salt called soluble saccharin (5). The insoluble structure of saccharin is given thus (13)



insoluble saccharin.

At present, saccharin is the only non-nutritive sweetener approved by the Food and Drug Administration (F.D.A) to be used for food and beverages in U.S.A. Other non-nutritive ingredients used for soft drinks in other parts of the world are naringin neohesperidin, sodium cyclamate and manitol. There are also other sweeteners viz: dipeptide sweeteners which are glycine, D-tryptophan and L-aspartyl-L-phenyl alanine.

1.6.4 Acids in soft drinks:

Acids are among the ingredients that give character and individuality to soft drinks. They are easy to measure and handle; amounts added are neither too small nor too large, hence errors from bulk syrup are usually avoided. Changes in the acidity values of soft drinks will indicate some types of reactions going on in the drinks that might lead to off-taste. The commonest acids used in soft drinks are:

i. Citric acid:

Citric acid blends well with fruit flavours. It is associated with malic acid in apples and apricots. Citric acid is used in soft drinks because of its acidic properties, as well as its salts e.g. sodium or calcium citrate. The use of citric acid is based on its powerful sequestering action. The crystalline or powdered form is easily soluble in water. Citric acid has a formula $COO.CH_2.C(OH)COOH.CH_2COOH$ (anhydrous form). The hydrated type commonly used has the formula $H_2O(HOOC)(OH)C(CH_2COOH)_2$.

ii. Phosphoric acid:

The phosphoric acid is universally used in cola drinks and probably acidifies more beverages than citric acid. The taste is sour in contrast to the sharp fruitness of citric, hence used with most non-fruit drink.

iii. Tartaric acid:

Tartaric acid was originally obtained from grape fruit. Other acids include fumaric, adipic and malic acid. Generally, citric acid, phosphoric and tartaric acids are synergists and they have also some antioxidant action in soft drinks.

1.6.5 Preservatives in soft drinks.

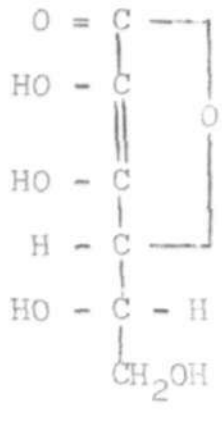
To check spoilage in soft drinks, certain chemicals commonly known as preservatives are added. There are three types of preservatives:

i. Antimicrobials.

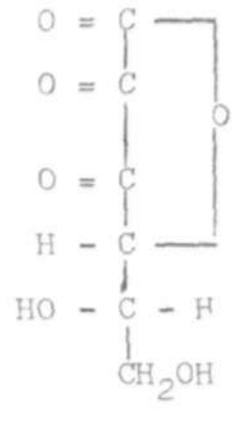
These are benzoic acid, hydroxybenzoic acid (33), sorbic acid, sulphur dioxide (9) and diethyl pyrocarbonate. They act as bacteriostatic and germicidal agents in soft drink. Benzoic acid are added to soft drink in form of its sodium salt (sodium benzoate). Sorbic acid is an unsaturated and aliphatic organic compound, it is a white crystalline solid. Its I.U.P.A.C. name is trans, trans-2,4-hexa dienoic acid with the formula $CH_3 - CH = CHCH = CHCOOH$ (4, 5, 22).
Sulphur dioxide is commonly introduced into the drinks in the form of its salts (potassium or sodium metabisulphite

ii. Antioxidants:

Ascorbic acid, gumguaiac, lecithin and tocopherols are among the anti-oxidants used in soft drink. Ascrobic acid improves the shelf life stability of flavours in drinks. It has two structures reduced and oxidised form.



reduced form



oxidised form.

iii. Antibiotics:

The antibiotics include mainly oxytetracylines and chlorotetracyclines. The addition of these preservatives do not make the drink. to become immune to spoilage, rather it increases the time it takes to get spoilt.

1.6.6 Colour additive in soft drinks

A colour additive is any material not exempted under the food law, that is a dye, pigment, or other substances made by a process of synthesis or similar artifice, or extract, isolated or otherwise derived, with or without

intermediate or final change of identity, from a vegetable, animal, mineral, or other sources and that when added or applied to a food, is capable of imparting a colour to it. This include all diluents. Substances capable of imparting a colour to a container are not colour additive e.g. red peppers, chocolates which contribute their own natural colour when mixed with other foods are not regarded as "colour additives", but where a food substance e.g. beetroot juice is deliberately used as a colour, as in pink lemonade; is a colour additive. Harmless colours are available and generally used e.g. coal-tar colours and caramel which confer black colour to cola drinks (5, 24). There are also imitation colours such as beta-carotene, xanthophylls and cryptoxanthin. It is obvious that the correct colour levels is used in all imitation fruit juice drinks. Drinks colour like the natural colour can fade with time. The colour fading of soft drinks is due to any or all of the following: sunlight, trace metals, ascrobic acid and micro-organisms.

1.6.7 Contaminants in soft drinks:

The term 'contaminants' refers to undesirable materials which have been added inadvertently before, during or after processing the drinks e.g. trace metals. Trace metals may get incorporated into the drinks due to attack on the processing plant, container, or from water itself.

Although it is difficult to legislate specifically against all possible forms of contaminations, maximum limits have been recommended for trace elements. From the view point of the food analyst, the term 'trace elements' refers to the inorganic elements which may be present in foods in amounts usually well below 50 ppm and have some toxicological or nutritional significance (24, 29). For example copper(Cu) causes off-flavours in dairy products and tends to destroy vitamin C in fruit products. Possible minimum concentration of various metals e.g. Cr, Fe, and Sn which are detectable by taste in food products has been discusssed in some texts (25, 26).

There are three possible sources of trace metals in soft drink (4).

i. Use of impure chemicals to manufacture raw materials e.g. Arsenic contaminated sulphuric acid to manufacture sugar, tartaric acid, phosphates and food colours.

ii. Food sources (especially acid foods and those containing salt or alcohol), which may dissolve metals from the equipments like tinplate, foils, solders, galvanized iron, cheap enamels and glazes.

iii. Water containing some of these trace metals e.g. Cu, Cr, Fe, Pb, Sn.

CHAPTER TWO

2.0 ANALYSIS OF SOFT DRINKS

The analysis of some soft drinks has been carried out with respect to the following materials (brands of non-carbonated soft drinks).

2.1.1 Materials and locations:

No	Materials	Abbreviations	Manufacturer's Location
1.	Juicy Orange	J.O.	Saladel Enterprises Ltd, Plot 19, Challawa Industri Estate, P.O. Box 820, Kano
2.	Juicy Apple	J.A.	- do -
3.	Juicy Tutti frutti	J.T.F.	- do -
4.	Juicy Cola	J.C.	- do -
5.	Lima Orange Juice	L.J.	Lima Services Ltd, Kawaji, Kano.
6.	Fruito Orange	F.O.	Midland foods and Beverages Ltd, Box 110, Ogbomosho, Oyo State.
7.	VIP Apple drink	V.A.D.	International Canners and Food Processing Co. Ltd. Lagos.
8.	Essdee Grape fruit drink	Ess.	Essdee Food Products Nig. Ltd, Isolo Road, Box 530, Mushin Lagos.
9.	Fruit Maid	F.M.P.	Nigerian Associated Best Foods Ltd; Jos.
10.	Caprisonne Orange	C.O.	New Food and Drinks Co. Ltd., Kaduna.
11.	Okin Pineapple juice	O.P.J.	Okin Bottling Co. Ltd, Box 1529, Kaduna.
12.	Tree top orange	T.T.O.	Lever Brothers Nig. Ltd., Lagos.
13.	Rola lemon-lime	R.L.L.	Alro Ltd., Kano.

2.1.2 Procurement of samples:

Bulk samples of the drinks No. 1 - 5 above were collected from the production plants on the day they were produced. Representative samples of every brand were selected at random and kept in their respective container and brought into the Laboratory for analysis. Samples No. 6 - 11 were purchased from the local market and some departmental stores, and then brought into the laboratory for similar analysis. Samples No. 12 - 13 were concentrated drinks, also purchased from the departmental stores.

2.1.3 Parameters determined from the above drinks.

The following subheadings show in detail the parameters determined.

a. Quantitative determinations:

i. Specific gravity

ii. Brix - % sugar content

iii. Average-liquid content and Head space.

iv. pH-values

v. Titratable acidity g/100cm^3

vi. Vitamin C mg/100cm^3

vii. Total solids g/10cm^3

viii. Moisture content (%)

ix. Ash content g/100cm^3

x. Alkalinity of ash mg K_2CO_3/100cm^3

Quantitative determinations (cont'd)

xi. Major elements in ppm e.g. Mg. Na, Ca and K

xii. Trace elements in ppm e.g. Co, Fe, Cu, Pb, Zn.

xiii. Refractive index

xiv. Crude protein content mg/100cm^3

xv. Benzoic acid content in ppm

xvi. Saccharin Content in ppm.

xvii. Sulphur dioxide content in ppm

xviii. Colour determination (changes in absorbance with time).

b. Qualitative Tests:

i. Taste

ii. Colour (appearance to the eye)

iii. Cost per bottle (retail price)

iv. liquid content on label

v. Type of container with cap.

2.1.4 Procedures and Reagents.

a. Procedures:

The general procedures for measurement of the various parameters under the above quantitative determinations were adopted according to the standard methods recommended and described in some standard textbooks of food analysis (4, 21, 22, 24, 27, 31, 33), and some standard methods used by some well known Analysts or Journals as fully enumerated and acknowledged under the reference section of this project (32, 34, 38, 40).

b. Reagents:

All reagents used were of analytical reagent grade, unless otherwise stated.

2.1.5 Sample preparation:

The sample preparation for every parameters determination was according to specification required by the specific parameter as would be met below.

2.2 GENERAL ANALYSIS OF THE DRINKS

2.2.1 Taste, Flavour and Odour tests:

Taste could be referred to as an oral perception of sensations like sweetness, sourness, salty and bitterness which were mediated by taste buds located on the tongue in the mouth (30). The taste of sweetness for example in foods is derived mainly from sugar such as sucrose and fructose. Acids are responsible for sour taste in food e.g. the tartness in cola drinks are attributed to the presence of phosphoric acid and in most orange drinks, the citric acid.

Like taste, flavour and odour, are sensory phenomenon which necessitate human judgements. Most people with normal taste and flavour perceptions do not perceive all flavours in the same manner. Taste and flavour like colour, give character and individuality to the soft drinks.

Method:

Six people were invited - three males and three females to the laboratory, and a cup each of the samples were presented one after the other to taste and smell. Results of the tests are shown in tables 1, 2 and 3.

2.2.2 Specific Gravity Determination (34, 36).

The specific gravity was determined using the specific gravity bottle method. The weight of known volume of the drink was compared to the weight of exactly the same volume of water at 20°C.

