Comparative Analysis of the Physico-Chemical Parameters and Mineral Contents of Selected Home-Made Juices Sold in Port Harcourt, Nigeria

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Abstract:

The physico-chemical parameters and mineral contents of soymilk, tiger nut, zobo and kunu zaki juices sold in selected areas of Port Harcourt, Nigeria was determined in this study using standard methods of analysis. Results showed pH (6.3, 2.5, 4.8 and 3.8), titratable acidity (1.4, 0.7, 0.8 and 1.2% as citric acid), moisture content (94.82, 95.83, 61.27 and 87.67%), and ash content (2.0, 5.0, 4.0 and 1.0) for soymilk, zobo, tiger nut and kunu zaki juices respectively. The results of the mineral contents assay were 1.286, 2.220, 3.294, and 3.112mg/kg for Zn; 33.372, 97.500, 25.584 and 26.722mg/kg for Ca; 11.836, 49.936, 44.878, and 32.234 mg/kg for Mg; 61.22, 87.28, 98.02, and 101.44 mg/kg for K; and 0.12, 0.32, 0.33 and 0.36mg/kg for P in soymilk, zobo, tiger nut, and kunu zaki juices respectively. Results of the physico-chemical parameters showed that zobo had low pH, low titratable acidity, high moisture content and high ash content comparable to the other juices. Based on the results, it can be concluded that each of the home-made juice have their own peculiar health benefits to offer, and so, consumption should be based on consumers' choice. However, two juices are recommended for consumption; zobo juice, owing to its high ash content, as also reflected in its high mineral values and high moisture contents which is useful for thirst quenching and soymilk juice, owing its high pH since the human body system works well in an alkaline medium.

Keywords: *Physico-chemical parameters, mineral contents, home-made juices, AAS, titrimetric.*

1. Introduction

The inevitability of increasing cost of cow milk in developing countries as well as social and economic importance of food products and lack of sustainability has put many researchers to study on non diary milk production methods as a viable and promising alternative milk juice

source (Awonorin and Udeozor, 2014). In fact, the complexity of producing and processing of fragile food materials require a more extensive knowledge of their physico-chemical parameters and mineral content (Shahnawaz and Shiekh, 2011). Exploring the physiochemical parameters and mineral contents of home-made juices is necessitated by the presence of dietary scenario (Aleem-Zakir *et al.*, 2012). The regular consumption of home-made juice, looking at the medical point of view maintains health and makes up for the losses in the human diet (Oyeleke *et al.*, 2013).

Fruit juices are well recognized for their nutritional, health and social benefits due to their mineral and vitamin contents (Hezron *et al.*, 2014; Gambo and Dau, 2014). Juices are the aqueous liquids expressed or otherwise extracted usually from one or more fruits, herbs, cereals grain, vegetables or any concentrates of such liquids or purees (Fraternale *et al.*, 2011).

Home-made juices are locally made ready to drink, non-alcoholic liquid, which is intended for human consumption (Oyeleke *et al.*, 2013). They are simply prepared by extracting, usually by mechanical means, the liquid and pulp of mature fruits, vegetables, nuts, herbs and cereal grains, etc. The final product is usually unfermented and clouded fresh juice, ready for consumption. The fresh juice could be diluted or blended in different mixed-blend varieties (Onwuka, 2014) as many fresh juices are either too acidic or too strongly flavoured to be pleasant for consumption (Bagde and Tumane, 2011). Home-made juices are preferred by the consumers because of the "fresh flavor" attributes and of recently their demand have increase in many parts of Nigeria (Ndife *et al.*, 2013).

