

Analysis of the Physico-chemical Properties of Commercial Fruit Juices Sold in a Local Market in Port Harcourt, Nigeria

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Abstract

The physico-chemical properties of four commercial fruit juices (Citrus, Carrot and Orange, Pineapple and Coconut and Mango) sold in a selected local market in Port Harcourt, Nigeria were analyzed in this study. The study was carried out using standard methods of analysis of pH, ash content, temperature, moisture content, total soluble solid, total dissolved solid, titratable acidity, sugar acid ratio, Brix acid ratio, conductivity, colour assessment, specific gravity and density. Results obtained showed that pH ranged from 3.6 to 4.5, ash content 2.0% to 6.0%, temperature 26°C to 27°C, moisture content 14.0% to 26.0%, total soluble solid 11.0 °Brix to 14.0 °Brix, total dissolved solid 2.0% to 8.0%, titratable acidity 0.10% citric acid to 0.21% citric acid, sugar acid ratio 59.5 to 140, Brix acid ratio 172.3 °Brix to 224 °Brix, conductivity 144 to 1714 $\mu\text{s}/\text{cm}$, colour assessment 33Cu to 228Cu, specific gravity 1.021 to 1.037% and density 1021 to 1037 kg/m^3 respectively. The commercial fruit juice samples are within the regulatory specification and are therefore recommended for consumption.

Keywords: Physico-chemical properties, commercial fruit juices, Citrus, Carrot and Pineapple

1.0 Introduction

Fruit juices are not unpopular in our society today and commercial fruit juices are well appreciated by consumers because of their taste, nutritional value, mineral content, and availability in the right time (Samir and Gehan, 2015; Nonga *et al.*, 2014). Fruit juices are non alcoholic and are a rich source of vitamins/minerals (Oyeleke *et al.*, 2013). They can be a single fruit juice or mixture of two or more juices or a mixture of fruit and vegetable juice. The nutritionists and doctors alike as well as the dietary guidelines for Americans (2005) recommended the consumption of several cups of commercial fruit juice per day (Onyeneto *et al.*, 2015).

Juices are often made from natural fruits although few juices are made of esters that contain flavors of the fruit the manufacturing company intends to market. Juices are obtained from a single fruit or from different kinds of fruits and vegetables (Tombak, 2000). Juice is within the fruit and can be prepared or extracted by mechanically squeezing the fruit to obtain the juice without applying heat (Chukwuemeka and Chukwuebuka, 2017). Therefore, Juices are the aqueous liquids extracted usually from one or more fruits, herbs, cereals, grain, vegetables or any concentrates of such liquids or purees (Fraternal *et al.*, 2011) and are simply prepared by mechanical extraction of a solution from the fruit and the solution is often treated before final package and delivery. A large portion of the orange fruit is used to produce orange juice (Patharkar *et al.*, 2017).

Fruit juices undergo different processes during production and manufacturing and as such they are required to be of great quality. Thus, the complexity of producing and processing fruit juices require a more extensive knowledge of their physico-chemical properties (Shahnawaz and Shiekh, 2011).

In Nigeria, a lot of suitable fruits such as citrus, carrot, oranges, pineapple, coconut, mango, water melon, carrot, among others are exploited for juice making. Large quantities of these fruits are processed into different varieties of commercial fruit juices such as citrus, orange, chivita, grape, apple, mango, and mixed fruit juices such as carrot and orange, pineapple and coconut, among others. A mixture of juices balances out certain nutrients which may not be present in a single fruit or vegetable (Adubofuor *et al.*, 2010). Although, there are several commercial fruit juices available in Port Harcourt, Nigeria, today, the ones considered in this research work include citrus, carrot and orange, pineapple and coconut and mango.