Apparatus:

50cm^3 specific gravity bottles with well fitted ground-glass stopper through which runs a narrow hole each.

Mettler weighing balance.

Each bottle was washed with chromic acid solution, and rinsed with distilled water then dried in an oven at 80°C (to constant weight).

Procedure:

Each of the dried specific gravity bottles was weighed and recorded as mass Mo. The bottles were then filled with distilled water and their stoppers inserted, the excess

water that oozed out was wiped away from each of the bottles with filter paper, leaving the water level with the top of the stopper. The wiped bottles with water were weighed and recorded as mass M_1 each. Then the distilled water was poured away and each of the bottles was cleaned with methylated spirit and dried. The soft drink sample was then shaken and filled into each of the bottles and stoppers replaced. The bottles with drinks were wiped off and dried as before, then weighed and now recorded as mass M_2. The experiment was repeated three times.

Calculation:-

The specific gravity of each of the samples was calculated using the formula given below.

Theory:-

Mass of water to fill bottle = $M_1 - M_o$

Mass of soft drink to fill bottle = $M_2 - M_o$

$\therefore$ Specific gravity of sample (soft drink)

$$= \frac{\text{mass of soft drink}}{\text{mass of an equal volume of water}}$$

$$= \frac{M_2 - M_o}{M_1 - M_o}$$

From this relationship, the average specific gravity of the soft drink samples were recorded as presented in tables 1, 2 and 3.

2.2.3 °Brix: Percentage Sugar Content (4, 33, 37, 38).

When pure syrups of known composition are to be examined, the refractometer affords a rapid and fairly accurate method of estimating the sugar content. The soluble solids (sugar) are determined from the refractive index and calculated as sucrose (irrespective of the actual soluble substances present). This technique of analysis is the most useful industrially for routine control purposes when a rapid comparative measure is the major consideration (4).

Apparatus:

A sugar refractometer 0 - 50% Brix, manufactured by Bellingham and Stanley Limited, Tunbridge Wells, England. Materials involved are water and samples.

Procedure:

Two drops of the drink samples were smeared on the prism and cover with the opened hinged cover, and directed to bright light or sun, then looked at the hairline which cuts through the calibrated sugar composition. The Brix value of every sample was read off from the illuminated scale of the refractometer and recorded (39). The experiment was repeated three times. The results are given in tables 1, 2 and 3.

2.2.4 Determination of Average liquid content and Head space value.

The determination is to check the amount of drink as printed on the label. In quality control, it helps in knowing amount per bottle.

The head space value is an indication of entrapped air in the drinks and this is delivered to help microbial growth and, rapid destruction of vitamin C due to oxidation.

The head space and the average liquid content were both determined in the factory where the samples were produced.

Procedure:

The cover of the container of the drink was opened carefully and the drink was poured into a $500cm^3$ measuring cylinder and recorded the actual volume of the drink as (V_1). The sealed type of aluminium foil containers were similarly opened and determined similarly with the bottle type. Then the empty container was filled with distilled water up to the brim and then poured into an empty $500cm^3$ measuring cylinder, and the containers volume was recorded as (V_2). The difference between these two readings is the Head space value (surface air content).

Calculation:

Head space value = $V_2 - V_1$ (cm^3), if the stipulated value on the label is V_3; then the true liquid content = $V_3 - V_1$ (cm^3). This was done in triplicate and an average value was recorded in tables 1, 2, and 3.

2.2.5 Determination of pH (37).

The pH of soft drinks gives an indication of their possible resistance to microbial spoilage. The acidity as measured by the pH value is an important controlling factor in many natural and manufacturing processes.

Apparatus:

Pye Unicam pH meter, model 290

mk_2 ($\pm$ 0.02pH); thermometer.

Reagents: Buffer solutions of pH 7 and 4 which were prepared by adding a satchet of each of the pH hydrion buffer to distilled water and the volume made up to $100cm^3$.

Procedure:

The pH meter was calibrated using the two buffer solutions. After calibrations, the pH of the drinks were taken immediately the bottles were opened, and pH was measured from the scale. The results are given in tables 1, 2 and 3.

2.2.6 Refractive Index Determination (33, 37)

The refractive index value when converted to ^{o}Brix (37) can be used in conjunction with the specific gravity values of the drinks to determine the sugar content.

Apparatus:

A refractometer type Abbe 60, was used but without the Brix calibration for direct sugar content reading. The prevailing temperature was recorded with the zeal thermometer for correction.

Procedure:

The main prism of the refractometer was exposed by opening the hinged illuminating prism through 180^{o}. Two drops of the soft drink sample were smeared on the horizontal prism. The light was put on and the hairline adjusted to the centre, then the refractive index value was read from the illuminating scale of the refractometer.

2.2.7 Determination of Colour in soft drinks (54)

The measurement of colour necessitate human judgement. Colour analysis of drinks is best accomplished by the International Commission on Illumination (C.I.E.) tristimulus system using the selected ordinate method (54).

For routine purposes, the colour determination was based on the observation of the absorbance of an appropriate dilution at a dominant wavelength.

Apparatus:

A Unicam, SP 800, ultraviolet spectrophotometer, a wavelength selector type of the pye Unicam model, cells of 1 cm width.

Procedure:

The cells were filled with the sample of the drink and scanned from the ultraviolet region to the visible region. The absorbance of the dominant wavelength was recorded for each sample and was used for subsequent determinations. The results are given in tables 1, 2 and 3.

2.3 DETERMINATION OF TITRATABLE ACIDITY (39, 40).

Acidity values (31) of soft drinks were determined titrimetrically and the results reported as grammes per $100cm^3$ of the predominating acid.

Apparatus:

Beakers, Burette, pipette, pH-meter and conical flasks.

Reagents:

0.05M sodium hydroxide was prepared by dissolving 0.5g of pure sodium hydroxide pellets in 250 cm^3 distilled water. Phenolphthalein indicator solution.

Procedure:

10cm^3 of the sample of the soft drink was measured into a conical flask and diluted with about 10cm^3 of distilled water. One drop of phenolphthalein indicator was added and titrated with standard 0.05M NaOH solution until the first pink colour just appeared.

For the coloured samples, the titration was carried out using a pH meter and titrated to a pH of 8.3.

Calculation:

$$\text{Conc. g/100 cm}^3 = \frac{M_b \times V_b \times 6.404}{V}$$

where M_b = molarity of NaOH

V_b = volume of NaOH used (cm^3)

V = volume of sample titrated (cm^3)

The results are given in tables 1, 2, and 3.

2.3.1 Determination of Ascorbic Acids (Vitamin C.) (5, 33)

Ascorbic acid content was determined by visual titration method. This method depends on the oxidation of ascorbic acid by iodine liberated from potassium iodide which with starch gives a dark blue colour at the end point of titration.

In the reaction medium L-ascorbic acid reacts with two equivalents of Cu^{++} ions in the form of Copper(II) sulphate ($CuSO_4$).

The cupric salts reacts with an excess of potassium iodide (KI) to form cupric iodide which is unstable and spontaneously decomposed to give cuprous iodide and free iodine.

$$2CuSO_4 + 4KI \longrightarrow 2CuI_2 + 2K_2SO_4$$

$$2CuI_2 \longrightarrow Cu_2I_2 + I_2$$

The iodine liberated then oxidises L-ascorbic acid to L-dihydroascorbic acid, and hydrogen iodide given out.



L-ascorbic acid

Dehydro-l-ascorbic acid.

This reaction continues until all the ascrobic acid present in the solution is oxidised by the liberated iodine; any excess of iodine will develop a blue colour with starch indicator solution.

Apparatus:

Microburette of 5cm^3 capacity graduated to 0.01cm^3, volumetric flask, and pipette.

Reagents:

i. Standard copper sulphate ($CuSO_4.5H_2O$) solution, prepared by dissolving 0.2497g of high purity hydrated copper sulphate crystals in distilled water then made up to 100cm^3.

ii. 30% and 50% ($^m/v$) potassium iodide solution were prepared by dissolving 30g and 50g respectively of KI in distilled water and made up to 100cm^3 each.

iii. 1% ($^m/v$) aqueous starch solution was also prepared by dissolving exactly 1g of soluble starch powder in warm water and the solution was diluted to 100cm^3 with distilled water.

Procedure:

A 5cm^3 of sample was accurately pippetted and transferred into a 25cm^3 volumetric flask and corked immediately, then 10cm^3 KI solution was added followed immediately by adding a few drops of starch indicator

solution. The mixture was then titrated with standard $CuSO_4.5H_2O$ solution until a brown colour of liberated iodine just appeared.

Calculation: L-ascorbic acid content (mg/aliquot)

= V.C. where

V = volume of 0.01M $CuSO_4.5H_2O$ solution used and

C = 0.88mg L-ascorbic equivalent to $1cm^3$ of 0.01M $CuSO_4.5H_2O$ solution.

The results are given in tables 1, 2 and 3.

2.3.2 Total solids and Moisture Content: (33, 41).

Fruits and fruits products usually contain invert sugar in considerable amount and this large amount of invert sugar (total solids) could be determined along with moisture content of the drink. The directions for its proximate analysis specified drying at $70^{o}C$ in vacuum oven under low pressure to prevent decomposition of the levulose.

Ordinary oven cannot be used because if soft drink is exposed to the air of the drying oven, constituents could be oxidised; and a gain in weight of such constituents offsets the loss in weight due to moisture.

Apparatus:

Vacuum oven, evaporating dishes,

Mettler balance and desiccator.

Procedure:

Some evaporating dishes were washed and dried in an ordinary oven at 80°C for about 20 minutes and then cooled in a desiccator, weighed and recorded as mass M_1. Then 10cm^3 of drink's samples was pippetted into every dish, weighed and recorded as Mass M_2. The dishes with samples were then placed into a vacuum drier oven which was maintained at a constant temperature of 70°C and a pressure of 50mmHg.

Drying, cooling and weighing in session to constant mass was carried out with the evaporating samples in this procedure.

1st day 5 hours

2nd day 3 hours

3rd day 3 hours.

The final weight at the end of the third day was recorded as mass M_3.

Experiment was done in triplicate.

Calculation:

The loss in weight of the samples after total evaporation is recorded as the moisture content.

$$= \frac{M_2 - M_3}{M_2 - M_1} \text{ g/10cm}^3.$$

$$\% \text{ Moisture content} = \frac{M_2 - M_3}{M_2 - M_1} \times \frac{100}{1}.$$

$$\text{OR \% moisture content} = \frac{\text{mass of liquid sample - mass of dry sample x 100}}{\text{mass of liquid sample}}$$

The weight of dry sample was the amount of total solid present and the results are given in tables 1, 2 and 3.