In Nigeria, there is an availability of suitable fruits and foods which could be exploited for juice making such as oranges, water melon, pineapple, carrot, tiger nut, herbs such as ginger and zobo leaf, cereal grain, legumes such as soya bean, among others (Fish *et al*., 2002). Large quantities of these fruits and foods are traditionally processed into different varieties of home-made juices such as fresh fruits juices of orange, water melon, pineapple fruit and herbal juice which include kunu zaki, soy-milk juice, tiger-nut juice, among others (Erentuk *et al.*, 2005). Home-made juices contain all the essential, physical, chemical and mineral contents of the fruits, herbs and foods used in their production (Akhtar *et al.*, 2013). Although, there are several home-made juices available in Nigeria today, the ones considered in this research work include tiger nut milk, soy-bean, kunu zaki and zobo juices, because they are commonly found in the markets.

Tiger nut (*Cyperus Esculentus*) is a tough erect fibrous-rooted perennial grass-like plant belonging to the family *Cyperaceae*, which produces rhizomes from the base and tubers that are somewhat spherical (Bamishaiye and Bamishaiye, 2011). Tiger nut is 1 to 3 ft high and can reach about 6 inches depth into the soil (Maduka and Ire, 2018). Reproduction of tiger nut is by seeds and pollination by wind (James *et al*., 1991; Bamishaiye and Bamishaiye, 2011).

Tiger nut milk juice is extensively consumed during the dry season (Okafor and Nwachukwu, 2013), and is a sweet, non-diary, nutritious, energetic and diuretic edible light brown coloured liquid extract obtained from tiger nut tubers (Belewu and Abodunrin, 2008; Nwobosi *et al.*, 2013; Gambo and Dau, 2014). Tiger nut traders (2005) reported that tiger nut milk is a rich source of nutrients such as vitamins C and E, and minerals such as P, Mg, K, Ca, Fe, and also

carbohydrates, unsaturated fats, proteins and some enzymes which help in digestion. Tiger nut drink contains more Fe, Mg and carbohydrates than cow milk (Chevallier, 1996).

Soya bean is an important protein and oil seed crop containing up to 18-22% and 40-42% protein (Xiao, 2008; Farinde *et al*., 2018). Soya bean milk juice is obtained from soybean. Other researchers have indicated that soy foods may decrease the risk of coronary heart disease (Malik *et al.,* 2004), have anti cancer and anti-inflammation properties (Yang *et al.,2009*; Peng *et al.,*2009) improve menopausal symptoms and increase the calcium absorption for women (Charoenphun *et al.,*2013; Bao *et al.,*2008), provide positive effects for type 1 or type 2 diabetes (Zimmermann *et al*., 2012) and maintain or even relieve dementia symptoms for patients who suffer from Alzheimer's disease (Duffy *et al.,* 2003).

Kunu-zaki (also known as kunu) is the traditional Hausa name of a cereal based non-alcohol, fermented beverage which is widely consumed in Nigeria, mostly in the North (Ikpo, *et al*., 2013; Ofudje *et al*., 2016). Kunu is made from cereal grains such as maize, millet and sorghum (Gaffa *et al*., 2002; Mamudu *et al*., 2013; Ofudje *et al.,* 2016). Other ingredients added to enhance its flavour during production include garlic, pepper and ginger while honey or sugar may be added to serve as sweetener (Ofudje *et al*., 2016).

Zobo leaf, known as *Hibiscus Sabdariffa* is a small (2-8m) tall vegetable plant in the family *Malvaceae*, widely grown in the tropical and semi-tropical regions of the world mainly in Africa and the East Indies (Nwachukwu *et al*., 2007; Umeh et al., 2015; Izah *et al*., 2015). Zobo juice is a reddish, non-alcoholic local beverage produced from the dried succulent calyces of the *Hibiscus Sabdariffa* flower by boiling and filtration (Ogiehor *et al*., 2008). The calyces have been found to be rich in vitamins, natural carbohydrates, protein, and other antioxidants (Wong *et al.,* 2002).

The physiochemical parameters and mineral contents considered in this research work include, moisture content, ash content, titratable acidity (as citric acid), pH, calcium, phosphorous, zinc, magnesium and potassium.

