ASSESSMENT OF NUTRITIONAL QUALITY OF MARKET SAMPLES OF FRUIT DRINKS IN OWERRI

BY

KORIE OGECHI VICTORIA

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CERTIFICATION

This is to certify that this research: **Assessment of Nutritional Quality of Market Samples of Fruit Drinks in Owerri** was carried out by **Korie, Ogechi Victoria** with registration number 20154940818 and has been approved by the Post Graduate school for the award of Post Graduate Diploma in Food Science and Technology.

PROF. N.C Onuegbu
(Project Supervisor)

25-07-2017

Date

Dr. Chijioke Osuji
(Head of Department)

9th August, 2017

Date

Prof. G.I Nwandikom
(Dean of SEET)

Date

Prof. Mrs. Nnenna N. Oti
(Dean of Postgraduate School)

Date

DEDICATION

To my supervisor, To my beloved family, For patience and unlimited support and To my friends and colleagues.

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Foremost, I owe sincere gratitude and praise to Almighty God who gave me the power and durable patience to finish this study.

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ABSTRACT

Nutritional quality of market samples of some fruit drinks were assessed through laboratory analysis. The assessment covered the determination of quality parameters of six brands of fruits drinks which include California brands of orange and pineapple drinks, orange and pineapple fruta drinks and 5 – alive orange and pineapple drinks. The assessment indices included the determination of proximate compositions, mineral composition and vitamin composition of the drinks. From the results obtained, protein content, fat content, fiber and ash content were low while moisture was very high in tall to them. Protein was in the range of 0.557% to 0.820%. fat 0.18% to 0.353%, ash 0.467% to 0.573% and the fiber 0.307% to 0.413%. for t he different fruit drinks. Vitamins A_1 B_1 B_2 C and E were detected in all the fruit drinks but at different concentrations. Vitamin A was in the range of 122.260Iu/100g to 135.13 Iu/100g while vitamin C varied between 31.093mg/100ml and 46.347mg/100ml. vitamin B_1 and B_2 were in the range of 6.147mg/100ml to 9.820mg/100. Vitamin $B_1$and B_2 were in the ranges of 0.043mg/100ml to 0.063mg/100ml and 0.23 to 0.042 mg/100ml respectively. Variations were also recorded in the mineral content of the fruit drinks. Calcium was highest in 5-alive orange drink (23.38mg/100ml) and least in pineapple fruta (17.36mg/100) while magnesium was highest (14.400mg/100ml (5-alive pineapple) to 170.667mg/100ml (califonia orange drink) iron and zinc were present in small concentrations ranging from 0.027mg/100ml respectively. Some variations in their concentrations were found to be significant ($p < 0.05$). however, some of the observed nutrient values different from the values claimed on the label of the drinks. The fruit drink represent good source of mineral and vitamins but were poor in the major nutrients as shown in their proximate composition.

Key words: Nutritional quality, quality parameters, assessment indices, mineral content, pineapple fruta, proximate composition.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Production and consumption of food is probably as old as mankind. The production of drinks is a culture and is practice in the Mediterranean East for hundred years and later it spread to Americans. In Africa, fruits are consumed directly and also consumption of different fruits at the same time is common.

The impact of humid tropical climate does not support storage of fruits for any length of time after harvest. This led to huge amount losses of fruit following harvest, a situation which prompted the need to the fruit into a more desirable form both to curtail the losses and to preserve them for use in off season periods. Some processing technologies involve the use of heat which affects the nutrients (vitamins) adversely. Also the use of large amount of water in extraction during juice production, often lead to dilution of the nutrient to low levels per unit quantity. Notwithstanding the above, fruit drinks makers claim high nutrient status of the common fruit drink sold to the public. Against this background, this project was conceived to quantify the nutrient value of this common fruit drinks sold in Owerri market.

1.2 PROBLEM STATEMENT

Fruits are known to be good source of nutritionally importance constituents like vitamins and minerals. However' most fruit ordinarily have short shelf life and this limits their useful applications. Also fruits are seasonal and often go out of the market when they are off-season. This situation necessitated processing of fruits into juices and smoothies which store longer than the ordinary fruits. However, most processing techniques impact negatively on the nutrient and this in turn necessitated fortification of such drinks with nutrient from artificial sources. There is need to know the level of

residual cum added nutrients in the fruit drinks as a means of quantifying their contribution to the nutrient requirement of the consumers.

1.3 AIMS AND OBJECTIVES

The main objective of the study is to evaluate the nutritional quantity of different fruit drinks sold in Owerri market. The specific objectives include the following:

a. To determine the proximate composition of the fruit drinks
b. To determine the vitamin content of the fruit drinks
c. To determine the mineral content of the fruit drinks
d. To compare the test values with the nutrient claims on label.
e. To assess the nutrient status of the different fruit drinks on comparative ground via statistical analysis of obtained data on nutrient content.

1.4 JUSTIFICATION

There are many claims by producers and marketers of brands of fruits drinks sold to the public. Nutrients and food health advocates on the other hand give out warning signals concerning consumption of different fruits drinks as against consumption of whole fruits. Against the above background, the project was conceived so as to reveal, by concrete investigation, the actual nutrient status of the different brands of fruit drink so as to assess their potential contribution to nutrient requirement of consumer.

1.5 SCOPE OF STUDY

The study covered the assessment of nutrient levels of the juices to the following extents

1. Determination of proximate composition including protein content, ash content, fat content dietaryfibre content and carbohydrate content.

2. Vitamin content determination covered the determination of water an oil vitamins in the fruit drinks including vitamin A, vitamin $B_{1,}$ (thiamin), vitamin B_2, and vitamin C (ascorbic acid).
3. Mineral content determination included the determination of some macro minerals and micro minerals of nutritional importance including Calcium, Magnesium, Potassium, Iron, and Zinc.

Furthermore, obtained data subjected to statistical analysis of variance was (ANOVA) using the statistical package for social sciences (SPSS) Version 16.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 WHAT ARE FRUIT DRINKS

Fruit drinks are drinks made from fruits or vegetables. Fruit drinks are mainly the natural fruit liquid-juice and fruit liquids altered by additives to improve the taste, nutritional quality or prolong shelf life. Fruit juices are described as beverages made by extracting or pressing out the natural liquid contained in fruits or vegetables. The term also refers to liquids flavoured with the other biological food sources (Ngoddy and Ihekoronye 1985). Fruit juices are commonly consumed as beverages or used as ingredient or flavoring in foods and other beverages.

Fruit drinks usually involve the addition of additives including sugar, artificial flavors or savory seasonings preservatives colorants etc. Fruit drinks may be produced without necessarily using natural fruits and in which case the equivalent flavors to the named fruits drink are used. Also fruit drinks are usually fortified with vitamin C and B series {vit. B_1,B_2,B_3 }(JECFA,2002).

2.2 TYPES OF FRUIT DRINKS

Fruit Juice: Codex Alimenterius defines juice as unfermented juice, intended for direct consumption, obtained by the mechanical process from sound, ripe fruits, preserved exclusively by physical means. The juice may be turbid or clear.The juice may have been concentrated and later reconstituted with water suitable for the purpose of maintaining the essential composition and quality factors of the juice.

Fruit Punch: Is the term for a wide assortment of drinks, both non-alcoholic and alcoholic, generally containing fruit or fruit juice (Wondrich 2004).

Fruit Squash: (also called cordial or dilute) is a non-alcoholic concentrated syrup used in beverage making. It is usually fruit-flavoured, made from fruit juice, water, and sugar or a sugar substitute. Squash are measured by their juice content, the average being 30% (Stella et al,2011).A variety of squash that contains a large amount of fruit juice, up to half or more of the volume of juice, is sold in the markets as ”high juice”, and squash are often called ”juice” when talking to children, especially these high-juice beverages, although this may be confusing. However, many squashes contain less than 20% juice,and some as little as 5-10% (Wondrich 2004). The latter are typically low in nutritional value, and the high juice versions are reasonably higher in nutrients, although one downside is that it is high in sugar and does not containfibre or minor nutrients.

Fruit Cordials: Fruit–flavored squash before and after being mixed with water, is a non-alcoholic concentrated syrup used in beverage making. It is usually fruit-flavoured, made fromfruit juice, water and sugar or a sugar substitute.”cordial” “diluted juice” and “squash” are similar products, although the products known as cordials tends to be thicker and stronger, requiring less syrup and more water to be blended (Stella et al.2011).

Fruit Syrups: These products are effectively a sub group of cordials except that they need to contain a minimum of 5% fruit juice when diluted as per the instructions (Stella et al 2011).

Fruit Nectars: These products are generally of a thick, somewhat syrup consistency and while they have a fruit content above 5% they usually contain less than 10% juice, and are often made from fruit purees rather than the fruit juice(Stella et al.2004). **Fruit Smoothies:**These products are generally dairy/fruit juice blends. The dairy component is usually ice cream or milk and the fruit component can be either juice, or fruit puree (Wondrich, 2004).

Fruit puree/pulp: Juice is classified as puree, if the resulting consistency is fluid that pours very slowly, or pulp if it pours even more slowly (Wondrich,2004).

2.3 NATURALAND ARTIFICIALFRUIT DRINK

A wide range of drinks can be manufactured which contain as the base material either fruit pulp or fruit juice. Many are drunk as a pure fruit juice without the addition of other ingredients, whereas others are diluted with sugar syrup(Wondrich, 2004). For simplicity, fruit drinks can be divided in to two groups: (1) “artificial” (2) “natural” fruit drinks.

Manufacturing: (artificial vs natural drinks)

Artificial drinks: Juice squeezed from the fruits or vegetables and then lots of sugar, preservatives, artificial flavors, coloring, and enhancers are added to make it remain fresh for the long days after it is packaged.Essential vitamins, minerals, enzymes, microorganisms, are lost during the process of pasteurization (Crandall et al 1981). Natural drinks: Natural drink is squeezed from the fresh fruits and vegetable and no sugar, preservatives, coloring, enhancers, are added Kader (2008*).*

Taste

Artificial drinks: These drinks taste are fresh and flavored unlike natural drinks because a lot of flavoring and colorings is done.Natural drink gives natural taste of fruit drinks Kader (2008).

Shelf life and storage

Artificial drinks: These drinks can be used in making wine and can be incorporated into cocktails. It contains added water etc. Natural drinks require consumption just after it is squeezed to prevent spoilage, it is mostly avoided using natural drink into any dish Fellers (1988).

Nutritional value

Artificial drinks: Artificial drinks have less nutritional value because essential ingredients for good health are lost in processing. The essentials needed for good health cannot be consumed in artificial drinks. Natural drinks have very high nutritional value because it contains all the ingredients needed for the good health .The natural ingredients remain in their original form (Nieva, 1955).

2.4 HEALTH BENEFIT OF FRUIT DRINK CONSUMPTION

The fruit drink consumption has been associated with a healthy diet. Beyond it's nutritional potential, these juices contain different compounds that show biological activities. Currently, the interest on phenolic compounds lies on its antioxidant capacity, which contributes to the protection of the harmful effects of oxidation stress on human health (Lozano 2006).

The health benefits of fruits and fruit drinks have been reviewed by Landon (2007). The high potassium and low sodium characteristic of most drinks help maintain a healthy blood pressure, furthermore the lack or near absence of fat in fruit drinks is beneficial for the cardiovascular system. The fortification juices with calcium (Andon,1996) and phytosteron provide some supplemental bone and cardiovascular benefits.

Vitamins have a special role since they are essential for life and most are not produced by the body. Vitamin C (ascorbic acid), naturally present or added to most drinks, is necessary for the body to form collagen, cartilage muscle, and blood vessels, and aids in the absorption of iron (Williamson 2008).

Several epidemiological studies have shown that fruit juices may have a beneficial role in preventing the development of cancer (Cutler et al, 2008). Many fruit drink photochemical, polyphenols, carotenoids and limonoids may influence mechanisms relevant for cancer prevention.

The formation of a blood clot in the circulatory system (thrombosis) can lead to disturbance in the blood supply resulting in embolism and stroke. Several fruit drinks seem to be able to limit blood clot formation by preventing platelets from agglutinating in the blood vessels (Andon, 1996).

Many reports have shown that fruit drinks may play an important role in maintain cognition, limiting brain aging and possibly slowing the progress of Alzheimer's disease (Dai et al 2006).