Citrus fruit has long been valued as part of a nutritious and tasty diet. It is well established that citrus product are a rich source of vitamins, minerals and dietary fiber (non starch polysaccharides) that are essential for normal growth and development and overall nutritional well being. The nutritional contents of citrus include carbohydrate, vitamin C, potassium and folate. Orange juice is also rich in fiber and citric acid. Carrot juice is rich in sugar and vitamins. Combining both carrot and orange as a single juice gives a juice that is rich in vitamin A, vitamin C, Folate, Ca, Na, K, and carbohydrates. Pineapple fruit can be processed into different products of which pineapple fruit juice is one of them. Pineapple juice is rich in a variety of minerals especially Mn as well as amino acids, various sugars, vitamins and polyphenols. Pineapple fruit juice is rich in water contents, energy contents, carbohydrate, total sugar, Ca, Mg, K, P, Vitamin A, vitamin C and Folate. Coconut provides a nutritious source of juice, milk and oil. Coconut juice is highly nutritious and rich in vitamins and minerals. Mango juice is prepared from mechanical extraction of a solution in diced mango fruit. Mango juice is rich in vitamin C, sugar content and carbohydrate and like most fruit juice is rich in minerals and polyphenolic compounds.

Some of the consumers of fruit juices are unaware of the nutritious benefits of fruit juices which makes the consumption of juice very low. The reason for this is varied but it indicates that knowledge of nutritional benefit is just the major factor that influence juice choice and also the taste and price of the juice influence juice choice too. Some of the barriers to obtaining and consuming fruit juice are; high cost, fear of harmful pesticide and quick spoilage, thus fruit juice undergo different processes during production and manufacturing.

Samir and Gehan in 2015 carried out a study on the quality and safety of several commercial fruit juices sold in Egypt by analyzing the microbiological and physicochemical properties, and incidence of spore-forming bacteria. A total of 360 fruit juices samples were analysed, from which they concluded that all similar fruit juices of the same type from different brands had similar physicochemical characteristics. Similarly, Onyeneto *et al.*, (2015) carried out another study on the physicochemical qualities of commercial samples of fruit juices sold in south eastern states of Nigeria. One hundred and thirty (130) samples of thirteen (13) different brands of juice were analyzed for their physical and chemical properties. It was shown that physico-chemical qualities contributed to the quality of fruit juices.

Obasi *et al.*, (2013) carried out studies on nutritional and sensory qualities of commercial and laboratory prepared orange juice. Their results showed that the laboratory processed orange juice in terms of the nutritional composition when comparable with the commercially processed orange juice had a better quality considering the parameters assessed.

The physicochemical properties of juice from pineapple and watermelon and their ready to drink (RTD) blends had also been carried out (Oyeleke *et al.*, 2013), and the result showed

that blending of fruit juices could enhance their nutritional quality and development of new products. Physicochemical properties and sensory evaluation of mixed fruit juice (orange, watermelon and tangerine) using date syrup as a sweetener had been evaluated by Onyekwelu, (2017). The study stated that addition of date syrup in mixed fruit juice improved the quality and sensory attributes of mixed fruit juice. Ndife *et al.*, (2013) comparatively evaluated the nutritional and sensory quality of different brands of orange-juice in Nigerian markets to determine overall quality. Their results showed that the orange juice samples would need to be supplemented with other nutrient sources to meet up with the recommended dietary allowance (RDA) requirements for a healthy nutrition. Comparative study related to physicochemical properties and sensory qualities of tomato juice and cocktail juice produced from oranges, tomatoes and carrots had also been determined by (Adubofuor *et al.*, (2010). The results indicated a significant difference ($p < 0.05$) in colour, flavour and mouth feel of the two products, and no significant differences ($p > 0.05$) in taste, aftertaste and overall acceptability of the two products.

Nonga *et al.*, (2014) assessed the physico-chemical characteristics and hygienic practices along the value chain of raw fruit juice vended in Dar es Salaam City, Tanzania and concluded that, the overall handling, preparation and physicochemical quality of raw fruit juices vended in Dar es Salaam were poor.