The sale and consumption of these locally made non-alcoholic beverages is on the increase in most cities in Nigeria including Port Harcourt with little attention being paid to the nutritional benefits and the quality of products. Thus, this research work is aimed at determining the physico-chemical parameters and mineral contents of these selected home-made juices sold in local markets in Port Harcourt, Nigeria. The research is done for the purpose of acquiring full knowledge of the physico-chemical and mineral contents of these home-made juices.

2. Materials and Methods

2.1 Materials

The tiger nut, soymilk, kunu-zaki and zobo juices were obtained from selected local markets in Port Harcourt, Rivers State, Nigeria. All chemicals and reagents used were of analytical grade. Model GBC Avanta version 2.02 Atomic Absorption spectrophotometer was used.

2.2 Methods

2.2.1 Sample collection

Samples of four selected home-made juices (Tiger nut, soymilk, kunu-zaki and zobo juices) were purchased in their ready to consume state from local producers in oil mill, mile 1, mile 3 and creek road markets in Port Harcourt, Rivers State, Nigeria. The sample containers were labeled respectively and transported to Ken Saro-Wiwa polytechnic, Bori for analysis.

2.2.2 Physico-chemical analysis

Determination of percentage total acidity (as % citric acid)

Twenty milliliters (20ml) of the home-made juice was measured using a measuring cylinder, after which it was diluted to 500ml with standardized 0.1N sodium hydroxide (NaOH) solution, using 0.3ml phenolphthalein indicator for each 100ml solution being titrated, which gave a pink colour at the end point. This procedure was repeated for the other samples of home-made Juices.

Determination of pH

The pH of the fresh home-made juice was determined by measuring 50ml of the fresh sample into 250ml beaker. Thereafter, a portable pH meter (HI 96107model) was inserted into it which was first calibrated using standard buffer solutions of pH 4.0 and 7.0. This procedure was repeated for the other samples of home-made juices.

Determination of percentage moisture content

A hot air oven was preheated to a stable temperature of 87^0C and 20ml of the sample of home-made juice was weighed in a clean and dry oven dish, as initial weight (X_1). The oven dish was thereafter place in the preheated oven for 3 hours at a stable temperature of 87^0C.

After 3 hours, the dish was removed from the oven and allowed to cool. After cooling, the dish was reweighed, as final weight (X_2). This procedure was repeated for the other samples of home-made juice. The percentage moisture was calculated by the formula:

$$\% \text{ Moisture content} = \frac{X_1 - X_2}{X_O} \text{ X } 100$$

X_O = Weight of empty crucible

X_1 = Weight of sample and crucible before heating

X_2 = Weight of sample and crucible after heating

Determination of percentage ash content

A clean empty crucible was placed in a muffle furnace at 580^{o}C for 1 hour after which it was removed and allowed to cool. The initial weight was determined and recorded as (W_1). Thereafter, 10ml of the juice sample was weighed into the preheated crucible and tagged (W_2). The sample was then preheated on a hot plate for pre-ashing, so as to eliminate fumes that may deposit in the muffle furnace. After pre-ashing, the crucible was placed in muffle furnace at a stable temperature of 580^{0}C for 4 hours. After ashing the sample, the crucible was removed (a grey white ash was observed, which indicated the complete elimination of carbon containing portion in the sample) and allowed to cool. After cooling, the crucible was reweighed and labeled (W_3). This procedure was repeated for the other samples of home-made juices. The percentage moisture was calculated by the formula:

$$\% \text{ Ash content} = \frac{W_3 - W_1}{W_2} \text{ X } 100$$

W_1 = Initial weight of empty crucible

W_2 = Weight of sample and crucible before heating

W_3 = Weight of sample and crucible after heating

2.2.3 Determination of mineral content

Sample digestion

Ten mllilitres (10ml) of the home-made juice sample was weighed and placed in a muffle furnace for 4-5 hours to ash. 5ml of 10% HNO_3 and 5ml of 10% HCl were measured and added to the ashed sample using a measuring cylinder. The solution was then transferred into a 250ml beaker and then heated for 1 minute to dissolve.