2.3.3 Nitrogen and Crude Protein Determination (55-63)

The determination of the organic nitrogen and crude protein content in soft drinks is extremely important in the corresponding research laboratories; more over, the Kjeldahl method, which is continually being improved, is the most wide spread. This method is more appropriate for this determination because the reaction rate is easily accelerated by some catalysts added to the drink sample. There is digestion process during which oxidation occur and caused nitrogen to be converted to a form that is easily determined.

For most routine purposes the "crude protein" is calculated by multiplying the total nitrogen by an empirical factor which is based on the proportion of nitrogen in the protein. Most protein contain about 16% Nitrogen (4, 44) and the total nitrogen estimated by this method is multiplied by 6.25 to express the average crude protein. The volumetric method of Kjeldahl is less time consuming, convenient and simple in technique. This determination is done in three stages.

1. Sample completely digested with concentrated sulphuric acid and nitrogen converted to ammonium sulphate.

2. Ammonia is liberated by making the mixture with $(NH_4)_2SO_4$ alkaline and NH_3 is distilled.

3. The distilled Ammonia is determined by titration.

Apparatus:

$100cm^3$ Kjeldahl flasks, conical flasks, Markham-micro nitrogen still, Kjeldahl distilling bulb, straight tube condenser, and Heating mantle.

Reagents:

All reagents used were of AnalaR grade free from nitrogen.

Procedure:

About 50cm^3 drink sample was measured into a clean dry 100cm^3 Kjeldahl flask. Mixed catalyst (1g) consisting of 160g. anhydrous K_2SO_4, 10g. $Cu.SO_4.5H_2O$ and 3g sodium pellets and 5cm^3 conc.H_2SO_4 were added. Few chips of pumice stones was also added as antibumping material. The mixture were carefully digested over an electrical heater to a clear greenish colour. About 30 minutes latter, the heat was put off and allowed to cool, then 15cm^3 of distilled water was added. The contents was then transfered into a 50cm^3 volumetric flask, more distilled water was used to rinse out, but leaving the pumice stones behind. The 50cm^3 flask with the digested material was shaken to mix well, then made up to the mark. The diluted digest was transferred to the steamed out apparatus and 15cm^3 of 40% NaOH added, then closed up immediately to prevent escape of ammonia. The liberated ammonia was steam distilled into 20cm^3 boric acid solution (2%) containing 4 drops of mixed indicators in a conical flask for 5 - 10 minutes. The distillate was then titrated with 0.1M HCl to the end point when the indicator changed from green through faint to a definit pink colour and amount of acid consumed was recorded.

Calculation:

$1cm^3$ of 0.1M HCl = 0.0014g N

= 1.4mg N

The calculation was based on the above given formula

% nitrogen content of sample is given by:

$$\frac{v\ cm^3 \times (0.1)\ HCl \times 0.0014 \times 100}{V}$$

where v = volume of acid used and

V = volume of sample digested.

Therefore, the % crude protein content

= % nitrogen content X 6.25.

The results are given in tables 1, 2 and 3.

2.4.0 Determination of sodium benzoate (4, 12, 64)

The volumetric determination of the acid is based on the partition Law using a solvent which is immiscible with the drink. A modified A.O.A.C. (1975) method of analysis was adopted; and for the purpose of regulations the amount present is calculated as the acid itself.

Apparatus:

Separating funnels, beakers and conical flasks.

Reagents:

Redistilled chloroform (AnalaR) grade, 30% ethanol obtained by diluting $30cm^3$ of absolute ethanol to $100cm^3$ with distilled water, phenolphthalein indicator,

0.1% alcoholic solution also obtained by diluting 0.1 cm^3 to 100cm^3, 0.05M NaOH which was prepared by weighing 0.5g NaOH pellets and dissolved with distilled water and made up to mark in 250cm^3 standard volumetric flask.

Procedure:

The drink sample (~10cm^3) was extracted with 7, 4, 5 and 3cm^3 portions of chloroform. The extracts were transferred into a 250cm^3 beaker and evaporated to dryness. The residue was dissolved in 30% ethanol and 2 drops of indicator solution were added, then titrated with 0.05M NaOH to the pink end point.

Calculation.

$$\text{Sodium benzoate (g/100 cm}^3\text{)} = \frac{\text{V.cm}^3\ \text{NaOH} \times \text{M} \times 0.144 \times 100}{\text{Volume of Sample (cm}^3\text{)}}$$

V = volume of NaOH used in the titration

M = molarity of NaOH.

The results are given in tables 1, 2 and 3.

2.4.1 Determination of Saccharin (4, 65, 67)

Saccharin can be extracted by making the sample strongly acidic with HCl and then extracted with ether. The combined extracts of saccharin is then estimated by titration after the solvent is removed.

Apparatus:

Separating funnel with corks.

Reagents:

NH_3 solution, ether, conc.HCl and acetone.

Procedure:

The sample -50cm^3 was measured into a separator, then 10cm^3 conc.HCl and 10cm^3 water was added. The saccharin was extracted by shaking with three separate portions of 25cm^3 ether. The combined extracts was then washed with two separate portions of water (10cm^3), and then filtered to remove the solvent. About 3cm^3 acetone was added to the residue and evaporated, then 2cm^3 of water added and titrated with 0.05M NaOH using bromothymol blue as indicator.

Calculation:

The calculation was based on the formula; 1cm^3 0.05M NaOH = 0.00916g saccharin. The results are given in tables 1, 2, and 3.

2.4.2 Determination of Free Sulphur dioxide (SO_2) (4, 38-40, 63, 70).

There are many methods proposed for the determination of (SO_2) in foods and drinks. Among them are:-

1. distillation of SO_2 in presence of acid and in an inert atmosphere.

2. absorption in an oxidising agent (e.g. iodine) which converts the H_2SO_3 into H_2SO_4.

The determination of SO_2 is based on the following reactions.

$$I_2 + KI \rightleftharpoons KI_3$$

$$I_2 + I^- \rightleftharpoons I_3$$

$$I_3^- + SO_2 + H_2) \longrightarrow SO_3 + 3I^- + 2H^+.$$

3. Direct titration method.

Apparatus:

Burrettes, pipettes, and other volumetric equipments needed.

Reagents:

Iodine solution (0.02M) prepared by weighing 2.54g of resublimed iodine and dissolved in 40% potassium iodide and then made up to 1 dm^3 mark with distilled water in a standard volumetric flask (40).

Acidified starch solution; this was prepared by dissolving 10g soluble starch in 900cm^3 hot water and then 100g citric acid added after cooling to make it acidic.

Procedure:

25cm^3 of the drink sample was pipetted into 250cm^3 Erlenmayer flasks and 0.5 cm^3 acidified starch solution added as indicator. The mixture was then titrated with 0.02M iodine solution to a dark blue end point. The titration was repeated three times.

Calculation:

Free SO_2(mg/dm^3)

$$= \frac{v.M.64.1000}{V}$$

where v = volume of iodine used (cm^3)

M = Molarity of iodine,

V = volume of sample (cm^3)

The results are given in tables 1 and 3.

2.4.3 Sorbic Acid Determination:(4, 70 - 72).

Sorbic acid is usually incorporated to foods as a salt of potassium or sodium. For its estimation, sorbic acid is steam distilled from the food materials. But in the case of drinks, it is saturated with $MgSO_4$ and then determined by U.V. absorption at pH 2- 4.

Equipments:

Distilling units, SP 800, U.V. spectrophotometer and its accessories, volumetric flask and double

Reagents:

Magnesium sulphate, dilute H_2SO_4 (0.5M), NaOH (1M) and the blank (distilled water).

Procedure:

50cm^3 of drink sample was measured into a 500cm^3 double neck flask, 100g magnesium sulphate and 100cm^3 0.5M H_2SO_4 added, and then distilled rapidly into 10cm^3 1MNaOH using Kjeldahl distilling flask to avoid coloured distillate. 50cm^3 distillate was collected in 15 minutes and then transferred into a 100cm^3 flask. Another 15cm^3 0.5M H_2SO_4 was added and made up to volume. The sorbic acid was determined by the non-oxidative method.

U.V. absorption:

A suitable dilution of the distillate with 0.005M H_2SO_4 was made. Using water as a reference, the extinction was measured at about 260nm and 280nm.

Calculation:

The corrected value for E_{260} was determined from the formula.

$$E_{260}^{\text{sorbic acid}} = 1.418E_{260} - 0.811E_{280}$$

where E = absorbance read from paper.

The corrected formula is design to allow for sugar decomposition products during distillation. The value of $E^{1\%}_{1cm}$ may be taken as 2260 (4)

$E = \epsilon CL$ where E = calculated absorbance from paper.

ϵ = Molar absorptivity

C = conc. in g/dm^3

L = Path length = 1 cm.

The results are given in tables 1, 2 and 3.

2.5 DETERMINATION OF THE ASH CONTENT (42, 43).

The ash value of a drink is an analytical term used for the inorganic residue after the organic matter has been incinerated. But ash value is not the exact inorganic matter that is present in the original food as there may be losses due to volatilization or chemical interaction between the constituents.

The main value of the ash, the alkalinity of the ash and the acid-insoluble ash if known are simple methods for assessing the quality of drinks or food generally e.g. a high total ash is undesirable in fruits and fruit products.

The ash content was determined by evaporation and ignition (incineration) of the drink at high temperature.

Apparatus:

A muffle furnace with Gallenkamp hot box oven size one, silica dishes brought to constant mass (M_1) by heating in the furance at 600°C, desiccator, pair of tongs and mettler weighing balance.

Procedure:

10cm^3 of every sample was pippetted into each of the constant mass silica dish and evaporated to dryness in the oven at 100°C, and then gently heated on hot plates placed inside a fume cupboard until smoking ceased. The smokeless samples were then transferred into the muffle furnace which was preheated at 500°C and incinerated at 500°C for 3 hours. The heating continued until all the carbon had been burnt away and the furnace switched off. The dishes with the residue were brought out with pair of tongs and placed in an efficient desiccator for cooling. Then the mass of silica dishes with ash were taken and recorded as M_2 each. The arithmetic mean of at least three determinations was often taken as the result.

Calculation:

Ash content of the sample was calculated thus:

$$\text{Ash content} = \frac{M_2 - M_1}{V} \times \frac{1000}{1} \text{ g/dm}^3.$$

where V = volume of sample used.

The results are given in tables 1, 2 and 3.

2.5.1 Alkalinity of the ash (4, 33)

From 2.5 above, the ash value of every sample obtained was subjected to further treatment for the determination of the alkalinity of ash. The alkalinity of ash was obtained by titration (volumetric) method and the following procedure was adopted.

Procedure:

About $20cm^3$ of distilled water was added to the ashed samples and each of them was transferred to different $100cm^3$ beakers. The silica dishes were further rinsed with $10cm^3$ distilled water and added to the ash solutions in beakers, and then made up to $50cm^3$. $10cm^3$ of 0.1MHCL was added to every beaker and boiled to half way to ensure complete removal of carbon dioxide. After cooling, they were back titrated with 0.1M NaOH, to the end point at pH 4.5 using methyl orange as an indicator.