2.4.1 COMPOSITION AND NUTRITIVE VALUE OF FRUIT DRINKS

The major part of the edible portion of fresh fruits consist of water (75-95%most type). Fruits are poor sources of protein (0.2-1.3%as N*6.25). But in general, contain a reasonable amount of carbohydrate. The latter may include varying proportions of dextrose, fructose and sucrose and possibly starch. The principal acids present in fruits are citric, tartaric and malic acids.

Carbohydrate*:*Most fruit drinks are high in sugars as they contain large amounts of dextrose and laevulose and in many cases sucrose as well. Grape juice is especially high in sugars. Concord juice ordinarily contains 16-17% of sugar; Califonia grape juices are usually considerably higher than this. Passion fruit juice is also very high in sugar. Sugars are important foods, being easily digested and yielding energy quickly (Dauthy,1995).

Protein: Most of the common fruits are low in protein. The loganberry is an exception, since it contains approximately 4.5% of protein (dry matter basis). A considerable proportion of the protein contents of fruits is insoluble and consequently remains in the pomace; there-fore, most fruit juices are very low in protein (Tressler and Joslyn,1961).

Fat: Nearly all of the fruit juices are very low in fats. Grapes with 1.6%, and blackberries and raspberries containing approximately 1% are exceptions. Because of the small amount of fat found in fruits, their juices are very low in fat (Tressler and Joslyn,1961).

Fibres: Crude fibre is the organic residue, which remains after the food sample has been treated under standardized conditions with petroleum spirit, boiling dilute sulphuric acid, boiling dilute sodium hydroxide solution and alcohol. The crude fibre consist of cellulose together with a little lignin (Min and Boff 2013).

Acidity and pH: Organic acids contribute to the particular flavour and palatability of fruit juice and are found as a result of biochemical processes or fermentations, through the development of certain spoilage microorganisms. Acidity protects against the development of a pathogens to a large extent. In orange juice, citric acid is the most abundant, followed by malic, both being present mostly as free acids, although in limited quantities they are also combined as citrates or malates, which gives orange juice its buffer effect. Other non-volatile free acids (oxalic, tartaric and galaturonic, quinic and many others) are found in much lower quantities (Esteveet al,2005).

The concentration of hydrogen ions is commonly expressed in terms of the pH scale. Low pH corresponds to high hydrogen ion concentration and vice versa. The pH of fruits varies from 2.5-4.5 with the range of 3-3.5 being in most type(Min and Boff 2013).

The total soluble solids (Brix): Brix is a measure of the concentration of soluble solids in a solution and is based upon the relationship between the specific gravity and soluble solids of a pure sucrose solution, ie. 1%Bris =1% sugar w/w (weight to weight).

The soluble solids to acid ratio are the best criterion to determine citrus quality.
The Brix/acid ratio which also known as the maturity index alters according to the growing regions and effect of early and late season fruit.The Brix and acid levels of juices are two of the most important parameters which determine organoleptic (taste) quality of juices. Whilst this relationship is only strictly applicable to sucrose solutions, the Brix provide a useful indication of the soluble solids of a fruit juice. The range of extracted orange juice and grapefruit juice is 9-12%. Measurement of either specific gravity or refractive index is widely used in the fruit juice and soft drink industry to provide a quick, empirical measure of soluble solids in solution. The soluble solids content of orange juice (exclusive of added sugars) shall not be less than 10% (Codex,1981).

Minerals: Fruit juices aremuch rich in potassium,andalso contain calcium,magnesium,sodium,phosphorus, chlorine, sulfur, iron, copper and other minerals needed by the body (Tressler and Joslyn,1961).

Potassium is an essential mineral that works to maintain the body'swater and acid balance. As an important electrolyte, it plays a role in transmitting nerve impulses to muscles, in muscle contraction and in the maintenance of normal blood pressure.

Potassium was a major macro mineral in orange juice ranging from 101-105mg/100ml. Van der horst et al..,(1984) found that very little sodium is found in cool drink and fruit juices.

Calcium is vital for the formation of strong bones and teeth and for the maintenance of healthy gums. It is also important in the maintenance of a regular heartbeat and in the transmission of nerve impulses. The amount of calcium in raw orange juice is 11mg/100g (USDA,2001).

Magnesium is necessary to prevent the calcification of soft tissue. This essential mineral protects the arterial linings from stress caused by sudden blood pressure changes, and plays a role in the formation of bone and in carbohydrate and mineral metabolism. USDA,(2001) Reported that the amount of magnesium in orange is 11mg/100g.

The sodium (Na), potassium (K), calcium (Ca) and phosphorus (P) content of cool drinks is low although K and P may contribute significantly to dietary intake when most fruit juices are consumed (Van der horst, et al,1982).

Vitamins: Most fruit juices are excellent sources of vitamin C, several are good sources of carotene, and may contain moderate amounts of pyridoxine, inositol, folic acid and biotin. Vitamin C (ascorbic acid), is one of the most important vitamins found in citrus juices, including orange juice.

Although vitamin A may be destroyed by heating, its precursor, carotene, is much more heat stable (Tressler and Joslyn,1961).

All fruits contain, more or less, anti-scorbutic vitamin C. most of them are good sources and several others are very rich in this vitamin. The freshly pressed juices of the citrus fruits are excellent sources of this vitamin (Tressler and Joslyn,1961).

2.4.2 DIFFERENT METHODS OF FRUIT DRINK PRESERVATION

In considering fruit drink preservation, attention is given to techniques that reduce contamination during the production processes. Kadar (2008) advocated the use of fresh healthy fruits as starting point combined with good sanitation. Several methods are however employed after the production of the juice to enhance its storage. These include.

Refrigeration: Treatment of the prepared drinks to low temperature environments reduces microbial spoilage activities. Even where there are no pathogens, the

naturalmicro flora will be active at ambient temperature. Refrigeration is normally done at 0-4^{o}C at which most microorganisms are kept static while some loose viability in maintained at the temperature for long.

Freezing:This involve freezing temperature than ordinary refrigeration. Sometimes, fruitdrinks are prepared at very low temperature in order to prevent deterioration. Reports show that single strength juice freezing stored in low oxygen environment, can maintain freshness more than many other processes. Such frozen drinks are thawed before used (Murtaza et al 2004).

Competitive inhibition of spoilage organisms: This is achieved by using benign microorganisms as inclusions in foods. Such organisms grow well after the strange conditions and produce inhibitory substances against spoilage organisms.

Use of heat: Heat is used to destroy spoilage organisms in a process called pasteurization. Although some spores of bacteria can survive pasteurization temperature (near 100^{o}C). In some cases autoclaving which involves use of high temperature (usually 121^{o}C) under pressure to eliminate microorganisms, is employed (Crandall et al, 1981).

Canning: This refers to enclosing the drinks in a can under specific conditions which ensures retention of microorganisms and retention of juice or drink quality. Many different techniques are employed to ensure rapid heating and cooling during the canning process. The use of rotary retort for instance ensures heating and cooling while the fruit drinks is continuously stirred in the can by the headspace bubble movement (Nieva,1955).

Hot filling is a fairly easy and the drink while hot is filled in the pack by rapidly heating the drink in a heat exchanger followed by sealing.

Aseptic processing: In this case, the juice is pasteurized and cooled under aseptic condition and filled into sterile laminated containers. According to Singh (2010), this

method has the advantage of the destruction of microbes and enzyme. Also the evolution of canning to aseptic processing has improved the fruit drink quality and safety (Nieva,1955).

2.4.3 FRUIT DRINKS PROCESSING

The manufacturing process of fruit products (viz slices and juice) involves many steps and different sub-processes. Ripe and matured fruits are washed, graded and peeled. Then they are crushed in the crusher to obtain juice.

In case of slices, after peeling, uniform slices are made on the slicer. Juice is then taken to vessels and boiled and certain preservatives are added. It is finally taken to storage tanks and packed in bottled on vacuum filling machine. In case of slices, they are dipped in sugar syrup for about 3 to 4 hours. Then the slices are taken to lacquered cans and cans are sterilized. While canning, sugar syrup is added. Cans are cooled quickly and after sealing and labeling, they are stored. The average yield is around 80% (Nieva,1955).The process flow char of pineapple and orange drink is as under.

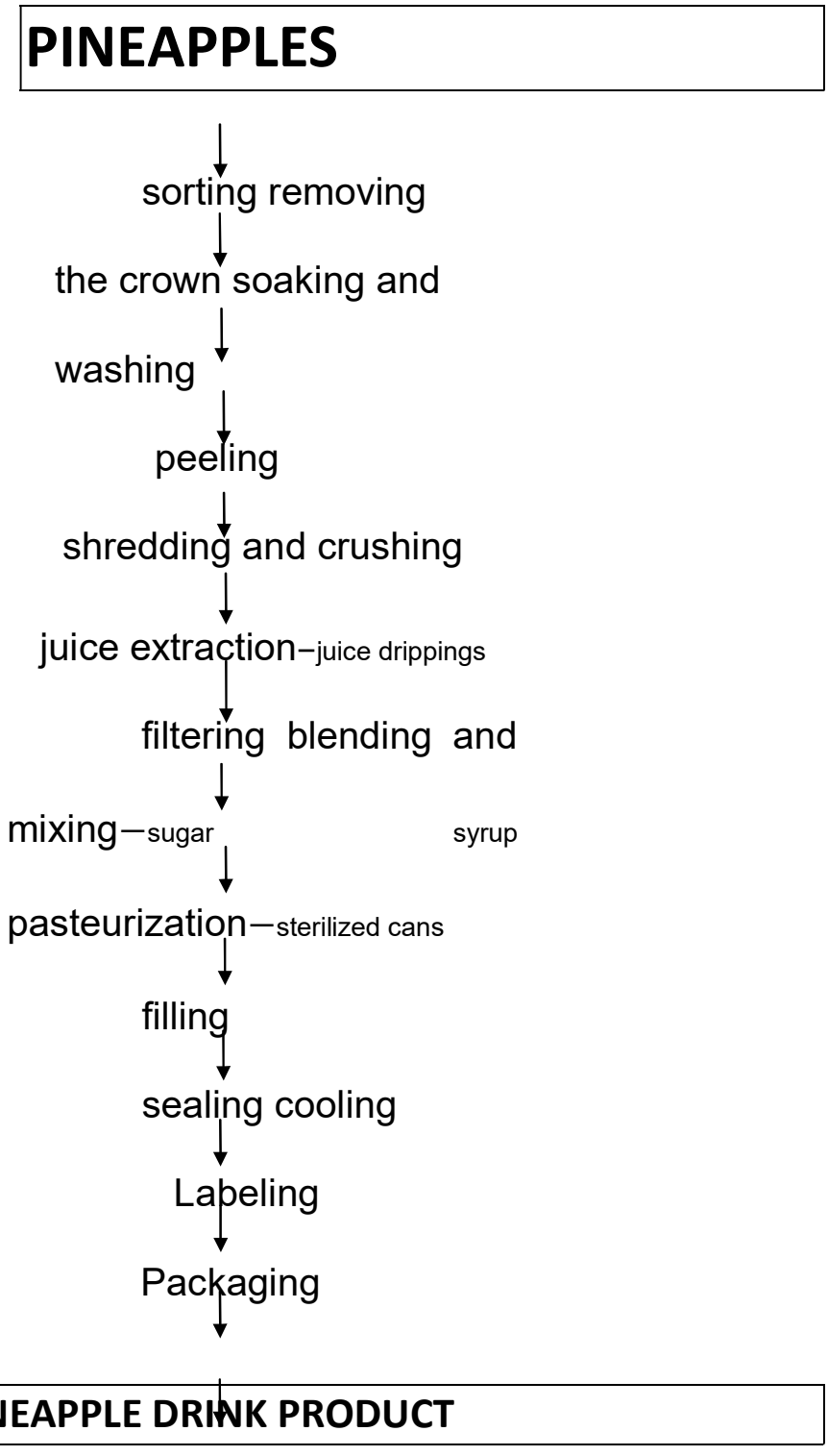

Figure 2.1.Flow chart for the production of pineapple drink (FAO 1992).

