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COMPARATIVE STUDY OF VITAMIN AND MINERAL CONTENTS OF SOME COMMERCIAL FRUIT JUICES AVAILABLE IN AFIKPO, SOUTH-EAST, NIGERIA

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ABSTRACT

In this study, the vitamin and mineral contents of seven different brands of commercially available fruit juices (samples A, B, C, D, E, F and G) in Eke market, Afikpo, South-East, Nigeria were examined using standard analytical methods of AOAC to compare their overall quality with World Health Organization (WHO). Results of the study revealed that the vitamin contents in mg/100ml for Vitamin A recorded the lowest in sample B with 1.01±0.16 to 1.01±0.05 while sample F recorded the highest value of Vitamin A with 1101±0.16. Vitamin C was least in sample E with 5.20±0.42 while the highest was obtained in Sample A with 22.26±1.63; Vitamin E was the least with a value of 0.22±0.06 in sample D and recorded the highest value of 1.47±0.10 in sample B; Vitamin B1 was the lowest in sample D with a value of 0.20±0.15 mg/100ml) and was highest in sample A with a value of 1.14±0.01; Vitamin B2 recorded the least value in Sample F with 0.43±0.05 and the highest value of 3.01±1.10 was reported in Sample C. Results of the mineral analysis also revealed that sample G and sample B recorded the highest mineral contents for Na (14.17±0.05 mg) and Ca (13.67±0.02 mg) respectively, while the lowest mineral contents recorded were Fe (0.07±0.01 mg) in sample F and phosphorus (0.12±0.01 mg) in sample C. Similarly, the preservative contents of the sampled fruit juices showed the highest sulphur dioxide (0.10±0.01 %) in sample D and lowest value (0.03± 0.02 %) in sample B while sodium benzoate highest value (0.16 ± 0.02 %) in sample D and lowest value (0.03±0.01) in sample E were recorded. Results of ANOVA performed also revealed that the vitamin and mineral contents of each fruit juice sample vary significantly ($P<0.05$) from each other and were within the WHO recommended values except for vitamin B2 (3.01±1.10 mg/100ml) in sample C which showed value higher than WHO recommended daily allowance. The results of all the Vitamins were below the regulatory dietary allowance. The findings showed that the fruit juice samples were suitable for consumption.

Key words: Fruit Juice, Vitamins, Minerals, Preservatives and Afikpo.

Introduction

Many essential micronutrients including vitamins and essential minerals have been linked to the prevention of degenerative processes including and particularly, mortality rate lowering of cancer and cardio-cerebro-vascular diseases (Ndife *et al*., 2013). Incidentally, fruits and vegetables have been recognized and reported as part of traditional foods which provide essential minerals and vitamins for the human diet due to their outstanding nutritional benefits (Nwozo *et al*., 2017). For instance, traditional fruits like citrus fruits are excellent sources of ascorbic acid, carotenoids; tocopherol and phenolic compounds (Morand *et al*., 2012). In 2016, Yarkwan & Oketunde further

reported that these fruits also contain a variety of other nutrients such as proteins, carbohydrate and some minerals.

Nowadays, there is a rising demand for various brands of fruit juices globally probably due to the associated taste, medicinal, nutritional and/or high invigorating benefits (Alaka *et al*, 2013). A fruit juice has been considered by Nzeagwa and Onimawo (2010) to be any drink containing 100% pure fruit juices, typically without preservatives or added ingredients and could be easily consumed by infants, children and adults to meet their nutrients needs, particularly that of the micronutrients. In 2005, Nnam & Njoku defined a fruit juice as a clear or uniformly cloudy unfermented liquid, recovered from sound fruits by pressing or by other mechanical means, while Oranusi *et al*. (2012) noted that a fruit juice is an unfermented but fermentable liquid or juice intended for direct consumption and is obtained from the edible portion of sound, appropriately mature and fresh fruits by mechanical extraction process and preserved exclusively by chemical and physical means. Reports of several investigations appear to link daily intake of fruit juices to minimized risk of cardiovascular diseases, neurodegenerative disease, ageing, hyperlipidaemia, insulin resistance, cancer, gastrointestinal disorders, allergies, skin related diseases, oxidative stress and inflammation (Chong *et al*., 2010; Wu *et al*., 2009; Kyle *et al*., 2009; Bae *et al.,* 2009; Wilson *et al*., 2008).