The different in volume of alkali (0.1MNaOH) used in the titration and volume of acid (0.1MHCl) first added gave the volume of acid corresponding to the amount of sample ashed.

Calculation:

The value of alkalinity of ash was calculated as carbonate of potassium thus:

$$1\ cm^3\ 0.1N\ NaOH = 0.0069g K_2CO_3\ (4).$$

The results are given in tables 1, 2 and 3.

2.5.2 Elemental Determination using Flame Photometer and and Atomic Absorption Spectrophotometer (A.A.S)

The wide application of spectral emission analysis in Analytical Chemistry makes it necessary to carry out work on the elemental determination of drinks, foods and other materials generally. There is particularly a rapid development in this technique of analysis. However, despite the merits of these sources, they have serious deficiencies limiting their applications, particularly for the analysis of high purity substances.

2.5.3 Flame Photometric Determination of Potassium and Sodium (4, 44 - 46).

When the investigated solution is spread in the flame of the photometer, the atoms of the metal are excited by absorbing radiant energy of the flame. On returning to the ground state, they emit the absorbed radiation. The intensity of the emitted radiation is directly proportional to the concentration of the element in the solution. The alkaline metals (Potassium and Sodium) were determined with flame photometer where they are more sensitive.

Preparation of Potassium Standard Stock Solution

The AnalaR Potassium chloride was dried and 1.912g weighed out and dissolved in deionised distilled water and made to volume in 1 dm^3 volumetric flask and labelled as 1000 ppm K (stock solution). 0.2cm^3, 0.4cm^3, 0.6cm^3, 0.8cm^3, 1.0cm^3, 1.2cm^3, 1.4cm^3, 1.6cm^3, 1.8cm^3 and 2.0cm^3 were taken from the stock solution and each diluted to 100cm^3 with deionised distilled water and labelled as the working standard solutions with concentrations 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20ppm respectively.

Sodium Standard Stock solution:

Sodium standard stock solution was similarly prepared by drying some AnalaR Sodium Chloride at 120^{o}C for one hour. After cooling for 30 minutes, 2.54g was weighed out, and dissolved in 1dm^3 volumetric flask and made up to the mark with distilled deionised water and labelled 1000ppm Na.

The working standard solutions of 2, 4, 6, 8 and 10ppm Na were similarly prepared as for potassium solutions. The two standard stock solutions were stored in plastic bottles.

Soft drink sample preparation:

10cm^3 of the drink samples were pippetted out into the silica dishes and ashed, then transferred into 200cm^3 beakers. 100cm^3 of deionised distilled water and 10cm^3 of conc.HCl were added to each beaker and boiled for several minutes.

Interference by salts of Ca, Fe, and Al were removed by adding ammonium solution after cooling and filtered with ashless filter paper. The ammonium solution was first prepared by diluting 60cm^3 of Ammonia solution to 200cm^3 with distilled water.

The filterates were transferred into 100cm^3 volumetric flask and each made up to volume.

Aspiration of the Working Standard Solution and the Drink Sample Solution.

Using a filter to give a spectral range of 776 - 770nm, the sensitivity of the instrument (Flame photometer) was set so that the full deflection i.e. 100% transmittance occur with 20ppm for potassium determination. The zero deflection was obtained with the blank and then each standard and sample solutions were aspirated in turn, flushing with deionised distilled water after every reading.

For sodium determination, the 100% transmittance was reset with 10ppm standard working solution, and zero deflection again with the blank.

From the readings obtained, the calibration graphs for potassium and sodium were plotted with the readings obtained with standard working solutions of each and the sample values for each of the element was read from the graphs.

Calculation:

From the calibration curve obtained, the concentration of the sample solutions were extrapolated, and the actual concentration of the sample solution was got by multiplying with the dilution factor. The results obtained are shown in table 1 and 2.

2.5.4 Determination of Calcium, Magnesium, and the trace metals (Iron, lead and Zinc) using Atomic Absorption Spectrophotometer (A.A.S). (44, 47 - 49, 52 - 53).

Apparatus:

Atomic Absorption Spectrophotometer Model Pye Unicam SP 1900, cathode lamps for the metals to be determined.

Flame: Air/acetylene flame.

Preparation of the Standard Stock Solution of metals.

Calcium.

2.4973g calcium carbonate (AnalaR grade) was weighed out and dissolved in 50cm^3 deionized distilled water followed by dropwise addition of 10cm^3 concentrated HCl to effect complete dissolution. The solution was transferred into a 1 dm^3 volumetric flask, made to mark and Labelled 1000ppm Ca. The solution was titrated against 0.1M EDTA. The calcium standard working solutions 0 - 10ppm were prepared by appropriate dilution of 0.2, 0.4, 0.6, 0.8 and 10cm^3 of the stock solution to 100cm^3 with deionised distilled water which gave 2, 4, 6, 8 and 10ppm respectively.

Releasing Agent: (Lanthanum solution)

A weighed sample of lanthanum nitrate (10g) was dissolved in deionised distilled water and then $20cm^3$ conc.HCl was slowly added, shaked to dissolve. After cooling, it was transferred to one litre ($1\ dm^3$) volumetric flask and made to mark.

Magnesium.

The starting solution of magnesium was prepared by weighing (10.0133g) Magnesium sulphate and dissolved with $200cm^3$ deionised distilled water. Then $1.5cm^3$ conc.HNO_3 was added and made up to 1 litre ($1\ dm^3$) in Standard volumetric flask with deionised water. The solution was then titrated against 0.1M EDTA Solution using Eriochrome Black T as indicator and found to contain 1000 ppm Mg and Labelled. The standard working solutions were similarly prepared as for calcium.

Iron:

9.8g Ferrons ammonium sulphate $(NH_4)_2SO_4.6H_2O$) was weighed out and dissolved in 1 litre ($1\ dm^3$) volumetric flask with deionised distilled water then made up to mark and labelled 1000 ppm Fe.

Lead:

This was also prepared by weighing out (1.8g) lead nitrate $Pb(NO_3)_2$ and dissolved with deionised water and made up to mark in 1 litre volumetric flask, then labelled 1000ppm Pb.

Zinc:

A weighed sample (4.3980g) Zinc sulphate hepta-hydrate ($ZnSO_4.7H_2O$) was dissolved in deionised distilled water and made up to 1 dm^3 mark in standard volumetric flask and also labelled 1000 ppm Zn.

All the three stock solutions were similarly titrated against 0.1M EDTA solution as for Magnesium above and all stored in plastic bottle. The working standard solutions were also prepared like calcium solutions.

Soft drink sample preparation for A.A.S. determination

The drink samples were ashed in the same way as for sodium and potassium determination except that there was no addition of ammonium solution to prevent interference by the elements Cr, Fe and Al.

The filterate obtained from ashed samples were stored in 100cm^3 volumetric flasks and each made up to mark.

Spraying of the Prepared Samples into A.A.S.

The appropriate lamp for every element was inserted into the instrument (A.A.S.) in turn and the reading of every element recorded, but in the case of calcium determination, the releasing agent (lanthanum nitrate solution) was added to every suitable volume of sample

solution taken for estimation. The standard solutions were successively sprayed together with the blank, washing the instrument with deionised water between every spray.

Mean of three readings for each standard solution were recorded for every element. The calcium content was assessed (allowing for that of the blank) from the sample and estimated from the standard curve. The concentrations of the elements (Fe, Pb and Zn) present in the samples were estimated from their calibration curves (40). The results are shown in tables1 and 2.

2.6 SHELF-LIFE STUDY OF SOME SOFT DRINKS.

Some of the available non-carbonated soft drinks produced in the country (Nigeria) were used for the shelf life study. Drinks used for the shelf life study were products of two different companies, both based in Kano.

2.6.1 Materials and locations:

The following drinks were used for the shelf life study.

No.	Name of drinks	Manufacturers and their location
1.	Juicy Orange (J.O)	Saladel Enterprises Ltd., Plot 19, Challawa Industrial Estate, P.O. Box 820, Kano.
2.	Juicy Apple (J.A)	-do-
3.	Juicy Tutti frutti(JTF)	-do-
4.	Juicy Cola (J.C)	-do-
5.	Lima orange Juice (L.J)	Lima Services Ltd., Kawaji, Kano

2.6.2 Procurement of Samples.

The sampling period for the shelf-life study was carried out in the month of June and July 1983. Bulk samples of the drinks were collected from the production plants on the day they were produced. The drinks were selected at random and one carton (crate) of twenty four bottles for every brand was collected on the dates stipulated below.

1. Juicy orange 04 - 07 - 1983
2. Juicy Apply 06 - 07 - 1983
3. Juicy Tutti frutti 21 - 06 - 1983
4. Juicy Cola 07 - 07 - 1983
5. Lima Fruit (orange) Juice 05 - 07 - 1983.

2.6.3 Shelf-life tests for the drinks:

The simplest method of determining the shelf life of a freshly bottled drink is the storage test. It entailed withdrawing a representative quantity of bottles from each production batch and stored them for a given period at a certain temperature. The samples were subjected to regular checks for changes in appearance, flavour and taste. The bulk samples were preferably stored in a room having diffused light and maintained at an average temperature of 23°C.

In Nigeria, soft drink storage is carried out by the producers the traders and the consumers. Most Nigerian traders leave their consignment of soft drinks outside, in the sun and covered with tarpaulin, some of the drinks are, however stored in the room, and those to be sold immediately are kept in the refrigerator.

2.6.4 Sampling for analysis.

Every month, some bottles of every brand of drink were collected from the cartons of the stored samples and kept in the refrigerator with an average temperature of about 4.0°C, and then used for the analysis for that month. An interval of thirty days were allowed for every parameter's determination and the results obtained for the same parameters were compared and recorded. The analysis was conducted from the 2nd to the 9th of every month starting from August to November 1983 in a predetermined sequence.

2.7 ANALYSIS FOR SHELF LIFE STUDY:

The analysis for the shelf life study has been carried out with respect to the following parameters: Specific gravity, % sugar content, refractive index, pH-values, titratable acidity value, ascorbic acid (vit. C), total solids, preservatives used e.g. sorbic acid, free sulphur dioxide, sodium benzoate. Others are saccharin content if any, crude protein content and colour. All these parameters were quantitatively determined as justified below.

1. Specific gravity:

Precipitation and possibly evaporation of some of the components of the drinks can lead to changes in the specific gravity on storage and this could affect the shelf life of the drinks. The procedure adopted for the determination was the same as described in the general analysis. (see no. 2.2.2). Results of the analysis are shown in table 4.

2. ^{o}Brix-% sugar content.

Fermentation and possibly other chemical reactions with the sugar content could lead to deterioration in sugar value and these changes in the sugar content of the drinks would certainly affect their shelf-life.