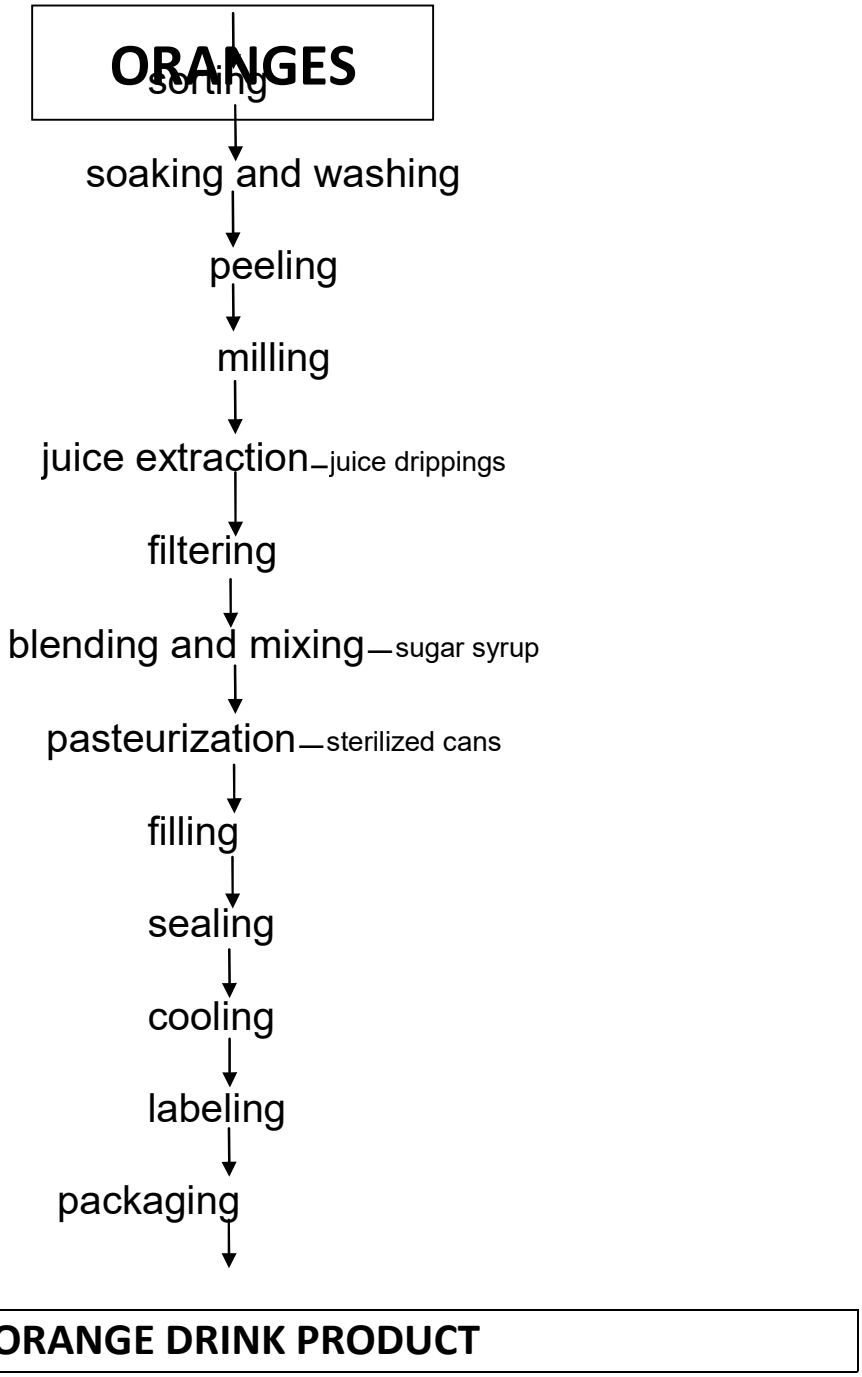

Figure 2.2.flow chart for the production of orange drink (FAO, 1992).

2.5 PREPARATION OF RAW MATERIAL

Sorting/ Washing: Once received at the factory the produce is graded and washed and to ensure the produce is sound, free from gross damage and contamination and

remove foreign objects (Varnam& Sutherland 1994). Washing can be in water flumes or spray washing depending on the product. The water can be hot or cold and/ or contain a sanitizer such as chlorine or pass through a UV light tunnels.

Peeling: This is often done manually, or with knives, yet sometimes the skin is loosened with steam and then subsequently rubbed away mechanically. Finally, the fruits are sorted again to remove any blackened pieces, bits of peeling, seed etc.

Milling: Some fruits require physical size reduction prior to juice extraction. Hammer mills are widely used as they give high juice yield. Fixed knife mills are also used, they are circular gravity fed chamber containing a three armed rotor that spins at high speed forcing the produce against fixed shredding knives. The pulp falls into a hopper and is pumped to the press through screen where stalks and other debris are removed (Varnam& Sutherland 1994).

Juicing: Juice is extracted from the produce using several different methods according to the starting raw material and the type of juice required. Juice is either pressed from the material or spun (centrifuged) or a combination of both. The efficiency of these methods is improved by the use of other pre-treatment processes to reduce the particle size and/or cause damage to the plant cell. Different techniques, including thermal, electro thermal, pulsed electric fields (PEF), chemical and enzymatic pre-treatment are suggested to enhance pressure assisted juice extraction (Praporscic et al,2007).

In fruit and vegetable tissues cells are surrounded with elastic membranes and rigid walls, which limit efficiency of the pressing extraction (Praporscic et al 2007). Juice can be extracted by pressing using either batch or continuous methods depending on the scale of juice to be extracted (Varnam& Sutherland 1994).

Filtering/pressing: The fruit is pressed by using the hydropress 160 litre container press and the juice filtered through a cloth filter placed over a screen/ plate filter which

is refined to 0.2 micron. The filtered is then further 2 times before being placed into the specially allocated juice barrels (Varnam& Sutherland,1994).

Mixing: Mixing, a common operation in food processing, aims to efficiently achieve a smooth, homogenous product with consistent quality. It is a highly complex operation and often taken place early or in the process of food production. Thus, it is crucial for food processors to have the right mixing solution from the start and ensure complete control over many factors that affect mixing efficiency and end-product quality (Varnam& Sutherland 1994) .

Heat Treatment: Liquid products are relatively easy to pasteurize. The flow properties permit fast heat transfer by turbulent mixing using convection and conduction. The three types of process are, batch, continuous orin-container (Wilbey, 2003a). Small scale processors cold fill juice into bottles and heat in a hot water bath. This method is inefficient and has adverse effects on taste and colour. Plate or shell and tube heat exchangers followed by hot fill into bottles and aseptic sealing is the most common method used (Varnam& Sutherland 1994).The temperature time conditions are process and product specific.

Pasteurization of citrus juice at 90^0c for 10s or 85^0C for 4mins denatures pectinase preventing cloud breakdown in fresh juice (Wilbey,2003a). Pasteurization of pineapple juice at 85^0Cfor 90s destroys potential spoilage organisms and denatures polyphenols oxidase, the enzyme that causes browning (Wilbey,2003a).

Packaging/Filling: How a fruit drink is packaged impacts on its shelf life, whether it is hot or cold filled, aseptically or not, with or without gas flushing, depending on the type of gas used and the packaging material. Protection from the environment, reduced exposure to light and oxygen, all can maintain the quality of a fruit drink (Wilbey, 2003a).

2.5.1 PINEAPPLE DRINK

Pineapple*(*Ananascomosus*)* is an economically important plant in the Bromelanceae family. Pineapple and its juice is non-alcoholic drink and demand continues to rise mainly due to increasing awareness of its health benefit (Nwachukwu and Ezejiaku 2014). It's juice have an proximate composition of 81.2-86.2% moisture, 13-19% to solid of which sucrose, glucose and fructose are the main compositions, 0.4% fibre and a rich source of vitamins C (Dull. 2000). Pineapple also contains polyphenolic compounds and possesses antioxidant activity (Hossain and Rahman,2011). It's pulp is juicy and fleshy with the stem serving as a supporting fibrous core. It is an excellent source of antioxidant vitamin C which is required for the collagen synthesis in the body. Pineapple juice is largely consumed around the world, mostly as canning industry by-products and in the blend composition to obtain new flavour in beverage and other products (De-Carvalho and Maia, 2007).

2.5.2 PHYSIOCHEMICAL CHANGES IN PINEAPPLE FRUIT DRINKS DURING STORAGE.

Generally processing of fruit promotes a faster physiological deterioration, biochemical changes and microbial degradation of the products which may result in degradation of its colour, texture and flavor, even when slight processing operations are used (O' Berine and Francis, 2003).

Physical characteristics of pineapple such as moisture content, reduced crown size, fruit weight, texture, delayed ripening and physical damage to the fruit greatly affect the chemical compositions of the fruit such as soluble sugars, pH, Vitamin C, phenols content and titratable acidity (Mohammed et al.,2005). The rates of changes depend on the types and degree of processing (Iqbal et al. 2008). Hence biochemical changes, such as the concentrations changes in vitamin C, sugars, soluble solid and phenols

during storage of fresh pineapple drink is very important since it is used as primary quantitative parameters of quality (Gorny, 2001).

Changes in vitamin C content during storage.

Vitamin C content of pineapple is dependent on factors such as the cultivar, stage of maturity, conditions of storage and the part of fruit. Its content in fresh pineapples ranges from about 20 to 34.44 mg/100 ml of juice (Ngoddy and Ihekoronye, 1985). It is well known that vitamin C is easily oxidized to dehydroascobic acid in alkaline solution whiles it is relatively stable in acidic solutions. The catalyzed oxidation pathway of vitamin C degradation is the most important reaction pathway for the loss of vitamin C in fruits. Therefore, vitamin C of fruits are readily oxidized and lost during staying of the juice or the cut fruit (Ball, 2006). According to Ball 2006, degradation of vitamin C undergoes both anaerobic and aerobic pathways. Oxidation of vitamin C in aerobic pathway occurs mainly during the processing of fruit whereas anaerobic degradation of vitamin C mainly during storage.

On the other hand, degradation rate of ascorbic acid is affected by several factors such as temperature, water activity, pH, storage time and metal ions (Fennema, 1993). According to Ball (2006), a meta-oxygen-ascorbate complex is formed in the presence of molecular oxygen and trace amounts of transition metals which particularly are copper (II) and iron (III). This complex rapidly decomposes to give the ascorbate radical anion. This radical anion reacts with the oxygen to give dehydro ascorbic acid (DHAA). In the anaerobic pathway, vitamin C degradation occurs in the absence of free oxygen, the degradation is caused by the formation of diketogluconic acid. The rate of degradation is maximum at pH 3 to pH 4 and this pathway is mostly responsible for anaerobic loss of vitamin C in packaged cut-fruits and drinks (Ball, 2006).

Several studies have reported on the ascorbic acid loss in fruit drinks during storage under fixed conditions of temperature and relative humidity (Nunes et al., 1998). The

decrease of vitamin C content with time has been recently studied. Murtaza et al., (2004) studied the content of ascorbic acid in a strawberry drink which was stored at room temperature (25^0C), refrigeration temperature (4-6^0C) and high temperature (4045^{0}C). Minimal changes were observed in the samples stored in a refrigerator. Decrease was from 65.0 to 44mg/100ml after three months.

This is because the dehydroascorbic acid, the oxidized form of ascorbic acid was more stable at lower temperatures. Thus, the vitamin C, in the form of dehydroascorbic acid refrigerated fruit drink was well retained than non-refrigerated fruit drink.

Changes in total soluble sugar (Brix) during storage

Total soluble sugars (Brix) in fruits and vegetables has been ascribed by some authors as having an increasing trend whiles others also report of them of having a decreasing trend during storage. According to Echeverria and Ismail (1990), the increase in soluble solids during storage may not necessary reflect in sucrose, glucose and fructose but rather may result in release of soluble components from insoluble material in the fruits whiles the decrease of total soluble solids in fruits is caused by a decline in the amount of carbohydrates and pectins, partial hydrolysis of protein and decomposition of glycosides into sub-units (Ball, 2006). It has also been reported of them of having a decreasing trend during storage. It has also been reported by several authors that correlation between TSS reduction, decrease in sugar content and high metabolic activity occurs when fruits are stored at high temperatures (Murtaza et al 2004). Several studies have been reported on the decreases in total soluble solids during storage over a period of time (Echeverria and Ismail, 1990) whiles Abadias et al (2008) also reported an increase observed in total soluble solids in fruits during storage.