Chukwuemeka and Chukwuebuka in 2017 carried out studies on the physicochemical and microbiological analysis of canned and bottled fruit juices sold in Owerri Metropolis. The samples were subjected to standard microbiological analysis and physicochemical parameters. The result obtained showed that the titratable acid value of fruit juice samples ranged from 0.15% to 0.31%. The total solid of all samples ranged from 4.10% to 12.25%. The pH value for the juices ranged from 3.0 to 4.0, the moisture content of the sample ranged from 2.32% to 4.81%, the total ash content ranged from 0.32% and 0.63% respectively.

Although, a lot of research has been carried out on the physico-chemical properties of juices (Nonga *et al.*, 2014; Adubofuor *et al.*, 2010; Onyekwelu, 2017), this study is concerned with the physico-chemical properties of single fruit juice, mixed fruit juice and vegetable and fruit juice mixtures. The physico-chemical properties of only commercially marketed juice in Port Harcourt were evaluated in this study. A total of four different juices were obtained from the market and their physico-chemical properties evaluated. The aim of this research is therefore, to compare the physico-chemical properties of some selected fruit juices sold in a market in Port Harcourt, Nigeria. This study will enable the consuming public and manufacturers of these commercial fruit juices to know the physico-chemical qualities in the juices that contribute to the good quality and health benefits of these fruit juices.

2. Materials and Methods:

2.1 Materials

The citrus, carrot and orange, pineapple and coconut and mango juices were obtained from a selected local market in Port Harcourt, Nigeria. All chemicals and reagents used were of analytical grade.

2.2 Methods

2.2.1 Sample collection

Samples of citrus, pineapple and coconut, carrot and orange and mango juices which fall into single fruit juice category, mixed fruit juice and vegetable and fruit juice mixture were bought from mile 1 market in Port Harcourt, Rivers State, Nigeria. The sample containers were labeled respectively and transported to Kenule Saro-Wiwa Polytechnic, Bori for analysis.

2.2.2 Physico-chemical analysis

Determination of pH

The pH of the fruit juice was determined using the AOAC (2010) method. It was determined by measuring 10ml of the juice sample into a dry 250ml beaker. Thereafter, the electrode of the digital pH meter (HI 96107 model) was dipped inside the beaker containing the sample and left for 10 minutes, after it had been calibrated using standard buffer solutions of pH 4.0 and 7.0. The electrode was removed from the sample and the reading was taken accurately. This procedure was repeated for the other samples of commercial fruit juices.

Determination of ash content

The ash content is a measure of the inorganic residue that remains after a sample is completely burnt and is calculated as percentage ash content. The ash content was determined using the weight reduction method (AOAC, 2010). It was determined by weighing 10ml of the juice sample into a dry pre-weighed crucible. This was transferred to a muffle furnace at 500°C for 3hrs to burn off the nutrient and fiber present in the juice in order to obtain a white ash in the crucible. After ashing the sample, the ash was cooled and weighed and its content was calculated using the expression: % Ash Content = Ash content / Mass of sample x 100
This procedure was repeated for the other samples of commercial fruit juices.

Determination of Moisture content

Moisture content refers to the amount of water in the fruit juice samples and is calculated as percentage moisture content. A cleaned and dried crucible was placed in an oven for 20mins and was cooled in a desiccator. Ten millilitres (10ml) of the juice sample was weighed in the dry pre-weighed crucible and placed in an oven at 110°C for 3hrs. The sample was transferred into a desiccator and weighed until the weight remained fixed. The loss of weight was taken as the moisture content and calculated as:

$$\% \text{ moisture content} = \text{Moisture content} / \text{Original of sample} \times 100$$

This procedure was repeated for the other samples of commercial fruit juices.

Determination of Total Dissolved Solids (TDS)

Ten millilitres (10ml) of the juice sample was weighed into a cleaned and dried conical flask and was heated for an hour with a Bunsen burner until all liquid evaporated, remaining the solids and this was transferred immediately into an oven at 500°C for 2hrs and was later weighed. This was done severally until constant weight was obtained. The total dissolved solid was calculated using the formula:

$$\% \text{TDS} = W_2/W_1 \times 100$$

Where W_2 = weight of sample after drying to constant weight

W_1 = weight of sample before drying

This procedure was repeated for the other samples of commercial fruit juices.