The Procedure for analysis was as described in the general analysis of sugar content (see no 2.2.3).
Results of the analysis are shown in table 5.

3. Refractive index

Since refractive index can be converted to brix, it could be used in conjunction with the specific gravity of the drinks to determine the sugar content. Changes in refractive index value therefore, implied that, there were changes in the sugar content of the drinks on storage which would definitely affect the shelf-life of the drinks. Procedure adopted in this analysis was similar to the one used on the general analysis as described in (no. 2.2.6). Results of analysis are shown in table 6.

4. pH-value of the drinks:

The pH of soft drinks give an indication of their possible resistance to microbial spoilage with time, so variation in pH-value on storage could be used to assess the shelf life of the drinks. The procedure for analysis was as described in the general analysis. (see no 2.2.5). Results of analysis are shown in table 7.

5. Titratable acidity value:

Changes in the acidity values of soft drinks indicate some types of reactions going on in the drinks, that might lead to off-taste of the drinks with time.

Procedure followed was as described in the general analysis (see no. 2.3.)

6. Ascorbic acids (vitamin C)

When ascorbic acid is added to soft drinks, it is preferentially oxidised and lost (5). Aldehydes, ketones and keto-esters are susceptible to oxidation, therefore, flavouring ingredients containing these compounds loose their characteristic flavours during storage, therefore vitamin C determination is another technique of assessing the self-life of the drinks. Procedure for analysis is similar to the one described in general analysis (see no. 2.3.1) Results are shown in table 9.

7. Total solids as % dry weight

The function of the storage time is due to different weather conditions. Chemical reactions in the drinks could result to decomposition and oxidation of components such as caramel in cola drinks, and hence caramel concentration in drinks is expected to deteriorate with time and affect the shelf life. Procedure for analysis was as described in the general analysis (see no 2.3.2).
Results are shown in table 10.

8. Sorbic acid (Preservative)

Sorbic acid is one of the major preservatives used in soft drinks, since all preservatives deteriorate on storage if used in drinks, the periodic determination of sorbic acid in soft drinks is a way of assessing the shelf-life of the drinks. The procedure for analysis is as described in No. 2.4.3.
Results are shown in table 11.

9. Free Sulphur dioxide:

Sulphur dioxide could be used as a preservative in soft drinks. Part of the total sulphur dioxide added to drinks combines with some of the drinks components, and only a portion is active against micro-organisms. The bound portion appeared to be inefficient and drinks with sulphur dioxide deteriorate on storage, hence reducing the shelf life of the drinks. Procedure for analysis was as described in the general analysis (see no 2.4.2). Results are shown in table 12.

10. Sodium benzoate.

Sodium benzoate is one of the preservatives used in non-carbonated soft drinks, and the liberated acid (benzoic acid) prevent the drinks from spoilage in time, hence used to assess the shelf life of the drinks.

Procedure used has been already described in the general analysis. (see no. 2.4.0).

Results are shown in table 12.

11. Saccharin content:

Saccharin generally decomposes with increase in the surrounding temperature with time (13), and this progressive loss can be used to study the shelf life of drinks.

Procedure for determination was as envisaged in the general analysis see no 2.4.1.
Results are shown in table 12.

12. Crude protein determination:

Generally crude protein value of food deteriorates with time and it also applies to drinks. The decrease in protein value indicates deterioration in nutritional value and makes the drinks to be less acceptable with time.

Procedure for analysis was similar to that already described in general analysis (see no 2.3.3).

Results are shown in table 13.

13. Colour changes in soft drinks:

Changes in the colour of a drink might be due to either changes in the composition of the colouring materials or changes in other certain components of the drinks. Colour deterioration phenomenon can be used to study the shelf life of drinks.

The procedure for analysis was as described in the general analysis (see no 2.2.7).

Results are shown in table 14.

CHAPTER THREE

3.0 DISCUSSION OF RESULTS:

The discussion of the results of this study would be based on how the experimental results obtained from the parameters determined, compared to one another, and to the stipulated quality standards needed in a soft drink (6, 20, 74, 75). The detected adulterant and contaminants were compared to the highest desirable level or maximum permissible amount as emphasised in the regulation. Table 1 - 3 showed the results obtained from parameters considered in the general analysis while tables 4 - 14 showed the results obtained from the parameters indicated for the shelf life study of the drinks selected.

3.1 SOFT DRINKS OBTAINED FROM FACTORIES IN KANO.

The results on the table 1 showed that all amounts of contaminants and level of additives added fell within the permitted limit needed for consumption, except that they all had very low nutritive value (protein content).

Looking through the table, it was observed that the specific gravity results were almost the same except that the lime juice had the lowest value as recorded. The same amount of sugar was added to the juicy brands of drinks while about half of this value was added to lima juice suggesting that they must have added an artificial sweetener.

The pH values were almost the same except that juicy cola had the highest value of 3.3. All the five brands of drink had very low pH value. The full benefit of the preservatives added was obtained only at low pH, but satisfactory results were achieved at values of between pH 2.5 - 4.0. Off-flavours due to growth of lactic acid bacteria can be prevented by reducing the pH to below 3.0 and growth of most yeasts was slowly inhibited below pH 3.0. In countries where the addition of preservative to soft drinks is not permitted, a low pH-value as observed in the table is the only way.

The acidity values were different in all the five brands analysed suggesting that different amount of acids were added to different brands initially. The titratable acidity value of a soft drink is a measure of the weak acids e.g. acetic, lactic, formic, tartaric and in most cases citric acid. According to Nigerian standard Organisation (N.S.O) and Nigerian Industrial Standard 1976, they should not exceed 0.5% of a finished soft drink, and the results obtained from the samples fell within this specified limit.

The results obtained from moisture, ash, major and trace elements showed that the percentage moisture contents were almost the same for all the samples. Lima orange juice was found to contain the highest concentration of inorganic

components (ash) of 5.80mg/10cm^3 followed by juicy cola 4.80mg/10cm^3, while the juicy orange had the lowest. The alkalinity of ash too was found to very with different types of drinks and lima juicealso had the highest value followed by juicy cola as observed.

From the table, about one or two trace elements were detected in some of the samples and the values fell within the specified limit. Trace elements like Co, Cu, Cr and Mn were below detectable level if at all they were present. Amount of potassium was the highest of all the major elements suggesting that most of the chemicals used in the manufacture were in the form of potassium salt rather than sodium or calcium salt. Other major elements detected may be present originally with the type of water used, and all of these metals were within the specified limit expected of a soft drink or food materials generally. The high amount of sodium observed resulted from either sodium citrate or water used for soft drink production. The average liquid content was not all true as printed in the label for all the samples. The head space for lima juice was the lowest of all the samples, and the juicy orange had the highest value.

Out of the five samples analysed, four of them (juicy brands) use sorbate as a preservative. The determination of sorbate in the drink was based on sorbic acid liberated into the drinks. It was observed that there was limited use of

sorbates with some fermentable fruit products. Sorbic acid appeared to be more soluble than benzoic acid being an aliphatic organic compound and more costly to be purchased, hence rarely used in food industries. Sorbate reduce surface yeast scum formation in soft drink tanks. The amount of sorbic acid present in each sample varied from each other indicating that either different quantities were added to each sample initially or that different samples consumed or destoryed the acid at different rate if the same amount was added initially. The only drink in which benzoate was used as preservative in conjunction with sulphur dioxide was the lima orange juice. The preservative power of benzoic acid or its salts is weak compared to sorbic acid. Sodium benzoate is only recommended for preserving acid products. Most fruits and fruit juices do not require pH-adjustment since their natural acidity is usually of pH 3.5. The choice between the use of the acid or its sodium salt is largely dictated by the condition of use, price and availability.

Looking through the table, juicy cola had the highest value of ascorbic acid while the lowest of the values were obtained from juicy apple and Tutti frutti. The total solids values (% dry weight) were almost the same except Lima juice which had the lowest value, The results of refractive index were almost constant with juicy brands and higher than that of the lima juice (1.341). The food value

as observed from crude protein column with the drinks were very low and the least of all occured with juicy cola. The higher crude protein values were recorded with juicy orange, Lima Orange juice and lima tutti frutti, suggesting that orange drinks used to have appreciable amount of food value.

In the table 1, the results obtained for qualitative analysis were shown. The tests involved parameters like the taste whether accepted or not, colour as appeared to the naked eyes and the odour. All the five samples analysed were sweet and acceptable initially, none has bitter sweet taste as expected of drinks with traces of quinine. For the type of materials used, all the juicy products were packed in aluminium foil with polythene polished internally and directly sealed. The Lima products were packed in plastic cups covered with aluminium foil sealer (cap).

3.1.1 Soft drinks bought from the Local market.

Table 2, showed the results of all the parameters analysed with the drinks purchased from the local markets and departmental stores. The drinks were manufactured by various industries from various zones of the country as seen earlier. The purpose of this study was to know whether or not the amount of these contaminants and the additives added fall within the specified level and also to verify whether or not the manufactuers used true fruit juice as most of them claimed.

TABLE 1

TABLE OF RESULTS FOR
SOFT DRINKS SAMPLED FROM FACTORIES IN KANO

PARAMETERS/SAMPLES	JUICY ORANGE	JUICY APPLY	JUICY TUTTI FRUTTI	JUICY COLA	LIMA JUICE
1. Specific gravity	1.0520	1.0513	1.0470	1.0476	1.0255
2. ^{o}Brix sugar content	12.00	12.00	12.00	11.90	6.10
3. Liquid content (cm^3)	195.00	200.00	205.00	200.00	194.00
4. pH values	2.5	2.6	2.5	3.3	2.3
5. Acidity values ($g/100cm^3$)	0.3074	0.2402	0.1985	0.3650	0.3938
6. Alkalinity of ash mg.K_2CO_3/$100cm^3$	10.35	9.68	8.97	10.35	24.15
7. Ascorbic acid $mg/100cm^3$	5.544	3.520	3.520	10.560	4.400
8. Total Solids (%) dry weight	10.82	10.75	10.94	10.05	8.92
9. Moisture content (%)	89.18	89.25	89.06	89.95	91.08
10. Ash content ($g/1000cm^3$)	4.80	4.10	4.60	4.80	5.80
11. Retractive index	1.351	1.352	1.352	1.352	1.341
12. Crude protein ($mg/100cm^3$)	7.53	4.55	5.78	3.15	6.65
13, Sorbic acid (mg/dm^3)	53.52	59.12	48.37	65.91	N.D
14. Sodium benzoate ($g/100cm^3$)	ND	ND	ND	ND	0.1728
15. Sulphur dioxide (mg/dm^3)	ND	ND	ND	ND	61.44
16. Saccharin (mg/dm^3)	ND	ND	ND	ND	109.9
17. Head space (cm^3)	55.00	50.00	45.00	50.00	6.00

Table 1 (cont'd)

PARAMETERS/SAMPLES	JUICY ORANGE	JUICY APPLY	JUICY TUTTI FRUTTI	JUICY COLA	LIMA JUICE
18. Elemental analysis (ppm)					
i. Mg	35.00	34.00	34.80	35.60	39.70
ii. Na	9.60	8.80	6.90	8.80	8.90
iii. Ca	29.80	28.80	29.60	21.20	35.30
iv. K	110.60	180.30	125.40	115.00	98.00
v. PB	ND	ND	0.01	0.2	ND
vi. Fe	0.03	0.05	ND	ND	0.10
vii. Zn	0.01	0.01	ND	ND	ND
19. Cost per bottle (K)	25	25	25	25	25
20. Capacity of container	250	250	250	250	200
21. Liquid content printed on Label	200	200	200	200	200
22. Taste: Sweet/sour/bitter	Sweet	Sweet	Sweet	Sweet	Sweet
23. Colour to naked eyes	Yellow	brown	dark pink	dark	Yellow
24. Taste/odour	A	A	A	A	A
25. Type of container/Cap	Aluminium foil with polythene polished internally direct sealing.				