In addition, Nwozo *et al*. (2017) who investigated the proximate, mineral and vitamin contents of some juices produced from imported and local lesser known fruits in Nigeria, reported that the vitamins concentrations varied in the following ranges: Ascorbic acid (9.18±0.52-32.06±1.28 mg/100ml), vitamin E (0.11±0.03-1.95±0.21 mg/100ml), vitamin A (0.45±0.13-7.01±0.28 mg/100ml), β-carotene (7.34±1.20-152.96±10.55 µg/g), riboflavin (0.06±0.02-0.54±0.08 mg/100ml) and thiamine (0.27±0.04-2.22±0.17 mg/100ml) with all the fruit juices containing Ca, Cu, Fe, Mg, K and Zn in varying proportions. A comparative evaluation of the nutritional and sensory quality of different brands of orange-juice in Nigerian market was conducted by Ndife *et al*. (2013). Their findings revealed a variation in the vitamin and mineral contents of the different orange juice samples studied with samples D and B having the highest contents of vitamin A (140.12 IU) and vitamin C (42.57 mg) respectively, while samples A and C had the lowest values for potassium (119.10 mg) and sodium (5.65 mg) contents (Ndife *et al*., 2013). Again, a study by Nitu *et al*. (2010) also revealed that via the intake of fruit juices, people can conveniently receive the benefits of various fruits even when the whole fruit is not readily available or desired. Consequently, as nutritious beverages, fruit juices play significant roles in healthy diets due to their good taste and availability of varieties of naturally occurring micronutrients (O'Neil & Nicklas, 2008; Hossain *et al*., 2012). A 2015 report by Salma *et al*. revealed the incidence of micronutrient deficiency as a common occurrence in both developing countries and developed countries of the world, with vitamin A, iodine and iron deficiency being reported by Allen *et al*., (2006) as the most prevalent micronutrient deficiencies affecting about one third of the world's population. In addition, to enable trade of the fruit juice products and also increase profitability for the producers, nutrients are added to foods nowadays in order to enhance their significance (Salma *et al*., 2015). In view of the above reports and observations, it therefore becomes imperative to find alternative means of using fruits and their juices for supplying humans with the right foods rich in micronutrients.

This study aims to determine and compare the vitamins and mineral contents of selected commercial fruit juice brands available in Afikpo, South-East Nigeria.

Materials and Methods

Sample Collection and Preservation

Seven different samples of fruit juices from dissimilar producers were randomly selected and analysed in this study. The selected fruit juices were purchased from different superstores in Eke market, Afikpo, South-East, Nigeria. It was ensured that collected samples were fresh, sealed and free from any kind of deterioration. Samples were coded as A, B, C, D, E, F and G and were stored in a cooled dried place until all the analyses were completed within one week.

Sample Preparation

Each sample collected was homogenized and accurate amount was weighed as required for different analysis. Four portions of each sample type of fruit juices were separated for measurements followed by ashing and analysis of the selected micronutrients.

Sample Analysis

Vitamin Assay

Vitamin contents of the fruit juices were analysed following the method described by Nielsen (2003) with some adjustments. In this research, five vitamins including vitamin A (B-carotene), vitamin C (ascorbic acid), vitamin E (α-tocopherol), vitamin B2 (riboflavin) and vitamin B1 (thiamine-folic acid) contents of the selected fruit juice samples were determined using UNICO UV 2100 spectrophotometer.

Mineral Analysis

Mineral analysis was carried out according to the method of Yarkwan & Oketunde (2016). The minerals: sodium, potassium, calcium, magnesium, iron and phosphorus were analysed in this study including preservatives such as sodium benzoate and sulphur dioxide. Exactly 1.0 gram of the respective ash samples was weighed using an electronic analytical balance into a digestion tube and 20 ml of acid mixture (650 ml conc. nitric acid, HNO_3, 80 ml perchloric acid (PCA) and 20 ml conc. sulphuric acid (H_2SO_4) was added. The flasks were then heated under Kjeldahl digestion unit until a clear digest was obtained. The digest obtained was diluted with distilled water to 100 ml. Standard solutions were prepared for each of the parameters following standard protocols. Wavelengths of maximum absorbance were determined for each standard using UNICO UV 2100 spectrophotometer and Corning 400 flame photometer for K and Na. Absorbances of the various standards were obtained and the maximum absorbance was selected with its corresponding wavelength. The selected wavelengths were used to measure the absorbances of the standards and of the samples and the concentration of each sample was calculated using the expression below:

$$\text{Conc. of sample} = \frac{\text{C. of std.} \times \text{A of sample}}{\text{A of std.}}$$