Determination of Total Soluble Solids (TSS)

The total soluble solid is a measure of the total sugars present in the juice. The refractometer was calibrated with distilled water and the prism surface was cleaned and dried properly. Thereafter, 5 drops of the juice was pipetted onto the prism. After the adjustment of the observer, the reading was taken in the direction of good light. This procedure was repeated for the other samples of commercial fruit juices.

Determination of Temperature

A mercury-in-glass thermometer was rinsed with distilled water and was dipped into the measuring cylinder containing an already measured 20ml of the juice sample. This was

allowed for 5 minutes, after which the mercury-in-glass thermometer was removed and the reading taken as the temperature. This procedure was repeated for the other samples of commercial fruit juices.

Determination of Titratable acidity

Twenty milliliters (20ml) of the juice sample was pipetted and transferred to a cleaned conical flask, followed by 3 drops of phenolphthalein indicator and carefully swirled together. The burette was filled with 0.1N NaOH solution and titrated against fruit juice to the endpoint when the solution turned pink. The titratable acidity was calculated using the formula below:

$$\% \text{ citric acid} = \frac{\text{ml of NaOH used} \times 0.1\text{N NaOH} \times 0.064}{\text{Grams of sample used} \times 100}$$

This procedure was repeated for the other samples of commercial fruit juices.

Determination of Density

Density was calculated as specific gravity multiplied by 1000. This was determined using Patharka *et al.*, (2017) method.

Determination of Specific gravity

This establishes a relationship between the density of the substance and of water. It was obtained by comparing the density of the juice to the density of water. This was determined using Patharka *et al.*, (2017) method. An empty bottle was weighed and later filled with distilled water and reweighed. The bottle was then filled with the sample, weighed and calculated as follows:

$$\text{Specific gravity} = W_s / W_w$$

Where,

W_s = weight of the known volume of sample in grams

W_w = weight of an equal volume of water in grams.

Determination of Conductivity

The conductivity meter was used to measure the electrical conductivity of the fruit juice. The protective cap of the instrument was removed and turned on. It was immersed in distilled water to the immersion level for 2 hours. The conductivity electrode was removed from the distilled water and dried up and was dipped in 1413 $\mu\text{S}/\text{cm}$ calibration solution to be calibrated. After calibration, it was rinsed in distilled water, dried up and dipped into the fruit juices to take the reading in $\mu\text{S}/\text{cm}$. This procedure was repeated for the other samples of commercial fruit juices.

Determination of Brix acid ratio

This measures the fruit maturity in a juice and it is calculated as degree Brix minus percentage of titratable acid multiplied by 4, all multiplied by 16.5. This was determined using the AOAC (2010) method for all the other samples.

Determination of Sugar acid ratio

The sugar acid ratio contributes to the unique flavor of the juice and it is calculated by dividing the degree Brix by the citric acid percentage. This was determined using the AOAC (2010) method.

Determination of Colour

This was determined using the dilution method. The colorimeter was turned on and color was selected from the testing menu of the colorimeter. The sample tube was rinsed with distilled water and filled to 10ml with distilled water and was inserted into the colorimeter and scan

for blank. It was removed from the colorimeter and emptied. The juice sample was filtered with filter paper and 0.5ml of the filtered juice sample was added to 9.5ml of distilled water in the sample tube. The tube was then inserted into the colorimeter to take the reading in colour unit (Cu).