Changes in pH and titratable acidity during storage

The change in pH is associated with number of reasons; it might be due to the effect of treatment on the biochemical condition of the fruit and slower rate of respiration and metabolic activity (Jitareeratet al., 2007). The acidity of the fruit is an important character to determine its quality and acceptability. A study conducted by Jitareerat et al., (2007) on coated and uncoated fruits indicate that pH increased and titratable acidity decreased significantly along with increase storage time. These results agree with those reported by El-Ghaouth et al., (1991). Others also have reported on the decrease in pH and increase in titratable acidity (TA) along with increase in storage time. An increase in TA is associated with decrease in pH. This is also in agreement with those reported by Tovar et al., (2000) on the decrease in pH and increase in titratable acidity observed in slice mangoes and pineapples. It is explained by (Nestle et al., 1998) that the decrease of acidity during storage demonstrates fruit senescence.

2.5.3 MICRO FLORA ASSOCIATED WITH PINEAPPLE FRUIT DRINK

A major challenge faced by the pineapple fruit drink industry is to maintain the quality of drinks produced so that their shelf-life is long enough to ensure efficient marketing (Nestle et al., 1998). The four sources of microbial contaminants are soil, water, air, and animals (Mohammad, 2005). Each microorganism has (i) an optimum temperature at which it grows best, (ii) a minimum temperature below which growth no longer takes, place, and (iii)a maximum temperature above which all development is suppressed. Microbial growth in foods results in food spoilage with the development of undesirable sensory characteristics, and in certain cases renders the food unsafe for consumption. The pathogenicity of certain microorganisms is a major safety concern in the processing and handling of foods in that they produce chemicals in foods that are toxic to humans. Their growth on foods may also result in undesirable appearances and off-flavour (Singh, 2010). Operations such as peeling or slicing increase the tissue

damage of fresh cut produce causing the released of intracellular liquids and consequently increase microbial growth (Singh,2010).

Among the microorganisms, yeasts and moulds have a competitive advantage over bacteria as they easily cause spoilage to pineapple fruit drink because of their ability to grow at a lower pH range (2.2-5.0). In their study on the microbiological quality of fresh minimally-processed fruits, Abadias et al.,(2008) reported that apple, peach, orange, mango and pineapple harbor small microbial populations consisting of yeasts and moulds, while no Enterobacteriacae were detected. They explained this trend by the fact that the investigated fruits were more acidic than other types and the combination of low pH and low temperature during storage also tend to inhibit growth. For most fruits such as pineapples and other fruits there is sufficient acid to limit spoilage primarily due to fungi and aciduric bacteria (lactic acid bacteria, Acetobacter, Gluconobater), Leuconstoc spp., and Enterococci spp. (Splittstoesser, 1987).

Martinez-Ferrer et al.,(2002) identified a relationship between increased shelf-life and reduced populations of yeasts and moulds on pineapple drinks during storage. O'Connor-Shaw et al., (1994) reported that evidence of mould growth on pineapples stored in closed containers was the major quality defect at both 4 and 20^0 C. Specification by the Ghana Standards Authority (GSA) on yeasts and moulds for preserved fruit drinks are not to exceed $5.0x10^1$ whiles that for unpreserved fruit drinks are supposed to be $1.0x10^3$cfu/g (GSA, 2012).

2.5.4 ORANGE DRINK

Orange (Citrus Cinensis) belongs to the genus citrus of the family Rutaceae. It is a distinguished, widely consumed fresh fruit and particularly appreciated for its tangy taste. It's pulp is an excellent source of vitamin C providing 64% of daily requirement

of an individual (USDA 2014). Apart from vitamin C content of orange drink, it is also rich in folic acid, potassium, as well as a good source of fibre.

Orange drinks are known for their health benefits, particularly it's concentration of vitamin C. Generally, the common orange drink is made from sweet orange, but different cultivars such as Valencia orange, bloom orange, navel oranges, clementine, and tangerine are known to have different properties which has to be considered in other to get the desired taste of the drink. Available reports shows that the stage of ripening of the orange fruit, has nutritional and seasoning implication on the juices produced from it (Kader 2008). In all, properly ripened fruits (not over-ripe) are needed to make very good and palatable orange drinks.

2.6 EFFECTS OF STORAGE ON THE NUTRITIVE VALUE OF ORANGE FRUIT DRINK.

Orange drinks are a significant source of ascorbic acid for humans and their consumption in the last years increased at very quick rate. However, ascorbic acid of orange drink is readily oxidized and lost during storage or handling of the drinks, at rates dependent on the conditions of storage. It is evidenced therefore that the quality of any orange drink and its value as a source of vitamin C depends on its content and its rate of loss during storage.

Retention of physical quality and palatability are the most important criteria for determining the storage life of canned orange drinks. The order of breakdown in quality of canned drink is flavour, colour, texture and nutritive losses Martinez-Ferrier et al (2002). The critical storage temperature for most orange drinks is 27 – 29^0C, and temperature higher than this should be limited to a few weeks (Murtaza et al 2004).

During storage of thermally preserved fruit product, many changes may occur that lead to deterioration in quality. The extent of these changes depend on the processing technology, the quality of the raw material and packaging materials and the storage conditions of the products (Lee et al.,1987) new varieties of fruits, improved containers more rapid pasteurization, lower warehousing temperature, and more rapid delivery to the ultimate consumers have all played an important part in minimizing deterioration in storage. This deterioration is confined for the greater part, but not entirely to undesirable changes in flavour and appearance rather than to changes in nutritive value.

On the other hand, orange and apple drink is not nearly so stable and suffer quite rapid flavor changes under common warehousing conditions (Hulme,1971). In orange drink stored at temperature, and up to 60^0F, the change in flavour is much less rapidly than those stored at room temperature, and are usually acceptable after a year (Tresslar and Joslyn, 1961).

Natural fruit drinks, even kept under refrigeration, have a short shelf life (Charalambous,1993).Orange drink stability depends on the raw material, processing conditions, packaging material and storage conditions. These factors should cause microbiological, enzymatic, chemical and physical alterations that damage the sensorial and nutritional characteristics (Correa Neto and Faria, 1999).

The sensorial aspect is directly related to consumer demand for the fruit drink in the research for similarity to recently processed fruit drink (Nisida et al.,1993). The alteration in natural fruit drinks intensifies continuously after extraction, resulting in the development of undesirable flavour and colour (Roig et al., 1996).

Microbial growth in orange drink is characterized by the production of unpleasant flavours and product deterioration that is commonly caused by yeast (Funnema, 1993).Several authors have observed that flavour quality in orange drink was maintained as long as appropriate sanitization and storage temperatures to the product were used(Fellars,1988).Colour and flavor indicate the degree of fruit ripeness (Roig et al., 1996).Thus several physical and chemical determinations (pH, total soluble solid content and total titratable acidity) are important for orange drink characterization and quality (Nisida et al, 1993).

Besides the chemical alterations, vitamin loss caused by temperature increase and/or oxidation reduced product acceptance (Charalambous, 1993).The ascorbic acid content represents a stimulating factor for orange drink consumption (Lee et al, 1987). Storage of commercial fruit drinks in closed containers and at room temperature for 4 months resulted in ascorbic acid losses ranging from 29 to 40%. Commercial orange drink when stored in open containers in the refrigerator for 31 days lost 60 – 67% of its ascorbic acid while fresh orange drink lost ascorbic acid at much slower rate of 7 – 13 %. Open containers of commercial fruit drink, when stored outside the refrigerator for 10 days, lost 12.5% of their ascorbic acid content while refrigerated for the same period, the ascorbic acid losses amounted to 9% (Contento., 1998).

2.6.1 MICROBES ASSOCIATED WITH ORANGE FRUIT DRINK

Orange drink contain a microflora which is normally present on the surface of fruits during harvest and postharvest processing which include transport, storage, and processing (Mohammad, 2005). Many microorganisms such as acid tolerant bacteria and fungi (moulds, yeasts) use them as a substrate for their growth.

The critical factors affecting the spoilage of orange drink include pH, oxidation reduction potential, water activity, availability of nutrients, presence of antimicrobial

compounds, and competing microflora. Among these factors, pH and water activity are the most influential factors affecting the spoilage of orange drink. The spoilage caused by microorganisms in orange drink includes cloud loss, development of-off flavours, $C0_2$ production, and changes in colour, texture, and appearance resulting in degradation of product (Jitareerat et al 2007) .The most commonly reported bacterial genera include Acetobacter, Alicyclobacillus, Leuconostoc, Zymomonas, and Zymobacter. Among yeasts Pichia, Candida, Sacharomyces, and Rhodotorula and common moulds such asPenicillium sp., Aspergillus sp., Eurotium.,Alternaria., Cladosporium., Paecilomyces, and Botrytis have also been reported in storage of orange drink (ICMSF,2005) .

2.6.2 FACTORS AFFECTING ORANGEAND PINEAPPLE DRINKS CONSUMPION

In many populations, even among people who know that orange/pineapple are nutritious; the consumption of orange and pineapple drinks is often very low. The reasons for this are varied, but it indicates that knowledge of nutritional benefit is just one of the many factors that influence food choice (Nestle et al.,1998).Among the other factors that greatly influence what foods people consume are : an individual's food preferences and previous experience with a given food; cultural values , perceptions, attitudes and societal influences including the media and advertising; and, most directly, the availability, taste and price of the food items. For these reasons, it is difficult to bring about widespread behavioral change. Clearly, strategies are more likely to modify behavior and improve health if they are directed towards the relevant influences and barriers (Bandura,1986; Contento,1998). Some of the barriers to

purchasing and consuming these drinks are high cost, fear of harmful pesticides and quick spoilage (FMI,1998).

Over the past two decades, rising incomes and shift in consumer preferences towards healthier, more convenient products have contributed to a growth in demand for orange and pineapple drinks. Income levels also influence the variety and form of orange and pineapple consumed than in developing countries where people consume more fresh fruits(Putnam,1997 and FMI,1998). Further increases in orange/pineapple drinks consumption are possible, but will require an integrated approach to improving consumer awareness and bringing about behavioral change.

2.6.3 FRUIT DRINKS GLOBAL MARKET

The global fruit drinks market is likely to be driven by the mounting consumer inclination towards fruit drink. The demand for healthy food products from diet and fitness conscious consumers is one of the leading drivers of the global fruit drinks market. To meet the requirements of the consumers, manufacturers of fruit drink products are focusing on introducing different varieties and flavors of drinks along with innovative packaging, and product development .As dietary and health concerns are rising among consumers, the demand for vegetables and fruit drinks is also rising (Putnam et al 1997).

Manufacturers of fruit drinks are striving to capitalize on the opportunities arising from the advent of new products such as blended vegetable and fruit juice. At present, the demand for orange and pineapple drinks is significantly high owing to it's easy availability and health benefit of the fruits. However, single and mixed juice of vegetables and fruits such as grapefruit, tomato, pineapple, grape, orange, apple are likely to gain popularity over the next couple of years. Fruit drinks that contain antioxidants made from fruits such as pineapple and orange are also expected to gain

prominence by 2021.The advent of diet fruit drinks and no- sweetener drinks is anticipated to provide manufacturers with lucrative growth opportunities. However, the prime factor that is likely to inhibit the growth of the global market is the availability of substitutes such as carbonated soft drinks (Putnam et al 1997).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 SOURCES OF MATERIAL

The test fruit drinks were sourced by random selection of the packets of brands from Owerri main market. Three of each brand was collected and the brands includeCalifornia brands of orange and pineapple drinks, orange and pineapple frutadrinks and 5-alive orangeand pineapple drinks.Indicatives on sample labels show that the expiring dates of the drinks varied. They were 11-12 months away from their expiring date. Laboratory facilities and chemicals were obtained from laboratories of the Food Science and Technology department of the Federal University of Technology Owerri.

3.2 PROXIMATE COMPOSITION

3.2.1 DETERMINATION OF MOISTURECONTENT

The gravimetric method describe by Brandley (2003) was used. In this regard, a measured quantity (10mls) of each sample was dispensed into a previously weighed moisture can and the weight of both was recorded. The sample in the can was evaporated over a steam bath and then further dried in the oven at 100^0C for 30mins. It was cooled in a desiccator and weighed repeatedly until constant weight was obtained. The formula below was used to calculate the moisture content.