Where A of sample = absorbance of sample
A of std = absorbance of standard
C of Std. = concentration of standard.

Determination of Preservatives

The preservatives investigated in this research are Sulphur dioxide and Sodium Benzoate. Sulphur dioxide was determined by titration process according to the method of Salma *et al*. (2015) while Sodium Benzoate was determined by the method of Ronald (1991).

Statistical Data Analysis

The results obtained in the present study were reported as mean values (obtained from four replications) ± standard deviation (SD). Statistical analyses were performed using Statistical Package for Social Science (SPSS) for Windows version 23.0. The significant differences between mean values were analysed by the Duncan multiple range test at a significance level of $p<0.05$.

Results and Discussion

The results obtained in this study are presented in Table 1 and Table 2 below. In all the samples collected for the study, all the selected vitamins were detected. Table 1 shows the results of the vitamin contents of the fruit juice samples analysed. The results revealed that sample A contents (mg/100ml) of vitamin A, vitamin C, vitamin E, vitamin B1 and vitamin B2 are respectively 1.51±0.08, 22.26±1.63, 0.36±0.06, 1.14±0.01 and 0.86±0.05. Sample B contents of the vitamins (mg/100ml) examined also revealed that vitamin A (1.01±0.05), vitamin C (20.50±2.26), vitamin E (1.47±0.10), vitamin B1 (0.86±0.05) and vitamin B2 (0.90±0.18). Similarly, samples C, D, E, F and G revealed the following results for vitamin A (2.11±0.16, 3.06±1.28, 1.11±0.18, 11.01±0.16 and 5.12±0.28 mg/100ml), vitamin C (10.40±1.90, 8.50±0.95, 5.20±0.42, 12.26±1.32 and 9.18±0.52 mg/100ml) vitamin E (2.28±0.05, 0.22±0.06, 0.24±0.08, 1.14±0.08 and 1.25±0.28 mg/100ml), vitamin B1 (1.03±0.15, 0.20±0.15, 1.03±0.15, 1.02±0.03 and 0.43±0.05 mg/100ml) and vitamin B2 (3.01±1.10, 0.65±0.04, 1.0±0.03, 0.43±0.05 and 0.90±0.18 mg/100ml) respectively.

Table 1: Results of the Mean Vitamin Contents of Studied Fruit Juice Samples ± Standard Deviation

Fruit Juice		**Vitamin contents (mg/100ml)**				
Sample	**N**	**Vitamin A**	**Vitamin C**	**Vitamin E**	**Vitamin B1**	**Vitamin B2**
Sample A	4	1.51 ± 0.08^{c}	22.26 ± 1.63^{b}	0.36 ± 0.06^{a}	1.14 ± 0.01^{c}	0.86 ± 0.05^{a}
Sample B	4	1.01 ± 0.05^{b}	20.50 ± 2.26^{c}	1.47 ± 0.10^{b}	0.86 ± 0.05^{a}	0.90 ± 0.18^{a}
Sample C	4	2.11 ± 0.16^{a}	10.40 ± 1.90^{b}	2.28 ± 0.05^{a}	1.03 ± 0.15^{a}	3.01 ± 1.10^{c}
Sample D	4	3.06 ± 1.28^{b}	8.50 ± 0.95^{c}	0.22 ± 0.06^{a}	0.20 ± 0.15^{a}	0.65 ± 0.04^{a}
Sample E	4	1.11 ± 0.18^{c}	5.20 ± 0.42^{b}	0.24 ± 0.08^{a}	1.03 ± 0.15^{a}	1.0 ± 0.03^{c}
Sample F	4	11.01 ± 0.16^{b}	12.26 ± 1.32^{a}	1.14 ± 0.08^{b}	1.02 ± 0.03^{b}	0.43 ± 0.05^{b}
Sample G	4	5.12 ± 0.28^{a}	9.18 ± 0.52^{b}	1.25 ± 0.28^{c}	0.43 ± 0.05^{c}	0.90 ± 0.18^{c}
RDA (mg/day)		750-900	75-90	14-16	1.1-1.2	1.1-1.3