3. Results and Discussion

Table 1: Physico-chemical properties of fruit juice samples

Physicochemical properties	Citrus	Carrot and Orange	Pineapple and Coconut	Mango	FAO Accepted Standards
pH	3.6	4.1	4.5	3.9	2.2 to 5.8
Ash content (%)	4.0	2.0	4.0	6.0	-
Temperature (°C)	27	26	27	26	-
Moisture content (%)	14.0	14.0	14.0	26.0	-
TSS °Brix	12.5	13.0	11.0	14.0	Above 7°Brix
TDS (%)	6.0	8.0	2.0	6.0	
Titrate acidity (%citric acid)	0.21	0.16	0.14	0.10	Below 120%
Sugar acid ratio	59.5	81.3	78.6	140.0	-
Brix acid ratio	192.4	203.9	172.3	224.0	-
Conductivity (µs/cm)	1705	1399	1714	1144	-
Colour (cu)	228	83	51	165	-
Specific gravity (%)	1.021	1.033	1.029	1.037	-
Density (kg/m³)	1021	1033	1029	1037	-

The pH of the tested juices ranged from 3.6 (citrus juice) to 4.5 (pineapple and coconut juice) as shown in Table 1. The citrus juice has the lowest pH value of 3.6 and pineapple and coconut have the highest pH value of 4.5. This shows that citrus juice is more acidic than other fruit juices because they have high citric acid content. The pH of citrus, carrot and orange, pineapple and coconut and mango juices was 3.6, 4.1, 4.5 and 3.9 respectively. Similar results have been reported (Ghenghesh *et al.*, 2005). In other words, this commercial juices are strongly acidic and the more acidic the fruit juice, the less susceptible to bacterial actions (Jay, 2000). The pH values obtained are in accordance with the pH values earlier reported by Chukwuemeka and Chukwuebuka (2017); Onyeneto *et al.*, (2015) and Samir and Gehan (2015).

The ash content in the commercial fruit juice analyzed ranged from 2.0% (carrot and orange juice) to 6.07% (mango juice). The carrot and orange juice had the lowest ash content of all the juices analyzed while mango juice had the highest ash content of 6.0%. The ash content of citrus, carrot and orange juice, pineapple and coconut juice and mango juice was 4.0, 2.0, 4.0 and 6.0% respectively. This shows that the mango juice contain more fibre than the other commercial fruit juices. In other words those commercial fruit juices contain nutrients and fibre. These results were higher than the ones reported by Chukwuemeka and Chukwuebuka (2017) and Oyeleke *et al.*, (2013) but similar to the results reported by Onyeneto *et al.*, (2015).

The temperature ranged from 26°C to 27°C. The carrot and orange and mango had the least value of temperature of 26°C, citrus and pineapple and coconut juice had the highest value of 27°C. The temperature of the citrus, carrot and orange, pineapple and coconut and mango

juice were 27°C, 26°C, 27°C, 26 °C respectively. In these results, the change in temperature value is due to the amount of heat supplied in and out of the juices (chemical change) and all the commercial fruit juices tested were slightly above room temperature.

The moisture content in these commercial fruit juices analyzed ranged from 14.0 to 26.0. It was observed that three of the commercial fruit juices have the same low value of moisture content value of 14.0. This shows that the water is high in the mango juice. The moisture content of citrus, carrot and orange, pineapple and coconut and mango was 14.0, 14.0, 14.0 and 26.0% respectively. The moisture content values in this research are however higher than those reported by Chukwuemeka and Chukwuebuka (2017) but lower than those reported by Adubofuor *et al.*, (2010). The moisture content has an inverse relationship with the total fruit juice content according to Ndife *et al.*, (2013).

The TSS of the tested juices ranged from 11.0°Brix (pineapple and coconut juice) to 14.0°Brix (mango juice). TSS value of citrus, carrot and orange, pineapple and coconut and mango juice was 12.5, 13.0, 11.0 and 14.0°Brix respectively. Similar result has been reported according to (Adedeji and Oluwalana, 2014). High TSS indicates that the fruit have high level of simple sugar inherent that has contributed to higher Brix level (FAO, 2005). However, juices blended or beverages with less than 7°Brix are categorized as weak and watery juices (excess water in the juice). TSS is a good assessment of sweetness (Maziar, 2006).

The TDS in the observed fruit juice analyzed ranged from 2.0% (pineapple and coconut juice) to 8.0% (Carrot and orange juice) as shown in the Table 1.