The digest (sample) was filtered. The filtrate which was previously 10ml was then made up to 20ml using distilled water and taken for AAS analysis. This procedure was repeated for the other samples of home-made juice, and labeled accordingly.

2.2.4 AAS Analysis

The zinc, calcium, magnesium and potassium contents in the digested samples were analyzed using the AAS.

2.2.5 Colorimetric Analysis

The phosphorus content in the digested samples was analyzed using the colorimeter (HACH DR. 890 Model).

3. Results and Discussion

Table 1: Moisture Content, Ash Content, Titratable Acidity (As Citric acid) and pH of Home-Made Juice

Parameters (%)	Soymilk juice	Zobo juice	Tiger nut juice	Kunu-zaki juice
Moisture Content (%)	94.82	95.83	61.27	87.67
Ash Content (%)	2.0	5.0	4.0	1.0
Titratable Acidity (as citric acid %)	1.40	0.70	0.80	1.20
pH	6.30	2.50	4.80	3.80

Table 2: Concentration of Mineral Contents in the Samples of Selected Home-Made Juice

Parameters (mg/l)	Soymilk juice	Zobo juice	Tiger nut juice	Kunu-zaki juice	WHO limit (mg/l) (2011)
Zinc (Zn)	1.286	2.220	3.294	3.112	3.0
Calcium (Ca)	33.372	97.500	25.584	26.722	75
Magnesium (Mg)	11.836	49.936	44.878	32.234	50
Potassium (K)	61.22	87.28	98.02	101.44	65

Phosphorus (P)	0.12	0.32	0.33	0.36

3. Discussion

3.1 Analysis of physico-chemical parameters

Parameters obtained for the physico-chemical analysis are presented in Table 1. The moisture content of soymilk, zobo, tiger nut and kunu-zaki juices were found to be 94.82, 95.83, 61.27 and 87.67 % respectively. Samples from zobo juice recorded the highest value of moisture contents while the least value of moisture content was observed in tiger-nut juice. The moisture content value of kunu-zaki agrees with that of commercial juice (87.8%) as reported by George and Moiloa (2015). Oyeleke *et al*., (2013) also reported similar water content values with those of the home-made juices analysed in this work. Although, the results showed varied percentage values of moisture contents, all the home-made juices have enough water content to quench thirst.

The percentage ash content values of soy milk, zobo, tiger nut and kunu-zaki juices were found to be 2.0, 5.0, 4.0 and 1.0% respectively. Kunu-zaki juice recorded the least value while zobo juice recorded the highest value of percentage ash content, indicating its high mineral value. Rao (1996) noted that high mineral value provides appreciable quantity of minerals required by the body. The percentage ash content of kunu zaki juice was higher than the values reported by George and Moiloa (2015), Otaru *et al*., (2013) and Essien *et al*., (2009) which were 0.19 to 1.97%, 0.2% and 0.3 to 0.72% respectively. The percentage ash content of kunu-zaki juice however, agrees with 1.0 to 2.0% obtained by Amusa and Ashaye (2009) and 1.00 to 2.00% obtained by Innocent *et al*., (2011) but was slightly lower than 1.30 to 2.00% reported by Afudje *et al*., (2016)

The results for titratable acidity analysis for soymilk, zobo, tiger nut and kunu-zaki juices were 1.40, 0.70, 0.80 and 1.20% respectively with zobo juice having the least value and soymilk juice having the highest titratable acidity. The variation in total acidity may be due to different ingredients used in their preparation and also the presence of some bacteria such as *Saccharomyces cerevisiae* and *Candida species* which play major roles in acid fermentation of the home-made juice (Ikpo *et al*., 2013). George and Moiloa (2015) noted that increase in acidity is as a result of fermentation and oxidation of the sugars during storage. The titratable acidity values obtained for the home-made juices analysed were however higher than the values reported for the home-made juices in Lesotho (George and Moiloa, 2015).