Note: Results were expressed as mean values of four replicate determinations ± standard deviation, and mean values followed by different letters within a row are significantly different at P<0.05 from one another. Significant difference was analysed using ANOVA. Where N.D. = Not Detected. *RDA = Recommended dietary allowance (WHO/FAO, 2004).

The results in Table 1 also revealed that from sample A to G, levels of the vitamins studied are in the range: vitamin A (11.01±0.16 to 1.01±0.05 mg/100ml), vitamin C (22.26±1.63 to 5.20±0.42 mg/100ml), vitamin E (2.28±0.05 to 0.22±0.06 mg/100ml), vitamin B1 (1.14±0.01 to 0.20±0.15 mg/100ml) and vitamin B2 (3.01±1.10 to 0.43±0.05 mg/100ml). Comparing with WHO/FOA recommended daily allowances (RDAs) for vitamin A (750-900 mg/day), vitamin C (750-900 mg/day), vitamin E (14-16 mg/day), vitamin B1 (1.1-1.2 mg/day) and vitamin B2 (1.1-1.3 mg/day), the results of this study were found to be within the RDA values except for sample C that recorded the value of vitamin B2 (3.01±1.10 mg/day) higher than the RDA of WHO/FOA (2004). In all the samples studied, the lowest vitamin content recorded was vitamin B1 (0.20±0.15 mg/100ml) for sample D. Using SPSS version 23.0, the results of the ANOVA performed on the data revealed that mean values of the vitamins studied within each sample followed by different letters are significantly different at P<0.05 from one another. The quality index of fruit juices is a function of their vitamin contents with Ascorbic acid (vitamin C) content of fruit juices being the most prominent quality index due to its health significance (Ndife *et al*., 2013). Thus, samples collected in this study could contribute significantly to the daily requirements of these vitamins for essential healthy living.

The weakening of the immune system as well as an increased susceptibility to infectious diseases has been linked to inadequate intake of minerals in the diet (Salma *et al*., 2015). Most fruits and fruit juices usually contain small amounts of minerals and preservatives. In this study, the results of the mineral and preservative contents of the fruit juice samples analysed are presented in Table 2. The results revealed that for each sample studied, the mineral contents are in the order: sample A (K > Ca > Na > Mg > Fe > P); sample B (Ca > Na > Fe > K > Mg > P = not detected); sample C (K > Na > Ca > Fe > Mg > P); sample D (Na > Ca > K > Mg = Fe = P = not detected); sample E (Na > Ca > Mg > K > Fe = P = not detected); sample F (Mg > Na > Ca > K > Fe >P = not detected) and sample G (Na > Ca > K > P > Mg = Fe = not detected). The results also revealed that the fruit juice samples were enriched with significant amounts of mineral elements required for healthy living. Sodium (Na) with RDA (1000-1500 mg/day) was found ranging from sample G (14.17±0.05 mg) to sample E (4.11±0.02 mg). Potassium (K) has RDA 4000-4700 mg/day and its content was found ranging from sample A (8.59±0.05 mg) to sample E (0.25± 0.03 mg). Similarly, magnesium (Mg), calcium (Ca), iron (Fe) and phosphorus (P) contents in the investigated samples were found in the following ranges: sample F (7.46±0.42 mg) to sample G (ND); sample B (13.67±0.02 mg) to sample F (2.43 ± 0.03 mg); sample C (1.96± 0.11 mg) to sample E (N.D.) and sample G (0.34±0.02 mg) to sample D and E (N.D), where N.D means not detected.