The pineapple and coconut juice have the lowest TDS value of 2.0% and carrot and Orange juice have the highest value of 8.0%. The TDS values of citrus, carrot and orange, pineapple and coconut juice and mango juice was 6.0, 8.0, 2.0 and 6.0 respectively. These values compares with the result of Chukwuemeka and Chukwuebuka (2017). The TDS characterizes the good quality of the fruit juice (Egbekun and Akubor, 2007; Adubofuor *et al.*, 2010).

The mango juice had the lowest titratable acidity value of 0.10% citric acid while the citrus juice had the highest titratable acidity value of 0.21% citric acid. The titratable acidity values of citrus, carrot and orange, pineapple and coconut and mango juice were 0.21, 0.16, 0.14 and 0.10% citric acid respectively. The acidity values reported in this research are in agreement with those reported elsewhere (Wissanee and Pinthong, 2007; Oranusi *et al.*, 2012; Rizzon and Miele, 2012; Ndife *et al.*, 2013). According to Anvoh *et al.*, (2009), fruit acids influence colour, flavour and gustative characteristics of the juice products. These show the maturity of the fruit used for the juices. According to FAO (2005), the juices containing more than ~1.2% acid are sour, independent of °Brix/acid (Bates *et al.*, 2001). The results of this research show that all the commercial fruit juices are not soured but sweet and they are within the acidity range value.

The sugar acid ratio ranged from 59.5 (citrus juice) to 140.0 (mango juice). The citrus juice has the lowest sugar acid ratio of 59.5 and mango juice has the highest sugar acid ratio of 140.0. The sugar acid ratio value of citrus, carrot and orange juice, pineapple and coconut juice and mango juice was 59.5, 81.3, 78.6 and 140.0 respectively. The ratio of sugar to acid gives an accurate prediction of the tartness and sweetness of the acid (Wardy *et al.*, 2009; Averbeck and Schieberie, 2010). Fruit juices with sweetness index greater than 19 are regarded as sweet with less acid by taste (Wardy *et al.*, 2009). In these results, all the commercial fruit juices tested for sugar acid ratios still maintain their unique flavour.

The Brix acid ratio ranged from 172.3 (pineapple and coconut) to 224.0 (mango juice). The pineapple and coconut juice had the lowest Brix acid ratio while the mango juice had the

highest Brix acid ratio. The value of the Brix acid ratio of citrus, carrot and orange, pineapple and coconut and mango juice was 192.4, 203.9, 172.3 and 224.0 respectively. The results indicate that all the commercial fruit juices tested for Brix acid ratio still maintain their fruit maturity.

The conductivity was observed using a conductivity meter. In this study the conductivity value of commercial juices ranged from $1144\mu\text{scm}^{-1}$ (mango juice) to $1714\mu\text{scm}^{-1}$ (pineapple and coconut juice). The mango juice has the lowest conductivity value of $1144\mu\text{scm}^{-1}$ while pineapple and coconut had the highest value of $1714\mu\text{scm}^{-1}$. The conductivity value of citrus, carrot and orange, pineapple and coconut and mango juice were 1705, 1399, 1714 and $1144\mu\text{scm}^{-1}$ respectively. The results show that all the commercial fruit juices tested for conductivity are good conductors of electricity.