ND = Not Detected

A = Acceptable.

TABLE 2

TABLE OF RESULTS FOR
SOFT DRINKS BOUGHT FROM THE LOCAL MARKET

	PARAMETERS/SAMPLES	Fruit Orange (F.O)	VIP Apple drink (V.A.D)	Essdee Grape fruit (Ess.)	Fruit Maid Pineapple (F.M.P)	Caprisonne Orange (C.O)	Okin Pineapple (O.P.J)
1.	Specific gravity	1.0398	1.0399	1.0605	1.0479	1.0357	1.0482
2.	^{o}Brix Value	10	10	15.5	12	9.5	12
3.	Average Liquid content cm^3	290	300	300	200	190	250
4.	pH-values	2.5	2.6	3.4	2.4	3.0	2.5
5.	Acidity $g/100cm^3$	0.3077	0.2562	0.4611	0.2241	0.3074	0.2113
6.	Alkalinity of ash $mg/K_2CO_3/100cm^3$	12.42	11.04	10.35	13.80	15.85	6.90
7.	Ascobric acid $mg/100cm^3$	7.568	5.280	18.480	7.040	3.520	20.240
8.	Total solids % dry weight	10.89	10.90	10.71	10.87	10.75	11.03
9.	Percentage moisture content	89.60	88.90	89.00	89.50	90.20	88.80
10.	Ash content $g/1000cm^3$	4.20	5.10	4.80	5.30	4.90	6.20
11.	Refractive index	1.349	1.349	1.357	1.351	1.348	1.351
12.	Protein Value $mg/100cm^3$	3.850	4.200	6.125	4.900	2.975	9.275
13.	Sodium benzoate $g/100cm^3$	0.0864	0.0720	0.0936	0.1008	0.1152	0.1358
14.	Sorbic acid mg/dm^3	N.D	79.29	N.D	N.D.	73.35	N.D
15.	Printed liquid content cm^3	300	200	330	200	200	250

Table 2 (cont'd)

PARAMETERS/SAMPLES	Fruit Orange (F.O)	VIP Apple drink (V.A.D)	Essdee Grape fruit (Ess.)	Fruit Maid Pineapple (F.M.P)	Caprisonne Orange (C.O)	Okin Pineapple juice (O.P.J)
16. Elemental Analysis(ppm)						
i) Ca	41.80	23.40	38.60	34.30	25.20	22.50
ii) Na	9.80	10.50	29.00	18.80	5.00	11.00
iii) K	187	190	195	168	194	114
iv) Mg	31.00	20.50	24.00	29.80	25.00	27.00
v) Fe	ND	0.08	0.04	ND	0.30	0.01
17. Colour	Yellow sweet(A)	dirty brown sweet(A)	light Yellow bitter sweet (A)	Yellow Sweet (A)	Yellow Sweet(A)	Light Yellow sweet (A)
18. Taste/Sweet/Sour/bitter						

Saccharin, free sulphur dioxide, Copper and Lead are below detectable Limit in these six samples.

N.D. - Not detected

A - Acceptable

The results on the table showed that all the amounts of contaminants and level of additives added conform (agree) with the permitted limit needed for consumption, and that they all had very low nutritive value (protein content). The only defect was that only synthetic flavours. were used to compound the syrup. At the vitamin C and protein content column, it was observed that Essdee grape fruit and Okin pineapple drink had the highest value of vitamin C and protein content, hence preferentially recommended for consumption to others. These two products could be safely said to have contained the natural juice and flavour. Again all the six samples analysed did not contain any of the artificial sweeteners as recorded by their brix value. The taste of all the six samples were sweet and acceptable to consumers except the Essdee grape fruit which could be suspected to have contained some traces of quinine materials which made it bitter sweet, but still acceptable.

3.1.2 Concentrated Drinks (D.T.T)

The two samples of concentrated drinks analysed were purchased from departmental stores. The results of their analysis were presented in table 3 for comparative purposes. The two samples' level of additives agree with the stipulated and acceptable limit. The level of nutritive value of the two drinks varied from each other. Only the Tree Top Orange could be said to have attained the standard required in a

concentrated drink, because it had a higher nutritive value than the Rola-lemon lime. For comparative pruposes, Tree Top Orange had about 70.40mg/100cm^3 of vitamin C while Rola lemon-lime had only 3.08mg/100cm^3. The crude protein value for the Tree Top Orange was 25.8mg/100cm^3 and 1.8mg/100cm^3 for Rola lemon-lime.

From these two data, Tree Top Orange could be safely said to be produced purely from natural juice and flavour, while the Rola lemon-lime was made from artificial (synthetic) flavours, hence not recommended for consumption.

From the table the specific gravity were almost equal. The brix value were exactly equal, the liquid content of lemon-lime was 1000cm^3 and cost ₦1.95 per bottle while Tree Top Orange was 720cm^3 and costs ₦1.50. The pH value were low 3.0 and 3.3 for Tree top Orange and Rola lemon-lime respectively. The ash value of Tree top was higher than Lemon-lime and their refractive index were almost equal. Sodium benzoate and sulphur dioxide were used in preserving them, and have a very high sugar content. The colour of Tree top orange was yellow while that of Lemon-lime was greenish. Glass bottle was used as the container for tree top while plastic bottle was used for the lemon-lime.

TABLE 3

CONCENTRATED DRINKS (DILUTE TO TASTE)

	PARAMETERS/SAMPLES	Tree top orange drink (T.O.O)	Rola Extra Strong Lemon-Lime (R.L.L)
1.	Specific gravity	1.152	1.153
2.	^{o}Brix	35.00	35.00
3.	Liquid content printed on Label cm^3	720	1000
4.	pH value	3.0	3.3
5.	Acidity g/$100cm^3$	0.4803	0.5764
6.	Vitamin C mg/$100cm^3$	70.40	3.08
7.	Total solids: % dry weight	23.90	20.00
8.	Percentage moisture content	76.00	78.00
9.	Ash content g/$1000cm^3$	3.80	2.60
10.	Refractive index	1.392	1.390
11.	Protein value mg/$100cm^3$	25.80	1.80
12.	Sodium benzoate g/$100cm^3$	0.3036	0.2583
13.	Saccharin content mg/dm^3	201.52	238.16
14.	Sulphur dioxide mg/dm^3	76.8	66.56
15.	Sorbic acid	ND	ND
16.	Cost per bottle	N1.50	N1.95
17.	Colour of drink	Yellow	Greenish
18.	Taste/Sweet/Sour/bitter	Sweet(A)	Sweet(A)
19.	Type of container	glass bottle	plastic bottle

ND - Not detected

A - Acceptable

3.2 DISCUSSION OF RESULTS OF ANALYSIS FOR SHELF LIFE STUDY.

The discussion of the results of analysis was subjected to variation or deterioration of the drinks parameters within the four month's storage period. Where there was variation, deductions of the possible reasons were made with every parameter noted to be changing during the storage period. Where no variation occured, possible reasons were given too.

The parameters sub-headed below were the parameters considered to be able to give us possible variations among various drinks under study. From these variations, the possible shelf life of every drink was deduced and the rate at which the food value of every drink depreciated was observed and noted.

Also small note was given to every parameter determined to justify the reasons of its variation.

3.2.1 The Specific Gravity (S.G).

The study of the specific gravity table of results for four months showed a regular increase of the data (see table 4). Since the containers were sealed and there was neither in-coming nor out-going materials from the drink, therefore, certain reactions must have occured that lead to the changes observed in the specific gravity values. The changes could be attributed to chemical or biological reactions or both.

From the chemical point of view, there could be any or all of the following reactions taking place.

1. Oxidation - reduction reaction which could be caused by the surface air content which was rich in oxygen and incorporated during filling and sealing. The surface air/oxygen could react with some of the additives or contaminants present in the drink, thereby causing precipitation and sedimentation or even possibly, coagulation. These conditions could lead to changes in the specific gravity, which could affect the shelf life of the drinks.

2. Fermentation reaction could occur due to the yeasts feeding on the sugar, thereby converting part of the sugar to alcohol and this could certainly change the specific gravity of the drink with time.

From the biological or microbiological point of view, certain micro-organisms or spores of the organisms could get into the drink during processing or their presence in the raw materials like sugar is another way of getting into the drink. Yeasts and moulds are examples of such organisms. Their growth and reproduction could affect the specific gravity value in some ways.

From the table of specific gravity, it was observed that lima orange juice had the greatest increase among all

the drinks examined for specific gravity value followed by juicy orange. If the increase in specific gravity was due to microbiological reaction, then the orange drinks had the highest concentration of bacteria, yeasts and moulds over the four months. The microbiological reaction could result to production of alcohol and other non-alcoholic products which could affect the shelf life of the drinks as fermentation occured. And if increase was due to chemical reaction, it means that the rate of chemical reaction of orange drink was higher compare to others.

3.2.2 Brix-Value-% sugar content.

There was little or no decrease in the sugar content as cited in table 5. The variations were not so pronounced during the first two months with the samples of juicy orange, apple and tutti frutti, but a regular decrease in amount of sugar was established with juicy cola and lima orange juice throughout the four months. It was observed that orange, apple, tutt ifrutti and cola samples had a brix value of 12%, while the sample of the lima orange juice had about half of this value which indicated the addition of an artificial sweetener. This was also confirmed from its taste and its throat scratch action after drinking. It was observed from the final analysis, that a considerable decrease in sugar content occured with all the drinks' samples at the end of the four months storage, although they did not follow

any particular pattern. The loss could be attributed to any or all of the followings:

1. Undesirable impurities that could react with the sugar content e.g. certain minerals and acids could interfere with the sugar synthesis.