The pH values obtained for soy milk juice (6.30), zobo juice (2.50), tiger nut juice (4.80) and kunu-zaki juice (3.80) indicated that they are all acidic. The lowest recorded for zobo juice showed its richness in organic acids such as oxalic, tartaric, malic and succinic acids. The results also showed that as the pH level decreased, titratable acidity values increase. Gaffa *et al.*, (2002) had reported that product with low pH value have high titratable acidity value and vice versa. Wong *et al.*, (2000) also reported the trend of product with low pH having high titratable acidity.

Ofudje *et al*., (2016) also investigated the proximate, mineral contents and microbial analysis of kunu-zaki in Ogun state, Nigeria. The results of the proximate analysis revealed moderate acidity and pH for all samples tested which suggest that they are of good nutritive value and could serve as source of protein and energy to human body.

3.2 Mineral Contents analysis

The results obtained for the mineral content analysis of soy milk, zobo, tiger nut and kunu- zaki juices are shown in Table 2.

The values of zinc obtained from the analysis of soy milk, zobo, tiger nut and kunu-zaki juices were 1.286, 2.220, 3.294 and 3.112mg/l respectively. The highest value of zinc was observed in tiger nut juice while the least value was observed in soymilk juice. On comparing the zinc concentrations with the World Health Organisation (W.H.O.) recommended limit; soy milk and zobo juices were below the WHO recommended limit while tiger nut and kunu-zaki juices were slightly above the WHO recommended limit of 3.0mg/l.

The calcium values obtained from the analysis were 33.372, 97.500, 25.584 and 26.722mg/l for soymilk, zobo, tiger nut and kunu-zaki juices respectively. The highest value was recorded for zobo juice while the least value was recorded for tiger nut juice. The results obtained for soy milk, tiger nut and kunu-zaki juices were far below the W.H.O. recommended limit while that of zobo juice was above the W.H.O. permissible limit of 75mg/l.

The Mg values were 11.836, 49.936, 44.87 and 32.234mg/l for soymilk, zobo, tiger nut and kunu-zaki juices respectively. The concentration of Mg in the four selected home-made juices recorded the highest value in zobo juice and least value in soymilk juice. Apart from zobo juice value which was approximately within the W.H.O. recommended limits of 50mg/l, all the other home-made juices were below the W.H.O. recommended limit.

From Table 2; 61.22, 87.28, 98.02 and 101.44mg/l were the respective values obtained for potassium in the samples of soymilk, zobo, tiger nut and kunu-zaki juices analysed. The highest potassium concentration value was observed in kunu-zaki juice and the least in soymilk juice. The potassium concentration value of soymilk juice was the only one below the W.H.O. recommended value of 65mg/l while others were above the W.H.O. recommended value. The elemental analysis of the work carried out by Ofudje *et al*., (2016) showed high levels of Ca, K and Fe which help to strengthen the teeth and also in the formation of bones.

The values obtained for phosphorus were 0.12, 0.32, 0.33 and 0.36mg/l for soy milk, zobo, tiger nut and kunu-zaki juices respectively with the highest values recorded for kunu-zaki juice and the least value for soymilk juice. These values were very much lower than the values obtained by Ndife *et al.,* 2013.
This research will therefore, educate and enlighten the general public and also enhance the wider acceptability and consumption of these locally made juices.

4. Conclusion

The present study showed that consumption of soymilk, zobo, tiger nut and kunu-zaki juices should be based on consumers' choice, owing to the fact that each of the home-made juice have its own peculiar nutrients content comparative to the others. Physico-chemical analysis revealed that there was requisite moisture content, moderate ash content, and appreciable quantity of minerals in the analysed juices required by the body; moderate acidity and pH for all the home-made juices analysed which suggest that they are of good nutritive value and could serve as sources of protein and energy needed by the human body. The mineral contents as shown by the results are good for strong teeth and bone formation, especially in children. They could also serve as blood supplement in the human body system. However, zobo juice is recommended for more consumption due to its high moisture content and high percentage ash content. Soymilk is also recommended for more consumption due to its high pH since the human body system works well in an alkaline medium.

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