Moisture content = 100 - % total solids

% total solids = $\frac{W2-W1}{W} \times \frac{100}{1}$

Where;

W = Weight of sample analyzed

W_1 = Weight of empty moisture can

W_2 = Weight of moisture can of sample before drying

3.2.2 DETERMINATIONOF ASH CONTENT

The furnance incineration gravimetric method Herbers and Nielson (2003) was used. A measured volume 10ml of each was put in a previously weighed porcelain crucible. The sample in the crucible was put in a muffle furnance at 550^0C. The sample was allowed to burn until it becomes gray ash. The crucible was carefully removed from the furnace (taking care not to allow air blow the ash away), cooled in a desiccator and reweighed. The different is weight ash

was– % ash = $\frac{W2-W1}{W} \times \frac{100}{1}$

Where

W = weight of sample

W_1 = weight of empty crucible

W_2 = weight of crucible + ash

3.2.3 FATCONTENT DETERMINATION

This was done using the rose – Goutier gravimetric method (James 1995). A measured volume of each sample, 10ml was treated with 1ml of ammonia solution and mixed inside the Rose – Gottiebtube. The 10ml of the 95% ethanol was added to it, mixed well and followed by 25ml of methyl ether. The tubes were covered and shake vigorously to mix well after which 25ml of petroleum spirit was added to it and mixed well. It was transferred to a separation funnel and allowed to separate into phases with the fat portion in the upper layer and was collected. Then the lower layer was re

extracted with portion of fresh petroleum spirit and pulled together with the first extract. It was then evaporated to dryness over a steam bath, dried in the oven at 80^0C for 30 minutes, cooled in a desiccator and reweighed. The weight of fat in the sample was calculated using the formula above

$$\% \text{ Fat} = \frac{W2-W1}{V} \times \frac{100}{1}$$

W = Weightof sample analyzed

W=Weight of sample analyzed W_1 =

Weight of empty evaporated dish

W_2 = Weight of dish + Fat extract.

3.2.4 DIETARY FIBRE DETERMINATION

Dietaryfibrewas determined using the enzyme degradationmethod (Bemiller,2003). A measured weight (vol) of each sample was measured into a clean conical flask and treated with □-amylase solution in buffer. After 15minus of digestion, the enzyme reaction was stopped. The sample was treated with a protease enzyme solution and allowed to digest for 15mins. The reaction was stopped and the sample mixture was treated with gluco amylase and allowed to act for 15mins. It was then filtered and the residue was washed. The filtrate was collected and treated with ethanol to precipitate the soluble fibre which was oven dried and weighed. Meanwhile the residue which is the soluble fibre was washed with distilled water followed by 95% ethanol and acetone. It was oven dried and weighed after cooling in adesiccator. The combined weights of the insoluble and soluble fibres gave the total dietary fibre given by the formular below:

$$\text{Total dietary fibre} = \frac{IDF \times SDF}{W} \times \frac{100}{1}$$

IDF = Insoluble Dietary fibre

SDF = Soluble dietary fibre

W =Weight (or volume) of sample analyzed

3.2.5 CRUDE PROTEIN DETERMINATION

The protein content was determined by the Kjeldhal method as described by Chaug (2003). The total nitrogen was determined and multiplied by the factor 6.25 to obtain the protein content 1.0ml of each sample was mixed with 10ml of concentrated sulphuricacid (H_2SO_4) in a kjeldahl digestion flask. A tablet of selenium catalyst was added to it and the mixture was digested by heating in a fume cupboard until a clear solution was obtained. Each of the digest was carefully transferred to 100ml volumetric flask and made up to the mark with distilled water. A 10ml portion of each digest was mixed with an equal volume of 45% $N_aOH$solution in a kjeldhal distillation unit. The mixture was distilled and the distillate collected into 10ml of 4% boric acid solution containing there (3) drop of mixed indicator–bromocressol green and methyl red. A total of 50mls distillate was collected (obtained) and titrated against 0.02N H_2SO_4 solution from green to a deep red end point. A reagent blank was also digested, distilled and titrated, just as the sample. The nitrogen and protein content was calculated, thus:

% Protein = % N x 6.25

% N_2 $= \frac{100}{V} \times \frac{14N}{1000} \times \frac{VF}{VA} \times T - B$

Where:

V = Volume of sample analyzed =1.0ml

N = Normality of titrant (H_2SO_4) = 0.02N

Vf = Total volume of digest= 100ml

Va = Volume of digest distilled 10ml

T = Titre value of sample

B = Titre value of reagent blank

The percentage of protein was calculated as % protein % $=N_2 \times 6.25$

3.2.6 DETERMINATION OF CARBOHYDRATE

The carbohydrate content of the test samples was determined by estimation using the arithmetic difference method described by Bemiller (2003). The carbohydrate was calculated and expressed as the nitrogen free extract (NFE) as shown below:

% CHO (Nitrogen free extracted) = 100 - %(a+b+c+d)

Where:

a = Protein b = Fat

c = ash

d = Fibre.

3.3 DETERMINATION OF MINERAL PROFILE

3.3.1 DETERMINATION OFCALCIUM AND MAGNESIUM

Calcium and magnesium content of the sample(s) extract was carried out by Versanate EDTA Complexiometric titration, described by Carpenter and Hendricks (2003).

A measured volume of each extract (20ml) was dispersed into a conical flask, pinch doses of the masking agents (potassium cyanide, potassium ferocyanide, hydroxylamine hydrochloride) were added to it. Then 20ml of ammonia buffer was added to adjust the PH to 10.0. A pinch of the indicator Erichrome black T was added and the mixture was shaken very well. Then it was titrated against 0.02N EDTA solution, until the colour changed from mauve to a permanent deep blue colour. This titration gave a reading for combined concentration of Ca and Mgions, this is as a result of $Ca^2$and Mg^2 forming complexes at Ph10.0 with EDTA. A second titration was

conducted to determine Caalone. This was a repeat of the previous one with a slight change, in that 10% NaOH solution was used to raise the PH of the digest to 12.0 and then titrated with 0.02N EDTA using selechrome dark blue as indicator in place of Erichromeblack T. At pH 12.0 Ca^2 complexes with EDTA. A reagent blank was titrated to serve as control. The experiment was repeated two more times. The calcium and magnesium contents were calculated separately using the formula.

% calcium or magnesium = $\frac{100}{V} \times EV \times N \times \frac{VF}{VA} \times T - B \times$

Where:

V = Volume of sample analyzed

EV = Equivalent volume

N = Normality of EDTA

Vf = Total volume of extract

Va = Volume of extract titrated

T = Titre value of sample

B = Titre value of blank

3.3.2 DETERMINATION OF POTASSIUM

Flame Photometry was used to determine the concentrations of potassium as described by Carpenter and Hendricks (2003).

The instrument (photometer) was set up according to the manufacturer'sinstructions. The equipment was switched on and allowed to stay for about 10mins. The gas and air inlets were opened and the start knob was turned on the equipment being self-igniting. After ignition, the flame was adjusted to a non-luminous (blue) flame.

Meanwhile, standard potassium solution was prepared and was diluted to concentration of 2,4,6,8 and 10ppm. The appropriate fitter was selected i.e. for potassium. The highest concentrated standard solution (10ppm) was aspirated and it emission intensity adjusted to 100 units. Thereafter, starting with the least

concentrated (2ppm), each standard solution was aspirated and caused to spray over the non-luminous butane gas flame. The emission intensity read directly on the instrument and the readings were recorded. Then the sample digests were also aspirated and their readings recorded. The emission intensities of the standards were plotted against their concentrations to obtain a standard curve (calibration graph) for each element. Subsequently, the optical density emissions recorded from each of the samples were matched against those in the curve, thus using the curve to extrapolate the quantity of each potassium ions in the sample. The experiment was repeated two more times to get a mean concentration. The concentration of the test minerals were calculated as follows.

K mg/100ml= $\frac{100}{V} \times \frac{X}{1000} \times \frac{VF}{VA} \times D$

Where:

V = Volume of sample used

X = Concentration (in ppm) from curve

Vf = Total volume of extract

Va = Volume of the extract (digest) flamed

D = Dilution factor where applicable

3.3.3 DETERMNATION OF THE TRACE ELEMENT (Fe and Zn)

An atomic absorption spectrophotometer (AAS) was used to determine the concentration of iron (a trace element/metal). The solution (digest) from the ash was used. Solutions containing metal ions were aspirated into a flame in which they were converted to afree atom vapour.A monochromatic light source was directed through the flame and the amount of radiation of a specific energy absorbed by the solution was recorded. A calibration graph was then prepared for the element and from this,

the amount of the element present in each sample was read. A general formula as shown below was used.

Emg/100ml $= \frac{100}{V} \times \frac{X}{1000} \times D$

v = volume of sample are analyzed.

X = equivalent concentration (in ppm) derived from standardcurve

D = dilute factor.

E = Element determined

3.3.4 DETERMINATION OF VITAMINS

The spectrophotometric method discussed by) Okwu (2004)was employed

3.4.1 DETERMINATION OF THIAMINE (VIT B1)

The spectro photometric method described by Okwu (2004) was used.

A measured volume (5ml) of each sample was homogenized with 50mls of 1N ethanoic sodium hydroxide and the homogenate was filtered to obtain the filtrate used for the analysis. An aliquot (10mls) of the filtrate was treated with equal volume of 0.1N $K_2Cr_2O_7$solution in a flask. Meanwhile, standard thiamine solution was prepared and diluted to a chosen concentration (0.05mg/ml). An aliquot of the standard thiamine solution was also treated with 10ml of the dichromate solution ($k_2cr_2O_7$) in a separate flask while a reagent blank was set up by treating 10mls of the ethanoic sodium hydroxide with the potassium dichromate solution. The absorbance of the sample and the standard solutions were measured in a spectrophotometer at a wavelength of 360nm with the reagent blank used to calibrate the instrument at zero. The thiamine content was calculated using the formula below;

Thiamine mg/100ml $= \frac{100}{V} \times \frac{AU}{AS} \times C \times \frac{VF}{VA} \times D$

Where

V = Volume of sample analyzed

Au = Absorbance of sample

As = Absorbance of standard thiamine solution

Vf = Total volume of filtrate

Va = Volume of filtrate analyzed

D = Dilution factor where applicable

3.4.2 DETERMINATION OF RIBOFLAVIN (VIT B_2)

Exactly 5ml of each sample was dispersed in 100mls of 5% ethanol solution in distilled water. The mixture was shaken for an hour mechanically and filtered. An aliquot (10mls) of the filtrate was mixed with an equal volume (10mls) of 5% potassium permanganate ($KMnO_4$) solution and 10mls of 30% hydrogen peroxide solution (H_2O_2) was added to it. The above treatment was also given to a 10ml portion of standard riboflavin solution as well as a reagent blank. All the flasks (standard, blank and sample were allowed to stand over a water bath for half an hour and 2mls of 40% Na_2So_4 solution was added to each of them. This was made up to 50ml in a volumetric flask. Their respective absorbance (sample and standard) were measured in a spectrophotometer at 510nm wavelength. Reading were taken with the reagent blank at zero. Thus, riboflavin content was calculated as:

Riboflavin mg/100ml $= \frac{100}{V} \times AU \times C \times \frac{VF}{Va} \times D$

Where:

V = Volume of sample

Au = Absorbance of sample

As = Absorbance of standard solution

C = Concentration of standard solution

Vf = Total volume of filtrate

Va = Volume of filtrate analyzed

D = Dilution factor where applicable

3.4.3 DETERMINATION OF VITAMIN C

This was determined using the Barakat titrimetricmethod describedby Okwu and Ndu (2006). Accordingly measure volume of each sample (5ml) was mixed with 50mls of extra solution (% TCA/EDTA) and mixed by shaking. The mixture was filtered after 30mins and the filtrate (extract) was used for the determination. The entire extract from each sample was treated with 20ml of 10% potassium iodide solution and diluted by addition of 50mls of distilled water, mixed well and then filtrated against 0.01m CuSO4 solution. Starch solution (1ml of 1% solution) was used as indicator and the endpoint was marked by the presence of dark colouration. The vitamin c content was calculate based on the relationship below.