2. When fermented sugars are used.

Fermentation of sugars could lead to a wide variety of products ranging from carbondioxide to antibiotics and yeasts (12). Several fermentations have been the sources of organic chemicals of considerable industrial significance, such as acetone and but-1-ol.

As seen from the table, Lima orange juice had the highest amount of reduction in sugar value suggesting that reaction here was more pronounced than others. It might have been heavily loaded with various types of additives and thereby causing numerous reactions in the drinks. The deterioration of the sugar content would certainly affect the shelf life of the drinks and become unpalatable to taste as characterised with the lima orange juice at the end of two months, showing that it had the shortest shelf life.

However, samples of Juicy cola had the least amount of decrease in the % sugar content as noted at the end of the fourth month.

TABLE 4

SPECIFIC GRAVITY VALUES

RESULT OF ANALYSIS FOR SHELF LIFE STUDY

SAMPLE/MONTH	DATE OF PRODUCTION	AUG.	SEPT.	OCT	NOV.
A. Juicy Orange	4/7/83	1.0520	1.0590	1.0602	1.0618
B. Juicy Apple	6/7/83	1.0513	1.0584	1.0590	1.0602
C. Juicy Tutti Frutti	21/6/83	1.0470	1.047.	1.0501	1.0534
D. Juicy Cola	7/7/83	1.0476	1.0540	1.0551	1.0558
E. Lima Juice	5/7/83	1.0255	1.0368	1.0373	1.0392

TABLE 5

BRIX VALUE - % SUGAR CONTENT

SAMPLE/MONTH	DATE OF PRODUCTION	AUG.	SEPT	OCT	NOV.
A. Juicy Orange	4/7/83	12.00	11.50	11.50	11.00
B. Juicy Apple	6/7/83	12.00	12.00	12.00	11.50
C. Juicy Tutti Frutti	21/7/83	12.00	11.50	11.50	10.50
D. Juicy Cola	7/7/83	11.90	11.00	11.00	10.50
E. Lima Juice	5/7/83	6.10	5.50	5.50	4.50

3.2.3 Refractive Index values:

A regular decrease was observed in the refractive index value of the drinks for four months as cited in table 6. The decrease in values of refractive index closely parallel those values on specific gravity. showing that figures on refraction were closely related to sugar content of the drinks. Substances responsible for these variations in drinks must be similar to those discussed earlier in specific gravity and Brix value.

Out of the five samples studied, only the lima orange juice had the highest amount of variation after four months (about 0.011) while the rest four samples had almost the same amount of variation that were very small in value about (0.004).

3.2.4 The pH-value.

The estimation of pH-value of soft drink is more useful than the acidity value because acidity of fruits and fruit products are usually calculated as malic and tartaric acid which predominate in some fruits and citric acid in others. The estimation of pH value is quite useful because the estimation of total acidity can be complicated by the presence of pigments. It was observed that all the soft drink samples had very low pH value. usually between 2.0-3.5 in most cases as established in table 7.

TABLE 6

REFRACTIVE INDEX VALUES

SAMPLE	AUG.	SEPT.	OCT.	NOV.
A. J.O	1.351	1.350	1.349	1.348
B. J.A.	1.352	1.352	1.35	1.350
C. J.T.F.	1.352	1.351	1.350	1.348
D. J.C.	1.353	1.351	1.351	1.349
E. L.J	1.341	1.340	1.330	1.330

TABLE 7

PH - VALUES

SAMPLE	AUG.	SEPT.	OCT.	NOV.
A. J.O	2.5	2.6	2.8	3.0
B. J.A	2.6	2.8	3.0	3.1
C. J.T.F	2.5	2.7	2.7	2.8
D. J.C.	3.3	3.4	3.5	3.5
E. L.J	2.3	2.5	4.1	4.4

This could be reasoned from the fact that, the growth of many micro-organisms depend on the pH optimum which lies between 6.5 - 7.5. The group concerned includes all the micro-organisms which are harmful to human health. With this in mind, it could be seen that drink having a pH value lower than 4.0 are very safe from the public health point of view. Soft drinks are acid products and have a pH-figures which vary considerably e.g. 2.4 in some cola drinks and between 2.5 - 3.5 in orange and other citrus fruit drinks. The pH has a considerable effect on flavour and taste of a drink product.

Low pH value was also used because it increased the shelf-life of drinks and the pH values exercise the most significant influence on the microbiological stability of soft drinks.

A high pH often indicates unsatisfactory settling of some properties and a low pH suggests that the preserve will "weep" on storage (4).

Results on the table 7 showed a regular increase in pH values with time, thus showing that the drink was more susceptible to bacterial growth or approached the optimum for the micro-organisms. The increase in the pH values can be attributed to some of the acids present, must especially the preservatives. It can therefore be said that the possibility of bacterial growth occured with

lima juice at the third month which was highly susceptible to high microbial attack and then got spoilt in time when compared to others.

3.2.5 Titratable Acidity:

When an unusual condition of off flavour or Spoilage developed, the type, quality and quantity of acid used is immediately suspected. From the results in table 8, the acidity values remain fairly constant over the four months storage period, though they varied from one drink to the other. The constant values implied that either no acid was produced or evolved in any of the reactions going on in the drink, or that the rate of loss of the acids equals the rate of their formation. Titratable acidity does not seem to have any visible effect on the shelf life of the drinks.

The sudden and early changes in the acidity value of the samples indicated some types of unpredictable reactions taking place in the drink which could lead to a very little undetectable off-taste within the early part of their shelf-lives.

3.2.6 Ascorbic acid values:

Ascorbic acid is one of the preservatives used in soft drinks. It acts as an antioxidant to prevent rancidity

generally, due to oxidation which could cause the formation of perioxides at the double bonds of fat molecules with subsequent break down of these peroxides to form aldehydes, ketones, and acids of lower molecular weights (72). To prevent this loss in flavour, ascorbic acid should be added so that it is preferentially lost while the flavour remains. Ascorbic acid increases the nutritional value, and during its application, its initial loss was caused by the available oxygen in the enclosed air. Theoretically, 1 cm^3 of oxygen oxidizes 15.7mg of ascorbic acid. The liquid itself and the head space are the main sources of the enclosed air. The loss is less for canned soft drinks than in the bottle type because of the small head space available. Ascorbic acid is the most stable in low pH frozen concentrates, and juices such as orange, grapefruit and grapefruit blends.

From table 9 as expected, there was a general decrease in ascorbic acid content throughout the storage period. In the fourth month, there was virtually little or no ascorbic acid left in Tutti frutti and few others suggesting commencement of spoilage.

TABLE 8

TITRATABLE ACIDITY VALUES g/100cm^3

SAMPLE	AUG.	SEPT.	OCT.	NOV.
A. J.O	0.3074	0.3682	0.3590	0.3586
B. J.A	0.2402	0.2594	0.2630	0.2594
C. J.T.F.	0.1985	0.282	0.2726	0.2820
D. J.C.	0.3650	0.4515	0.4515	0.4482
E. L.J	0.3938	0.4611	0.4548	0.4579

TABLE 9

ASCORBIC ACID VALUES mg/100cm^3

SAMPLE	AUG.	SEPT	OCT.	NOV.
A. J.O.	5.544	3.960	2.640	0.962
B. J.A.	3.520	2.640	1.760	0.832
C. J.T.F.	3.520	1.760	0.880	0.324
D. J.C.	10.560	7.480	4.880	0.324
E. L.J.	4.400	2.640	0.880	0.042

3.2.7 Sorbic acid content

The sorbic acid and its water-soluble salt of potassium (collectively referred to as sorbates) are of major commercial significance as preservatives for foods and, to a lesser extent, for drugs and cosmetics (16). Sorbic acid is said to inhibit the growth of mould without impeding the "beneficial" lactobacilli in some food products. The major commercial use of the acid and its alkaline salts is as a fungistatic agent in foods. It inhibits the growth of most fungi and a few of the bacteria normally associated with food spoilage. Low pH values favour its antimicrobial activity. With high pH, you need high concentration of the acid in preserving the drink. The toxicity of sorbic acid is extremely low, about $\frac{1}{3}$ of that of benzoic acid. Out of the five samples of soft drink analysed for shelf, four of them use sorbate as a preservative.

As shown in table 11, results established a progressive decrease in the level of sorbic acid content of each sample from September to November. And by the end of the third month storage, juicy apple and tuttifrutti had the lowest value, showing that they have shorter shelf-life than the others.

3.2.8 Total Solids' Value

The function of a storage time is due to different weather conditions. The dry matter content in general increased with storage time as shown in table 10. The rise in total solid value at the end of every month, might be attributed to the slow rate of chemical changes that took place between the different components of the drinks during storage. Other works done on drinks showed that in the sun, this rate of chemical reactions was faster than in both room and the refrigerator. The reaction could result to decomposition and oxidation of the components such as caramel in cola drinks which could be disintegrated into smaller end products and hence lower values of caramel in drinks were expected. The total increase in dry matter might also be due to sedimentation of these products, resulting from various types of chemical reaction taking place during storage.

TABLE 10

TOTAL SOLIDS AS PERCENTAGE DRY WEITHT (%)

	SAMPLE	AUG	SEPT	OCT.	NOV
A.	J.O.	10.82	10.94	10.88	10.97
B.	J.A.	10.75	10.82	10.84	10.92
C.	J.T.F.	10.94	11.06	11.00	11.17
D.	J.C.	10.05	10.80	11.83	11.85
E.	L.J.	8.92	9.08	9.05	9.15

TABLE 11

SORBIC ACID CONTENT mg/dm^3

	SAMPLE	SEPT.	OCT.	NOV.
A.	J.O.	53.52	48.91	21.61
B.	J.A.	59.12	43.71	17.74
C.	J.T.F.	48.57	39.84	17.15
D.	J.C.	65.91	54.91	25.47
E.	L.J	ND		

N.D. - NOT DETECTED.

3.2.9 Sodium benzoate values:

Looking through table 12, there was very little amount of benzoate left with the drinks by the end of four months storage. This might be due to the pH. value of the product which increased, and the preserving power of sodium benzoate which deteriorated as shown by the reaction below.

$$C_6H_5COONa \rightleftharpoons C_6H_5COO^- + Na^+$$

This dissociation might also cause an increase in the pH-value. Therefore, higher concentration of benzoates are required for preservation, especially when the pH is more than 3.5.

The continous deterioration of benzoic acid observed might be due to the fact that lima orange drink was heavily loaded with micro-organism and benzoic acid being a germicidial or bacteriocidal agents, is expected to react with the cells of the micro-organisms thus killing them. A decrease was therefore expected in the benzoic acid content of the drink. The decrease also points out the fact that there was constant increase in bacterial growth in the drink, unless the benzoic acid was involved in other reactions occuring in the drink.