In all the samples, Fe (0.07±0.01 mg) was recorded the lowest in sample F while Na (14.17±0.05 mg) for sample G followed by Ca (13.67±0.02 mg) in sample B were recorded as the most abundant mineral element. Although the mean results of the mineral contents, followed by different letters, within each sample studied were significantly different from each other at P<0.05, they were found below the WHO/FAO (2004) RDA values. The results of this study are also in agreement with the findings reported by Dosunmu *et al*. (2009) and Ndife *et al*. (2013).

Table 2: Results of the Mean Mineral and Preservative Contents of Selected Fruit Juices Studied ± Standard Deviation

Sample		Minerals (mg)						Preservative contents (%)	
	N	Na	K	Mg	Ca	Fe	P	Sulphur dioxide	Sodium benzoate
Sample A	4	7.32±0.06^b	8.59±0.05^b	3.52±0.07^c	7.88±0.03^b	1.36±0.04^a	0.16±0.02^a	0.04± 0.03	0.12 ± 0.02
Sample B	4	5.53± 0.07^b	0.96±0.02^a	0.94±0.02^a	13.67±0.02^c	1.86±0.01^a	0.11±0.01^a	0.03± 0.02	0.10 ± 0.02
Sample C	4	8.50± 0.05^b	8.09±0.02^b	1.36±0.04^c	3.11 ±0.01^a	1.96± 0.11^c	0.12±0.01^c	0.04± 0.01	0.09 ± 0.02
Sample D	4	12.39±0.02^b	2.43±0.03^a	N.D.	10.18±0.04^b	0.45±0.05^a	N.D.	0.10± 0.01	0.16 ± 0.02
Sample E	4	4.11 ± 0.02^b	0.25±0.03^a	1.39±0.03^a	3.42 ±0.03^b	N.D.	N.D.	0.06± 0.01	0.03 ± 0.01
Sample F	4	6.14 ± 0.33^b	2.16±0.12^c	7.46±0.42^b	2.43 ± 0.03^c	0.07±0.01^a	0.22±0.02^a.	0.04± 0.01	0.09 ± 0.04
Sample G	4	14.17±0.05^c	1.86±0.01^a	N.D.	7.46 ± 0.42^b	1.01±0.03^a	0.34±0.02^a	0.06± 0.01	0.07 ± 0.01
RDA (mg/day)		1000-1500	4000-4700	110-300	800-1100	8-22	380-1055	---	---

Note: Results were expressed as mean values of four replicate determinations ± standard deviation and mean values followed by different letters within a row are significantly different at $P<0.05$ from each other. Significant difference was analysed using ANOVA. N.D. = Not Detected. *RDA = Recommended dietary allowance (WHO/FAO, 2004).

The preservative contents measured in the selected fruit juice samples and expressed in percentage (%) showed that Sulphur dioxide ranged from sample D (0.10±0.01 %) to sample B (0.03±0.02 %) while Sodium benzoate ranged from sample D (0.16±0.02 %) to sample E (0.03±0.01 %). Among the preservatives commonly used, Sodium benzoate is the most preferred for use as an antimicrobial agent in foods and beverages preservation due to its efficacy which is dependent on the pH of the food. In addition, the results of this study were in agreement with the report of Salma *et al*. (2015). However, despite the fact that the results obtained in this study have revealed varying amounts of the vitamins and minerals including the preservatives, only sample D, E and G indicated the absence of magnesium, iron and phosphorus.

Conclusion

The results of this study have confirmed that different brands of fruit juices can be good sources of essential vitamins and minerals required for healthy living. The findings also revealed that the selected fruit juice samples were also enriched with minerals like sodium, potassium, calcium, magnesium, iron and phosphorus in varying amounts ranging from N.D. - 14.17±0.05 mg/100ml, while the vitamins and preservatives were in the range of 0.20±0.15 - 22.26±1.63 mg/100ml and 0.16 ± 0.02 - 0.03 ± 0.01 % respectively. Except for vitamin B2 in sample C, all other results were found below the WHO/FAO recommended dietary allowance for the vitamins and mineral contents. Hence, the fruit juice samples were suitable for consumption.

Recommendations

With respect to this study, the following recommendations were put forward:

- Locally available preservatives should be encouraged for used in the preservation of fruit juices

- Further research should be carried out to further investigate other properties of fruit juices available in the market
- Anti-nutrient contents of fruit juices commonly available in the market should be constantly checked

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