1ml of 0.01ml $CuSO_4$soln = 0.88mg VitC

$$\text{Vit C mg/100ml} = \frac{100}{V} \times 0.88 + \text{Titre}$$

V = volume of sample (ml)

3.4.4 DETERMINATION OF VITAMIN A

The colorimetric method of the association of vitamin chemists described by Kirk and Sayer (1991) was read.

A weighed quantity 5.0g of each sample was mixed with 30mls of ethanol and 3ml of 50% kurt solution was added to it. It was saponified by boiling gently under reflux for 30mins. It was cooled in cold water and 30ml of distilled water was added to it. The mixture was transferred to a separation funnel and 50mls of petroleum ether was added to it and mixed gently to avoid formation of emulsion. The aqueous layer was discarded while the upper layer was treated with another 50ml of the petroleum ether after mixing very well, four portions of 50mls each of distilled water was used to wash

the mixture in the separating funnel. Each time, the lower aqueous layer was discarded. At the end, the outer layer was evaporated to dryness over a steam bath.

The dry vitamin A extract was re-absolved in 20mls of isopropyl alcohol.

Meanwhile, standard vitamin A solution was prepared and diluted to contain 5m/ml. exactly 1ml of the standard solution was dissolved in 20mls of isopropyl alcohol and its absorbance was read alongside that of the extract at the wavelength325nm in a spectrophotometer. The formula below was used to calculate the vitamin A content.

$$\text{VitAIu/100g} = \frac{100}{V} \times \frac{au}{as} \times c$$

Where:-

V = Volume of the sample analyzed

au = absorbance of the test sample

as = absorbance of standard vitamin A

c = concentration of vitamin Astandard (Iu/ml)

3.4.5 DETERMINATION OF VITAMIN E:

Vitamin E was determined using the further-Meyer colorimetric method of the association of vitamin chemist described by Kirk and Sawyer (1991).At measured quantity of each oil sample (5ml), was used with 20mls of absolute alcohol (ethanol) in a flask and 20ml of molar alcoholic sulphuric acid was added to it. The flask was wrapped with aluminum foil to reduce light effect, and the sample mixture was boiled under reflux for 30mins. Then 50ml distilled water was added to it, mixed well and transferred to a separating funnel using an additional 50ml of distilled water to rinse out the flask into the separating funnel. The unsaponifiablematter in the oil mixture was extracted using 3x 50ml of diethyl ether each time and the ether extracts were pooled together and dried under anhydrous solution sulphate in a desiccator. After that the extract was allowed to evaporate to dryness under air. The vitamin E extract was then dissolved in 10ml of absolute alcohol (ethanol) and used for the analysis as described below.

As aliquot part, 1ml, of the reconstituted extract from each sample, was mixed with 5ml of absolute alcohol followed by a careful addition of1ml of concentrated Nitric acid. Similarly, 1ml of standard vitamin E solution (0.5Iu/ml) was put in a separate test tube and treated with the nitric acid as the sample was treated. The flasks were allowed to heat in water bath at 90^{o}c for exactly 3mins the time the content started boiling. Thereafter, they were cooled rapidly under running water and made up to 20mls with the absolutealcohol. Their absorbances (sample and standard) were read in a spectrophotometric at a wavelength of 470nm. A reagent black was used to calibrate the instrument at zero. Theformula below as used to calibrate the vitamin E content.

Vit E mg/100ml $= \frac{100}{V} \times \frac{AU}{AS} \times c \times \frac{VF}{VA} \times D$

V = volume of oil sample analyzed

Au = absorbance of sample

As = absorbance of standard vitamin E solution

C = conc. Of standard vitamin E solution

Vf = total volume of extract

Va = Volume of aliquot part of extract analyzed D

= dilution factor where applicable

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results of the proximate analysis is shown on table 4.1. From the results it can be seen that 5-alive Pineapple drink had the highest protein content while Califonia orange had the lowest.

Results of vitamin analysis is shown in table 4.2. The results show that vitamin A was highest in the califonia orange drink and least in pineapple fruta drink. Also thiamin was highest in the same califonia orange drink and lowest in 5-alive pineapple drink.The highest value for riboflavin was recorded in orange fruta while the least was in the 5-alive drinks and califonia orange drink with 0.023mg/100ml each.Vitamin C was highest in califonia orange and lowest in pineapple fruta while vitamin E was highest in 5-alive orange and lowest in califonia pineapple.

Table 4.3 show result of mineral analysis of the test fruit drinks. From the result, the highest calcium content was in 5-alive orange while the least was in pineapple fruta whereas the highest magnesium content was in califonia pineapple and the lowest was in orange fruta drink. Potassium was highest in 5-alive orange and least in 5-alive pineapple. Iron and Zinc were highest in califonia orange and 5-alive orange respectively and theirlowest values were recorded in califonia pineapple for both.

4.1 RESULTS

Table 4.1 Results of Proximate Analysis.

Sample	Protein%	Fat%	Fibre%	Ash%	MC%	CHO%
Pineapple Fruta	$0.760^{b}\pm0.10$	$0.213^{ab}\pm0.3$	$0.307^{a}\pm0.02$	$0.473^{a}\pm0.01$	$79.507^{e}\pm0.47$	$18.800^{a}\pm0.41$
Label Value	NI	NI	NI	NI	NI	21.00
Orang Fruta	$0.587^{a}\pm0.9$	$0.180^{a}\pm0.02$	$0.313^{a}\pm0.02$	$0.527^{c}\pm0.01$	$77.740^{d}\pm0.78$	$21.063^{b}\pm0.73$
Label Value	NI	NI	NI	NI	NI	23.0
5-AlivePineapple	$0.820^{b}\pm0.05$	$0.353^{d}\pm0.01$	$0.413^{c}\pm0.03$	$0.467^{a}\pm0.02$	$76.647^{c}\pm-0.34$	$21.300^{b}\pm0.34$
Label Value	0.00	0.00	NI	NI	NI	NI
5-Alive Orang	$0.583^{a}\pm0.04$	$0.287^{c}\pm0.01$	$0.413^{c}\pm0.01$	$0.573^{d}\pm0.01$	$73.793^{a}\pm-0.39$	$24.350^{e}\pm0.40$
Label Value	NI	NI	NI	NI	NI	NI
CalifoniaPineapple	$0.730^{a}\pm0.05$	$0.233^{b}\pm0.01$	$0.367^{b}\pm0.01$	$0.487^{ab}\pm0.01$	$74.960^{b}\pm-0.13$	$23.237^{d}\pm0.12$
Label Value	NI	NI	NI	NI	NI	NI
CalifoniaOrang	$0.557^{b}\pm0.04$	$0.213^{ab}\pm0.03$	$0.0327^{a}\pm0.02$	$0.507^{bc}\pm0.02$	$76.160^{c}\pm-0.06$	$22.237^{c}\pm0.13$
Label Value	NI	NI	NI	NI	NI	NI

Values showed mean of triplicate analysis $\pm$ standard deviation. Values with different superscript down the columns are significantly different ($P < 0.05$).

NI = show not indicated in the labels.

Table 4.2 Results of Vitamin Analysis.

Sample	IU/100g Vitamin A	mg/100ml Thiamin	mg/100ml Riboflavin	mg/100ml Vitamin C	mg/100ml Vitamin E
Pineapple Fruta	$122.260^{a}\pm4.13$	$0.063^{c}\pm0.00$	$0.028^{b}\pm0.00$	$31.093^{a}\pm1.02$	$9.473^{d}\pm0.64$
Label Value	126.0	NI	NI	NI	NI
Orang Fruta	$133.000^{c}\pm1.38$	$0.054^{b}\pm0.00$	$0.042^{c}\pm0.00$	$42.827^{c}\pm1.02$	$9.820^{d}\pm0.14$
Label Value	137.0	NI	NI	NI	NI
5-AlivePineapple	$125.200^{ab}\pm2.08$	$0.043^{a}\pm0.00$	$0.023^{a}\pm0.00$	$34.027^{c}\pm1.02$	$8.653^{c}\pm0.01$
Label Value	NI	NI	NI	26.05	NI
5-Alive Orang	$131.800^{c}\pm2.77$	$0.049^{b}\pm0.00$	$0.023^{a}\pm0.00$	$46.347^{d}\pm1.02$	$9.720^{d}\pm0.11$
Label Value	NI	NI	NI	38.00	NI
Califonia Pineapple	$127.033^{c}\pm1.67$	$0.049^{b}\pm0.00$	$0.027^{b}\pm0.00$	$32.267^{ab}\pm1.02$	$6.147^{a}\pm0.5$
Label Value	130.0	NI	NI	25.00	7.05
Califonia Orang	$135.133^{c}\pm1.50$	$0.065^{c}\pm0.00$	$0.023^{a}\pm0.00$	$45.007^{d}\pm0.91$	$7.513^{b}\pm$-0.25
Label Value	138.0	NI	NI	35.0	6.0

Values showed mean of triplicate analysis ± standard deviation. Values with different superscript down the columns are significantly different ($P < 0.05$).

NI = show not indicated in the labels.

Table 4.3 Results of Mineral Analysis

Sample	Calcium mg/100ml	Magnesium mg/100ml	Potassium mg/100ml	Iron mg/100ml	Zinc mg/100ml
Pineapple Fruta	$17.363^{a}\pm1.15$	$12.800^{bC}\pm0.69$	$130.067^{a}\pm2.54$	$0.03^{b}\pm0.00$	$0.061^{b\pm}0.00$
Label Value	NI	13.00	NI	NI	NI
Orange Fruta	$21.373^{bc\pm}1.15$	$10.400^{a\pm}1.39$	$159.433^{b}\pm3.06$	$0.187^{c}\pm0.00$	$0.061^{d}\pm0.00$
Label Value	NI	10.00	NI	NI	NI
5-alivepineapple	$19.370^{ab}\pm1.16$	$14.400^{c}\pm1.20$	$125.867^{a}\pm0.92$	$0.037^{c}\pm0.00$	$0.054^{ab}\pm0.00$
Label Value	NI	NI	NI	NI	NI
5-alive Orange	$23.380^{c}\pm1.16$	$11.200^{ab}\pm0.69$	$170.667^{c}\pm3.69$	$0.167^{d}\pm0.00$	$0.076^{c}\pm0.11$
Label Value	NI	NI	NI	NI	NI
Califonia Pineapple	$18.700^{a}\pm1.16$	$13.600^{c}\pm0.69$	$130.000^{a}\pm3.12$	$0.027^{a}\pm0.00$	$0.049^{a}\pm0.00$
Label Value	23.00	NI	NI	NI	NI
Califonia Orange	$22.710^{c}\pm1.16$	$13.400^{c}\pm0.35$	$159.467^{a}\pm2.54$	$0.171^{e}\pm0.00$	$0.071^{c}\pm0.00$
Label Value	25.01	NI	NI	NI	NI

Value

s

showed mean of triplicate analysis ± standard deviation. Values with different superscript down the columns are significantly different ($P < 0.05$).

NI = show not indicated in the labels.

DISCUSSION:

4.2RESULTS OF PROXIMATE ANALYSIS

From the results, it was observed that the major nutrients, protein, fat, ash and carbohydrate were relatively low. The protein content was in the range of 0.557% ±0.04 (califonia orange) to 0.820% ±0.05 (5-alive pineapple). Generally speaking, the pineapple drinks had significantly ($p<0.05$) higher protein content than the orange drinks. Protein is nutritionally essential due to its role in repair and regeneration of damaged cells in the body as well as its involvement in vital physiological reaction. Fat content of the fruits was in the range of 0.18% ±0.02 to0.353% ± 0.01 although the fat content was low. Generally, there were variations of significant difference ($P<0.05$) between the fat content of the different fruit drinks. The 5-alive pineapple had the highest fat content (0.353% ± 0.01) while the orange fruta drink had the least drink. Dietary fats are nutritionally important since fats enhance retention of flavour of foods, they acts as insulators as well as solvents for important vitamins such as vitamin A and E (Landon,2007).