3.2.10 Free Sulphur dioxide content

It was observed with lima juice that sulphur dioxide was used as a preservative. It may be used in the form of sulphurous acid solution or as the sulphites of sodium, potassium or calcium, but for the purpose of the regulations, the amount present in soft drink is usually calculated as sulphur dioxide because it is used in gaseous form (4). It assists in conserving vitamin C, but appears to inactivate vitamin B_1 (4).

Only a portion of the total sulphur dioxide was active against micro-organisms and this is called free sulphur dioxide which was actually determined in this work. In observing the table 12 critically, high amount of sulphur dioxide was lost by the end of every month and as cited, from the table. There was virtually none by the end of October. The loss could be due to any or all of the following:

1. Sulphites combine with aldehydes, ketones, and simple sugars, so that with foods such as fruit juices, part of the sulphur dioxide was "bound" to some of the drinks components and appear to be inefficient as a preservative, hence products got spoilt in time which was observed with lima juice. It also appeared that the dissociated "free" (unbound) sulphite was ineffective. The active anti-microbial agent was the unbound, or the

undissociated sulphite, the proportion of which increases with increasing acidity.

2. due to experimental procedure and during the manufacturing process in the factory.

3.3 ARTIFICIAL SWEETENER

Lima fruit juice was also found to contain saccharin as an artificial sweetener which was vividly shown from its very low brix value. Table 12 showed that there was a progressive loss in amount of saccharin by the end of every month. This might be due to dry or hot weather as saccharin generally decomposes with increase in surrounding temperature (13).

3.3.1 Crude Protein Content:

The crude protein values of the drinks decreased with time, implying that, there was continous deterioration in the nutritive value of the drinks (Table 13). The smallest amount of protein was recorded with juicy cola and apple, while the least of all was observed with the Lima orange juice which was 0.09 mg/100cm^3. Juicy orange had the highest proteinous value by the end of the fourth month.

TABLE 12

FOR LIMA ORANGE JUICE ONLY

SAMPLE	AUG.	SEPT.	OCT.	NOV.
Free sulphur dioxide content mg/dm^3	61.44	25.60	5.12	ND
Sodium benzoate content g/100 cm^3	0.1728	0.1152	0.0504	0.0360
Saccharin content mg/dm^3	109.90	82.44	73.28	53.45

Note: Sample A, B, C and D do not contain any of the components tabulated in table 12 above.

N.D. = NOT DETECTED.

TABLE 13

CRUDE PROTEIN CONTENT mg/100cm^3

SAMPLE	AUG.	SEPT.	OCT.	NOV.
A. J.O.	7.530	5.000	3.150	1.030
B. J.A	4.550	2.800	1.930	0.810
C. J.T.F.	5.780	3.378	2.100	1.070
D. J.C.	3.150	1.400	1.050	0.660
E. L.J.	6.650	3.330	2.175	0.090

3.3.2 Colour Intensity.

As shown by table 14, colour intensity of the drinks deteriorated gradually with storage time. The rate of decrease in colour intensity was comparatively higher in samples of Lima juice followed by juicy cola and orange. The slowest rate of loss of colour occured with both juicy apple and tutti-frutti. These could be due to the various types of chemical reactions taking place in the drink. The rate must definitely be fast if some of the samples are stored in the sun, due to sunlight rays penetrating into the drink and caused decomposition of the colour material. This results to fading characteristics in some drinks e.g. lima orange juice which changes from its original orange colour to a light yellow colour.

The absorbance measured in the colour determination was believed to involve more than one absorbing species because of an increased absorbance observed. If a system contains more than one absorbing components, it is assumed that the species act independently of each other and their absorbance is additive (42). The increase in the absorbance might not be due to increase in the principal absorbing species but rather, an increase in the minor components which resulted from reactions going on in the drink. This will eventually affect the eye appeal of the drink.

TABLE 14

COLOUR ABSORBANCE (ARBITRARY)

	SAMPLE	OCT. 1ST	OCT. 15TH	NOV. 2nd	NOV 17th
A.	J.O.	0.73	0.62	0.58	0.57
B.	J.A.	0.69	0.51	0.47	0.48
C.	J.F.F.	0.56	0.52	0.49	0.47
D.	J.C.	0.88	0.73	0.68	0.65
E.	L.J.	1.10	0.94	0.82	0.79

3.3.3 Conclusions and Suggestions:

The data obtained from this investigation showed that the lower the pH of soft drinks, the longer the shelf-life. The amount of trace iron present in some of the drinks is likely to have affected the shelf life of soft drinks due to oxidation. With the type of prevailing climatic condition in this country, the shelf-life of soft drinks is probably within three to four months. This was concluded from the fact that, practically all beverages deteriorated with age in nutritional value, flavour and taste. To improve the shelf-life, internal better production, storage techniques and better facilities are required. This gives more attention to technical ways and means of protecting soft drinks deterioration. The storage condition should be able to prevent loss due to damage from within as well as from without. The shelf life of soft drinks, being a semiperishable foods, is very important to consumers, and it depends on the rate of consumption of that particular drink in least consumption area. Other spoilage includes; absorbed foreign odours i.e. most insidous contaminations because it is not immediate in its action. This is caused by failure to keep the manufacturing plant clean.

In view of the fact that the tests were carried out at a temperature condusive to microbial attacks, an observation period of six weeks is adequate to determine

the shelf life. Beverages requiring a very long shelf-life however should be tested for three months. If, under the stated conditions, no defects are observed at the end of this period, then the product can be safely said to have a shelf life of 10 - 12 months. But from this study, none of the soft drinks can fall into this category in this country. In countries where the addition of preservative to soft drinks is not permitted, a low pH-value is the only way, and product is extremely sensitive to contamination and it will have a shorter shelf-life or will require the addition of larger quantities of preservative. It is always better to take soft drinks that is not more than a week old in order to receive the nutrient content before spoilage, begins, e.g. vitamin C and protein which deteriorate with time. Except the concentrated drinks which can be kept safely with time for they are not easily affected by micro-organisms due to high sugar content, because cells of micro-organisms are easily destroyed with high sugar concentration in drinks. It was again noted that orange brands of soft drinks are easily susceptible to microbial spoilage compare to other brands.

The addition of sufficient excess of ascorbic acid to combine with the dissolved and head space oxygen is an economic means of prolonging the shelf life of the beverage.

The enrichment of fruit juices and beverages has therefore become a standard practice (15). Finally the analysis showed that the additives (adulterant) Level and Contaminants detected fell within the specified limit as permitted by Food (limit for contaminants) Regulation 1980 and Food Additive Regulation 1980 (N.S.O), for fruit and vegetable products (74, 75). It was observed that most manufacturers claimed to be using natural juice and flavours as indicated in their Labels, but from this study, it can be safely pointed out that most soft drink manufacturers used synthetic flavours.

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APPENDIX I

SOME MAXIMUM PERMISSIBLE LIMIT FOR MAJOR AND TRACE METAL CONTAMINANTS IN FOODS AND DRINKS

	Drinks/Metallic content	Ca ppm	Mg ppm	Na ppm	K ppm	Fe ppm	Pb ppm	As ppm	Cu ppm	Zn ppm	Sn ppm	F ppm
1.	Orange drink	10	11.8	1.18	206.5	0.12	0.2	0.1	2			
2.	Pineapple drink	23.6	23.6	2.95	334	0.531		0.5				
3.	Apple drink	32.45	-	5.31	549	3.25						
4.	Cola drink											
5.	Lemon/Cordial R.T.D.											
6.	Squash/cordial DT D.T.T.					100	1	0.5	7.0	100		
7.	Concentrate						2.5	0.5	20			
8.	Grape Fruit Juice					15	0.3	-	5	5	250	250
9.	Fresh fruit juice					-	7.0	2	50	50	-	2
10.	Lemon Juice					15	1.2	-	5.20	5.50	250	-
11.	Lime Juice											
12.	Orange Juice					15	0.3	-	5	5	250	-
13.	Pineapple Juice											
14.	Apple Juice											
15.	Foods generally						2	1	20	50	250	
16.	Beverages RTD						0.2	0.2	2	5	11	1

Note: Appendix I, and III are lifted from the following sources:

1. Food (Limit for contaminants) Regulation 1980
2. Food additive regulation of 1980 (N.S.O) (for fruit and vegetable products)
3. Food and drugs decree 1974, No. 35, (soft drinks regulation of 1980)

*1-3. were made in Law: by Federal Minister for Health.

APPENDIX II

ACCEPTABLE WATER QUALITY STANDARDS

Substances or parameters	Highest desirable Level mg/dm^3	Maximum permissible mg/dm^3
Calcium	75	200
Copper	0.05	0.05
Iron	0.1	1.0
Magnesium	30	150
Zinc	5	15
Lead	0.1	0.1

Source: Deirdre, K.G. and Born, B.J. Textile Waste Waters, Treatment and Environmental Effects. J. Chem. Ed. August 1978, pp.344.

APPENDIX III

OFFICIAL PERMISSIBLE LEVEL OF ADDITIVES IN SOFT DRINKS

Drinks/	Vit. C ppm	B.A. ppm	S.A. ppm	SO_2 ppm	Brix	A.V. %m/v	Sacc ppm	C.P %
Soft drinks generally R.T.D.		160		70			80	
Soft drinks generally D.T.T.		800		350			400	
R.T.D: Ready to Drink								
1. Orange drink	188.8	113	200	51		0.32		0.07
2. Apple drink	188.8							0.09
3. Pineapple drink	253.7	42	300	70		0.25		0.12
4. Cola		158	100	26		0.15		
5. Lime/Lemon		113	200	51		0.50		
6. Grape fruit								
7. Lemon juice						4.5		
8. Lime juice						4.5		
D.T.T. Dilute to taste								
1. Orange		380	300	160	30-33	1.1		
2. Lemon		400	300	160	30-33	1.4		
3. Lime		-	300	310	29-32	2.25		
4. Black currant		160	300	160	29-32	1.55		

Note:

The official permissible levels of some additives in fruit juice and its products are:

1. Vitamin C: The value of vitamin C must not be less than 10% of soluble solids determined, and not exceeding 0.4g per kg acid expressed as acetic acid (volatile acid) for apple juice, and not less than 15% in grape fruit.

2. Sugar: The sugar value must not be less than 9% of soluble solid usually read as degrees brix on the international sucrose scales, and not less than 25% for concentrated drinks like squash or cordial. It should also not be less than 6% in lemon juice, 10% for orange juice and pineapple juice.

Titratable acidity: Not less than 4.5% citric acid for lemon, orange and pineapple juice, and not more than 25% (v/v) fruit juice, not less than 15% for lime/lemon.

Quinine: Not exceeding 11 ppm.

Sources: 1. Preservatives Regulation Committee Nigeria (1975).

2. Food Additive Regulation of 1980 (W.S.O) (for fruit and vegetable products).

3. Food and Drugs Decree 1974. No. 35 (soft drinks regulation of 1980).