The color assessment of fruit juice ranged between 51cu (pineapple and coconut juice) to 228cu(citrus).The pineapple and coconut had the lowest value for color assessment of 51cu and citrus have the highest colour assessment value of 228cu. The value of colour assessment of citrus, carrot and orange, pineapple and coconut and mango juice was 228, 33, 51 and 165cu respectively. Colouring and flavoring indicates fruit ripeness to produce quality fruit juice. The measurement of colour is important for the quality assessment of juice, however, the sample tested for colour still maintained the colour quality of the juice colour and the difference in colour value depend on the type of juice. The specific gravity of the fruit juices ranged between 1.021% (citrus juice) and 1.037% (mango juice). The highest specific gravity value of 1.037% was recorded for the mango juice and the lowest specific gravity of 1.021% was observed for citrus juice. The specific gravity value of citrus, carrot and orange juice, pineapple and coconut juice and mango juice was 1.021, 1.033, 1.029 and 1.037 respectively. Similar results have been recorded by Kareem and Adebawale (2007); Onyeneto *et al.*, (2015). The results obtained show that all the commercial fruit juices analyzed for specific gravity still maintain a standard volume. The density of the fruit juices ranged between 1021kgm^{-3} (citrus juice) and 1037kgm^{-3} (mango juice). The highest density value of 1037kgm^{-3} was recorded for mango juice and 1021kgm^{-3} was recorded for citrus fruit juice which had the lowest value of density. The density value of citrus, carrot and orange, pineapple and coconut and mango juice was 1021, 1034, 1029 and 1037kgm^{-3} respectively.

4. Conclusion

The physico-chemical properties of the commercial fruit juices studied indicate that the fruit juices are of good qualities and within the regulatory specifications. They are therefore, nutritious and healthy for consumption as they serve as sources of protein and energy needed by the human body. However, regular monitoring of the quality of commercial fruit juices to check their fitness for consumption to avoid any outbreak of diseases should always be carried out.

References

- Adedeji, T.O. and Oluwalana, I.B. (2014). Development of Quality Elevation of Non Alcoholic Beverages from Cocoyam (*Kanthosoma saghtifolium* and *Colocesia esculenta*). *J Food Technol*, 32:10-20.
- Adubofuor, J., Amankwah, E. A., Authur, B. S. and Appiah F. (2010). Comparative Study Related to Physicochemical Properties and Sensory Qualities of Tomatoes Juice and Cocktail Juice Produced from Oranges, Tomatoes and Carrots. *African Journal of Food Science* 4(7):427-433.