Dietraryfibre content of the fruit drinks were very low being in the range of 0.307% ±0.02 to 0.413% ± 0.03. The low fibre content of the drinks was attributed to the fact that the fibre portion of the fruit raw material is almost always removed (by sieving or filtration) during the production process of the fruit drinks. The low fibre content was seen as a difficult attribute in the nutritional value of the fruit drinks in view of the important roles fibers play in foods. Onwuka ((2005) repeated that fibre acids digestion of food add, bulk to food and ensures good bowel movement. Also, the ash content gave low values in the range of 0.467% ± 0.02 5-alive pineapple) to 0.527% ± 0.01 (orange fruta). Ash

content of foods depicts the total mineral content hence moderate to high ash content is desirable.

Moisture content of the fruit drinks is high generally and was within the range of 73.793% ± 0.39(5-alive orange) to 79.507% ± 0.47 (pineapple fruta) while the carbohydrate content was calculated to be in the range of 18.80% ± 0.41 to 24.35% ± 0.40. The high moisture content of the fruit drinks was attributed to the fact that extraction of the juice prior to preparation of the drinks is based on the use of water. Again the high moisture content increases the fruit drinks vulnerable to microbial attack, contamination and spoilage resulting in short shelf life. This is more so when considered against the background that the carbohydrates consists mainly of fruit based or added sugars which are good carbon source for microbial proliferation (Echeverria and Ismail 1990).

Generally, the proximate composition of the fruit drinks indicates low nutrient status. Also there were variations of significant amongst the different fruit drinks weather is single fruit or combination of different fruits. These differences may not be unconnected with their respective production techniques which have varying impact on their food qualities (Hancock and Stewart 2010). Also the obtained result proximate composition did not agree totally with claimed nutrients on the sample.

4.3 RESULTS OF VITAMIN ANALYSIS

Results of vitamin analysis of the test fruit drinks samples are shown in table 4.2. The result show variations of significant differences ($p<0.05$) between the vitamin content of the different fruit drink brands on one hand and between the content of the different

vitamins in the same brand of fruit drinks. Vitamin A content of the drinks was in the range of 122.26IU/100g ±4.13 to 135.1333IU/100g ± 1.5. It was observed that the vitamin A content of the orange based fruit drinks (orange fruta,5-alive orange and califonia orange) were significantly higher ($p<0.05$) than those of the pineapple based drinks. Vitamin A is essential nutritionally for good vision especially in children. It also plays important role in immune boosting. Vitamin B_2 in the fruit drinks also showed variations in their respective contents. VitaminB_1 (thiamin) was highest (0.065mg/100ml) in califonia orange drink and lowest (0.043mg/100ml) in 5-alive pineapple drink. The thiamin content varied between the two extremes in the other drinks. Similarly riboflavin (vitamin B_2) varied slightly but significantly between the different drinks. The vitamin B_2 are water soluble vitamins that have very essential role in diets including acting as coenzymes in important reactions, improving immune system etc. the relatively low values of the vitamin B_2 in the fruit drinks could be due to possible effect of heat treatment (pasteurization etc.) during the production process (Friedman, and Shalala, 1998) observed some significant negative impact of heat treatment on the nutritional quality of fruit drinks.

Vitamin C content of the test fruit drinks was much higher than the other vitamin with a range of 31.093mg/100ml ±1.02, to 46.347mg/100ml ± 1.02. The orange drinks had comparatively higher vitamin C values than the pineapple drinks. The high vitamin C content of the drinks could be due to possible fortification with the vitamin from outside sources. Vitamin C is essential nutritionally as it helps to prevent diseases such as scurvy. It also facilitates wound heating as well as offer protection to the body by its antioxidant activities. Generally, the vitamin content of the fruit drinks were on low

except for the vitamin C. Notwithstanding, the fruit drinks constitute a dietary source of the vitamins even though they may not meet the daily requirement for all the different vitamins (Williamson,2008).

It was also noted that some fruit drinks contained slightly higher vitamins than was shown on the labels while others contained much less than what was claimed.

Variations may be due to analytical methods and techniques.

4.4 RESULTS OF MINERAL ANALYSIS

Table 4.3 show the mineral content of the test fruit drinks. There are significant variations in mineral content of the drinks. The calcium, magnesium, iron and zinc content of the drinks were low while potassium content was relatively high. The range of calcium in the drinks was between 17.363mg/100ml and 23.38mg/100ml while that of magnesium content was in the range of 10.40mg/100ml to 13.60mg/100ml. calcium is important in diets as it helps to strengthen and repair bones and teeth. It is also involved in the manufacture of red blood cells. Potassium in the drinks also varied significantly from 125.867mg/100ml to 170.667mg/100ml.

The highest value for potassium was recorded in the 5-alive orange drink while the lowest was recorded in pineapple fruta drink. Magnesium and potassium play vital roles in body metabolism. Both form essential constituents of blood fluids and also help in osmo-regulation of body internal environment (Landon 2007).

Iron content of the drinks was low and in the range between 0.027mg/100ml and

0.187mg/100ml and 0.076mg/100ml. The variations in the values of the minerals in the drinks, showed significant variations ($P<0.05$).The values of these essential minerals in the drinks casts doubts in ability to be good source of the minerals to meet the daily requirement for the body.

CHAPTER FIVE

CONCLUSION

Based on the results obtained in the project work, it was concluded that there is a variation in the nutritional content of the different fruit drinks sold and consumed in Owerri. Generally however, all the fruit drinks have low nutrient status in terms of their proximate composition which showed low protein, fat fibre and ash contents.

Notwithstanding, the vitamin and mineral contents of the fruit drinks were more promising and the relative high vitamin and minerals contents was attributed to possible fortification by addition of same from external sources into the drinks. It was also observed that these fruit drinks contribute moderate sources of nutritional vitamins and minerals.

Again, it was found that there were significant variations in the quantity of the different test nutrients as analyzed compared with the written claims on the labels. Also most labels indicate just a few major constituent given no information on the rest.

RECOMMENDATION

It is recommended that manufacturers of fruit drinks should give a more comprehensive list of nutrients and their amount in the label.

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APPENDIX

PROXIMATE ANALYSIS OF MARKET SAMPLES OF FRUIT DRINKS IN OWERRI

DESCRIPTIVES

						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
protein	pineapple fruta	3	.7600	.10392	.06000	.5018	1.0182	.70	.88
	orange fruta	3	.5867	.09815	.05667	.3428	.8305	.53	.70
	5-alive pineapple	3	.8200	.05196	.03000	.6909	.9491	.79	.88
	5-aliv orange	3	.5833	.04619	.02667	.4686	.6981	.53	.61
	califonia pineapple	3	.7300	.05196	.03000	.6009	.8591	.70	.79
	califonia orange	3	.5567	.04619	.02667	.4419	.6714	.53	.61
	Total	18	.6728	.11994	.02827	.6131	.7324	.53	.88
Fat	pineapple fruta	3	.2133	.03055	.01764	.1374	.2892	.18	.24
	orange fruta	3	.1800	.02000	.01155	.1303	.2297	.16	.20
	5-alive pineapple	3	.3533	.01155	.00667	.3246	.3820	.34	.36

	5-aliv orange	3	.2867	.01155	.00667	.2580	.3154	.28	.30
	califonia pineapple	3	.2333	.01155	.00667	.2046	.2620	.22	.24
	califonia orange	3	.2133	.03055	.01764	.1374	.2892	.18	.24
	Total	18	.2467	.06174	.01455	.2160	.2774	.16	.36
Fibre	pineapple fruta	3	.3067	.02309	.01333	.2493	.3640	.28	.32
	orange fruta	3	.3133	.02309	.01333	.2560	.3707	.30	.34
	5-alive pineapple	3	.4133	.03055	.01764	.3374	.4892	.38	.44
	5-aliv orange	3	.4133	.01155	.00667	.3846	.4420	.40	.42
	califonia pineapple	3	.3667	.01155	.00667	.3380	.3954	.36	.38
	califonia orange	3	.3267	.02309	.01333	.2693	.3840	.30	.34
	Total	18	.3567	.04911	.01158	.3322	.3811	.28	.44
Ash	pineapple fruta	3	.4733	.01155	.00667	.4446	.5020	.46	.48
	orange fruta	3	.5267	.01155	.00667	.4980	.5554	.52	.54
	5-alive pineapple	3	.4667	.02309	.01333	.4093	.5240	.44	.48
	5-aliv orange	3	.5733	.01155	.00667	.5446	.6020	.56	.58
	califonia pineapple	3	.4867	.01155	.00667	.4580	.5154	.48	.50
	califonia orange	3	.5067	.02309	.01333	.4493	.5640	.48	.52

	Total	18	.5056	.03989	.00940	.4857	.5254	.44	.58
MC	pineapple fruta	3	79.506	.47721	.27552	78.3212	80.6921	79.12	80.04
	orange fruta	3	77.740	.78000	.45033	75.8024	79.6776	76.84	78.22
	5-alive pineapple	3	76.646	.34775	.20078	75.7828	77.5105	76.38	77.04
	5-aliv orange	3	73.793	.39209	.22637	72.8193	74.7673	73.38	74.16
	califonia pineapple	3	74.960	.13856	.08000	74.6158	75.3042	74.88	75.12
	califonia orange	3	76.1600	.06000	.03464	76.0110	76.3090	76.10	76.22
	Total	18	76.4678	1.93247	.45549	75.5068	77.4288	73.38	80.04
CHO	pineapple fruta	3	18.800	.41328	.23861	17.7734	19.8266	18.34	19.14
	orange fruta	3	21.063	.73921	.42678	19.2270	22.8996	20.23	21.64
	5-alive pineapple	3	21.300	.34044	.19655	20.4543	22.1457	20.95	21.63

5-aliv orange	3	24.350	.40596	0	.23438	23.3416	25.3584	23.99	24.79
califonia pineapple	3	23.236	.12014	7	.06936	22.9382	23.5351	23.12	23.36
califonia orange	3	22.236	.13013	7	.07513	21.9134	22.5599	22.11	22.37
Total	18	21.831 1	1.84217		.43420	20.9150	22.7472	18.34	24.79

HOMOGENEOUS SUBSETS

Duncan[a]	califonia orange	3	.5567	
	5-aliv orange	3	.5833	
	orange fruta	3	.5867	
	califonia pineapple	3		.7300
	pineapple fruta	3		.7600

5-alive pineapple	3		.8200
Sig.		.631	.164

Protein

		Subset for alpha = 0.05	
group	N	1	2

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Fat

			Subset for alpha = 0.05			
Group		N	1	2	3	4
Duncan[a]	orange fruta	3	.1800			

pineapple fruta	3	.2133	.2133		
califonia orange	3	.2133	.2133		
califonia pineapple	3		.2333		
5-aliv orange	3			.2867	
5-alive pineapple	3				.3533
Sig.		.089	.291	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Fibre

			Subset for alpha = 0.05		
	Group	N	1	2	3
Duncan[a]	pineapple fruta	3	.3067		
	orange fruta	3	.3133		
	califonia orange	3	.3267		
	califonia pineapple	3		.3667	
	5-alive pineapple	3			.4133
	5-aliv orange	3			.4133

Sig.	.302	1.000	1.000	

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Ash

		Subset for alpha = 0.05			
Group	N	1	2	3	4
Duncan[a] 5-alive pineapple	3	.4667			
pineapple fruta	3	.4733			
califonia pineapple	3	.4867	.4867		
califonia orange	3		.5067	.5067	
orange fruta	3			.5267	
5-aliv orange	3				.5733
Sig.		.179	.159	.159	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

MC

	Subset for alpha = 0.05

	Group	N	1	2	3	4	5
Duncan[a]	5-aliv orange	3	73.7933				
	califonia pineapple	3		74.9600			
	califonia orange	3			76.1600		
	5-alive pineapple	3			76.6467		
	orange fruta	3				77.7400	
	pineapple fruta	3					79.5067
	Sig.		1.000	1.000	.195	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

CHO

			Subset for alpha = 0.05				
	Group	N	1	2	3	4	5
Duncan[a]	pineapple fruta	3	18.8000				
	orange fruta	3		21.0633			
	5-alive pineapple	3	21.3000				
	califonia orange	3			22.2367		
	califonia pineapple	3				23.2367	

5-aliv orange	3					24.3500
Sig.		1.000	.497	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

DETERMINATION OF VITAMIN OF MARKET SAMPLES OF FRUIT DRINKS IN OWERRI

DESCRIPTIVES

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
protein	pineapple fruta	3	.7600	.10392	.06000	.5018	1.0182	.70	.88
	orange fruta	3	.5867	.09815	.05667	.3428	.8305	.53	.70
	5-alive pineapple	3	.8200	.05196	.03000	.6909	.9491	.79	.88
	5-aliv orange	3	.5833	.04619	.02667	.4686	.6981	.53	.61
	califonia pineapple	3	.7300	.05196	.03000	.6009	.8591	.70	.79
	califonia orange	3	.5567	.04619	.02667	.4419	.6714	.53	.61
	Total	18	.6728	.11994	.02827	.6131	.7324	.53	.88
Fat	pineapple fruta	3	.2133	.03055	.01764	.1374	.2892	.18	.24
	orange fruta	3	.1800	.02000	.01155	.1303	.2297	.16	.20
	5-alive pineapple	3	.3533	.01155	.00667	.3246	.3820	.34	.36

	5-aliv orange	3	.2867	.01155	.00667	.2580	.3154	.28	.30
	califonia pineapple	3	.2333	.01155	.00667	.2046	.2620	.22	.24
	califonia orange	3	.2133	.03055	.01764	.1374	.2892	.18	.24
	Total	18	.2467	.06174	.01455	.2160	.2774	.16	.36
Fibre	pineapple fruta	3	.3067	.02309	.01333	.2493	.3640	.28	.32
	orange fruta	3	.3133	.02309	.01333	.2560	.3707	.30	.34
	5-alive pineapple	3	.4133	.03055	.01764	.3374	.4892	.38	.44
	5-aliv orange	3	.4133	.01155	.00667	.3846	.4420	.40	.42
	califonia pineapple	3	.3667	.01155	.00667	.3380	.3954	.36	.38
	califonia orange	3	.3267	.02309	.01333	.2693	.3840	.30	.34
	Total	18	.3567	.04911	.01158	.3322	.3811	.28	.44
Ash	pineapple fruta	3	.4733	.01155	.00667	.4446	.5020	.46	.48
	orange fruta	3	.5267	.01155	.00667	.4980	.5554	.52	.54
	5-alive pineapple	3	.4667	.02309	.01333	.4093	.5240	.44	.48
	5-aliv orange	3	.5733	.01155	.00667	.5446	.6020	.56	.58
	califonia pineapple	3	.4867	.01155	.00667	.4580	.5154	.48	.50
	califonia orange	3	.5067	.02309	.01333	.4493	.5640	.48	.52

	Total	18	.5056	.03989	.00940	.4857	.5254	.44	.58
MC	pineapple fruta	3	79.5067	.47721	.27552	78.3212	80.6921	79.12	80.04
	orange fruta	3	77.7400	.78000	.45033	75.8024	79.6776	76.84	78.22
	5-alive pineapple	3	76.6467	.34775	.20078	75.7828	77.5105	76.38	77.04
	5-aliv orange	3	73.7933	.39209	.22637	72.8193	74.7673	73.38	74.16
	califonia pineapple	3	74.9600	.13856	.08000	74.6158	75.3042	74.88	75.12
	califonia orange	3	76.1600	.06000	.03464	76.0110	76.3090	76.10	76.22
	Total	18	76.4678	1.93247	.45549	75.5068	77.4288	73.38	80.04
CHO	pineapple fruta	3	18.8000	.41328	.23861	17.7734	19.8266	18.34	19.14
	orange fruta	3	21.0633	.73921	.42678	19.2270	22.8996	20.23	21.64
	5-alive pineapple	3	21.3000	.34044	.19655	20.4543	22.1457	20.95	21.63
	5-aliv orange	3	24.3500	.40596	.23438	23.3416	25.3584	23.99	24.79

califonia pineapple	3	23.23	.12014	.06936	22.9382	67	23.5351	23.12	23.36
califonia orange	3	22.23	.13013	.07513	21.9134	67	22.5599	22.11	22.37
Total	18	21.8311	1.84217	.43420	20.9150		22.7472	18.34	24.79

HOMOGENEOUS SUBSETS

Protein

			Subset for alpha = 0.05	
	Group	N	1	2
Duncan[a]	califonia orange	3	.5567	
	5-aliv orange	3	.5833	
	orange fruta	3	.5867	
	califonia pineapple	3		.7300
	pineapple fruta	3		.7600
	5-alive pineapple	3		.8200
	Sig.		.631	.164

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Fat

			Subset for alpha = 0.05			
	group	N	1	2	3	4
Duncan[a]	orange fruta	3	.1800			
	pineapple fruta	3	.2133	.2133		
	califonia orange	3	.2133	.2133		
	califonia pineapple	3		.2333		
	5-aliv orange	3			.2867	
	5-alive pineapple	3				.3533
	Sig.		.089	.291	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Fibre

			Subset for alpha = 0.05
	group	N	1
Duncan[a]	pineapple fruta	3	.3067

Group	N	1	2	3
orange fruta	3	.3133		
califonia orange	3	.3267		
califonia pineapple	3		.3667	
5-alive pineapple	3			.4133
5-aliv orange	3			.4133
Sig.		.302	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Ash

			Subset for alpha = 0.05			
	Group	N	1	2	3	4
Duncan[a]	5-alive pineapple	3	.4667			
	pineapple fruta	3	.4733			
	califonia pineapple	3	.4867	.4867		
	califonia orange	3		.5067	.5067	
	orange fruta	3			.5267	
	5-aliv orange	3				.5733

	Sig.		.179	.159	.159	1.000	

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

MC

			Subset for alpha = 0.05				
	Group	N	1	2	3	4	5
Duncan[a]	5-aliv orange	3	73.7933				
MC	califonia pineapple	3		74.9600			
	califonia orange	3			76.1600		
	5-alive pineapple	3			76.6467		
	orange fruta	3				77.7400	
D	pineapple fruta	3					79.5067
	Sig.		1.000	1.000	.195	1.000	1.000

uncan[a] 5-aliv orange 3 73.7933 califonia 3 74.9600 pineapple califonia orange 3 76.1600 5-alive pineapple 3 76.6467 orange fruta 3 77.7400 pineapple fruta 3 79.5067 Sig. 1.000 1.000 .195 1.000 1.000

Means for groups in homogeneous subsets are

displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

CHO

		Subset for alpha = 0.05				
Group	N	1	2	3	4	5
Duncan[a] pineapple fruta	3	18.8000				
orange fruta	3			21.0633		
5-alive pineapple	3			21.3000		
califonia orange	3		22.2367			
califonia pineapple	3				23.2367	
5-aliv orange	3					24.3500
Sig.		1.000	.497	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

PHYTOCHEMICAL PROXIMATE OF MARKET SAMPLES OF FRUIT DRINKS IN OWERRI

DESCRIPTIVES

					95% Confidence Interval for Mean

		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Calcium	pineapple fruta	3	17.3633	1.15470	.66667	14.4949	20.2318	16.03	18.03
	Orange fruta	3	21.3733	1.15470	.66667	18.5049	24.2418	20.04	22.04
	5-Alive pineapple	3	19.3700	1.16047	.67000	16.4872	22.2528	18.03	20.04
	5-Alive orange	3	23.3800	1.16047	.67000	20.4972	26.2628	22.04	24.05
	Califonia pineapple	3	18.7000	1.16047	.67000	15.8172	21.5828	18.03	20.04
	Califonia orange	3	22.7100	1.16047	.67000	19.8272	25.5928	22.04	24.05
	Total	18	20.4828	2.43736	.57449	19.2707	21.6948	16.03	24.05
Mg	pineapple fruta	3	12.8000	.69282	.40000	11.0789	14.5211	12.00	13.20
	Orange fruta	3	10.4000	1.38564	.80000	6.9579	13.8421	9.60	12.00
	5-Alive pineapple	3	14.4000	1.20000	.69282	11.4190	17.3810	13.20	15.60
	5-Alive orange	3	11.2000	.69282	.40000	9.4789	12.9211	10.80	12.00

	Califonia pineapple	3	13.6000	.69282	.40000	11.8789	15.3211	13.20	14.40
	Califonia orange	3	13.4000	.34641	.20000	12.5395	14.2605	13.20	13.80
	Total	18	12.6333	1.62662	.38340	11.8244	13.4422	9.60	15.60
Potassium	pineapple fruta	3	130.0667	2.54034	1.46667	123.7561	136.3772	128.60	133.00
	Orange fruta	3	159.4333	3.05996	1.76667	151.8320	167.0347	155.90	161.20
	5-Alive pineapple	3	125.8667	.92376	.53333	123.5719	128.1614	124.80	126.40
	5-Alive orange	3	170.6667	3.69504	2.13333	161.4877	179.8457	166.40	172.80
	Califonia pineapple	3	130.0000	3.11769	1.80000	122.2552	137.7448	126.40	131.80
	Califaonia orange	3	159.4667	2.54034	1.46667	153.1561	165.7772	158.00	162.40
	Total	18	145.9167	18.39003	4.33457	136.7715	155.0618	124.80	172.80
Iron	pineapple fruta	3	.0313	.00306	.00176	.0237	.0389	.03	.03

	Orange fruta	3	.1873	.00115	.00067	.1845	.1902	.19	.19
	5-Alive pineapple	3	.0367	.00115	.00067	.0338	.0395	.04	.04
	5-Alive orange	3	.1673	.00115	.00067	.1645	.1702	.17	.17
	Califonia pineapple	3	.0273	.00115	.00067	.0245	.0302	.03	.03
	Califonia orange	3	.1713	.00115	.00067	.1685	.1742	.17	.17
	Total	18	.1036	.07419	.01749	.0667	.1404	.03	.19
Zinc	pineapple	3 fruta	.0607	.00462	.00267	.0492	.0721	.06	.07
	Orange fruta	3	.0613	.00231	.00133	.0556	.0671	.06	.06
	5-Alive pineapple	3	.0537	.00513	.00296	.0409	.0664	.05	.06
	5-Alive orange	3	.0757	.00709	.00410	.0580	.0933	.07	.08
	Califonia pineapple	3	.0493	.00231	.00133	.0436	.0551	.05	.05
	Califonia								

	3	.0707	.00231	.00133	.0649	.0764	.07	.07
orange								
Total	18	.0619	.01003	.00236	.0569	.0669	.05	.08

Homogeneous Subsets

Calcium

			Subset for alpha = 0.05		
	Group	N	1	2	3
Duncan[a]	pineapple fruta	3	17.3633		
	Califonia pineapple	3	18.7000		
	5-Alive pineapple	3	19.3700	19.3700	
	Orange fruta	3		21.3733	21.3733
	Califonia orange	3			22.7100
	5-Alive orange	3			23.3800
	Sig.		.066	.056	.066

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Mg

	Group	N	Subset for alpha = 0.05		
			1	2	3
Duncan[a]	Orange fruta	3	10.4000		
	5-Alive orange	3	11.2000	11.2000	
	pineapple fruta	3		12.8000	12.8000
	Califaonia orange	3			13.4000
	Califonia pineapple	3			13.6000
	5-Alive pineapple	3			14.4000
	Sig.		.301	.051	.067

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Potassium

	Group	N	Subset for alpha = 0.05		
			1	2	3
Duncan[a]	5-Alive pineapple	3	125.8667		
	Califonia pineapple	3	130.0000		

pineapple fruta	3	130.0667			
Orange fruta	3		159.4333		
Califaorangeoni	3		159.4667		
5-Alive orange	3				170.6667
Sig.		.103	.989		1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Iron

		Subset for alpha = 0.05					
Group	N	1	2	3	4	5	6
Duncan[a] Califonia pineapple	3	.0273					
pineapple fruta	3		.0313				
5-Alive pineapple	3			.0367			
5-Alive orange	3				.1673		
Califonia orange	3					.1713	
Orange fruta	3						.1873
Sig.		1.000	1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Zinc

			Subset for alpha = 0.05		
	Group	N	1	2	3
	Sig.		.247	.062	.185
Duncan[a]	Califonia		.0493		
	pineapple	3			
	5-Alive pineapple	3	.0537	.0537	
	pineapple fruta	3		.0607	
	Orange fruta	3		.0613	
	Califonia orange	3			.0707
	5-Alive orange	3			.0757
	Sig.		.247	.062	.185

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.