- Anvoh, K., Zoro-Bi, A. and Gnakin, D. (2009). Production and characterization of juice from mucilage of cocoa beans and its transformation to marmalade. *Pak. J. Nutr.* 8 (2): 129-133.
- AOAC. (2010). Official Method of Analysis 16th Edition Washington D.C,U.S.A. *Association of Official Analytical Chemists*, 362-508.
- Averbeck, M. and Schieberie, P. (2010). Influence of Different Storage Conditions on Change in the Key Aroma Compounds of Orange Juice Reconstituted from Concentrate *Eur. Food Res. Technol.*217:1366-1380.
- Bates, R.P., Morris, J.R. and Crandal, P.G.(2001). Principles and Practices of Small and Medium Scale Fruit Juice Processing. *FAO Agricultural Services Bulletin*. 146:135-149.
- Chukwuemeka, I.S. and Chukwuebuka, I.F. (2017). Physicochemical and Microbiological Analysis of Canned and Bottled Fruit Juices Sold in Owerri Metropolis. *World News of Natural Sciences*, 14:97-105.
- Egbekun, M.K. and Akubor, P.I. (2007). Chemical Composition and Sensory Properties of Melon Seed - Orange Juice Beverage. *Nig.Food J.*24(1):42-45.
- FAO. (2005). General Standard for Fruit Juices and nectar. *CODEX Alimentarius commission* [[www.codex alimentarius. Org/.../standards/.../CXS](http://www.codexalimentarius.Org/.../standards/.../CXS)].247.
- Fraternale, D., Ricci, D., Flamini, G., and Giomaro, G. (2011). Volatile profiles of red apple from march region (Italy). *Records Of National Products*, 5:202-207.
- Ghenghesh, K.S., Belha, J. K., EL-Amin, W.B., EL-Nefathi, S.E. and Zalmum, A.(2005). Microbiological Quality of Fruit Juices Sold in Tripoli-Libya. *Food Con.*16:855-858.
- Jay, J.M. (2000). Modern Food Microbiology 6th Ed. Maryland. *Aspen Publishers, Inc*, 289.
- Kareem, S.O. and Adebowale, A. A. (2007). Clarification of Orange Juice by Crude Fungi Pectinase from Citrus Peel. *Nig. Food J.* 25(1):130-137.
- Maziar, S.A. (2006). A Study on some Efficient Parameters in Batch Fermentation of Ethanol Using *Saccharomyces cerevesia* Science Extraction from Fermented Siahesardasth Pomace. *African Journal of Biotechnology*, 9(20):2906-2912.
- Ndife, J., Awoghenja, D. and Zakari, U. (2013). Comparative Evaluation of the Nutritional and Sensory Quality of Different Brands of Orange-Juice in Nigerian Market. *African Journal of Food Science*, 7(12):479-484.
- Nonga, H.E., Simforian, E. A. and Ndabikunze, B. K. (2014). Assessment of Physicochemical Characteristics and Hygienic Practices Along the Value Chain of Raw Fruit Juice Vended in Dares Salaam City, Tanzania. *Tanzania Journal of Health Research*,16(4):1-12.
- Obasi, B.C., Whong, C.M. Z. and Ameh, J.B. (2013). Nutritional and Sensory Qualities of Commercially and Laboratory Prepared Orange Juice. *African Journal of Food Science* 11(7):189-199.
- Onyekwelu, C.N. (2017). Physicochemical Properties and Sensory Evaluation of Mixed Fruit Juice (Orange, Watermelon and Tangerine) Using Date Syrup As a Sweetener. *Innovare Journal of Food Science*. 5(1):1-4.
- Oyeleke, G.O., Ojo, A., Ajao, F.D. and Adetoro, R.O. (2013). Development and Analysis of Blended Pineapple-Watermelon Ready to Drink (RTD) Juice. *Journal of environmental Science, Toxicology and Food Technology*,4(6):22-34.
- Onyeneto, T.C., Nwachukwu, I.N. and Nwogwugwu,N.U. (2015). Physicochemical Qualities of Commercial Samples of Fruit Juices Sold in South Eastern States of Nigeria. *Annals of Biological Research*, 6(10):7-14.
- Oranusi, U.S., Braide, W. and Neziyanya, H.O. (2012). Microbiological and Chemical Quality Assessment of some Commercially Packed Fruit Juices Sold in Nigeria. *Greener Journal of Biological Science* 2:001-006.

- Patharka, S.I., Shendge, S.N. and Khapre, A.P. (2017). Study of Physicochemical Parameters of Orange (Citrus Reticulate Blanco) for the Development of Orange Wine. *Journal of Applied and Natural Science*. 9(4):2305-2308.
- Rizzon, L.A. and Miele, A. (2012). Analytical Characteristics and Discrimination of Commercial Grape Juice, Nectar and Beverages, *Ciencia E Tecnologia De Alimentos*, 32:93-97.
- Samir, A. M. M and Gehan, A.E. (2015). Microbial and Physicochemical Criteria of Fruit Juices Sold in Egypt: Incidence of Spore-Forming Bacteria. *Emirates Journal of Food and Agriculture*, 27(11): 864-871.
- Shahnawaz, M. and Shiekh, S.A . (2011). Analysis of viscosity of Jamin fruit Juice, Squash and Jam at different compositions to ensure the suitability of processing Applications. *International Journal of plant physiology and Biochemistry*, 3(5): 89-94.
- Tombak, M. (2000). Start Healthy Life 2nd Edition. *Healthy Life Press Inc. Korea*, 59-62.
- Wardy, W., Saalia, F., Steiner-Asiedu, M., Budu A. and Sefa-Dedeh,S. (2009). A Comparison of some Physical, Chemical and Sensory Attributes of Three Pineapple (Ananas Comosus) Varieties grown in Ghana. *Afr. J. Food Sci.* 3(1):022-025.
- Wissanee, S. and Pinthong, R. (2007). Physical, Chemical and Microbiological Changes During Storage of Orange Juices in Northern Thailand. *International Journal of Agriculture and Biology* 9:726-730.