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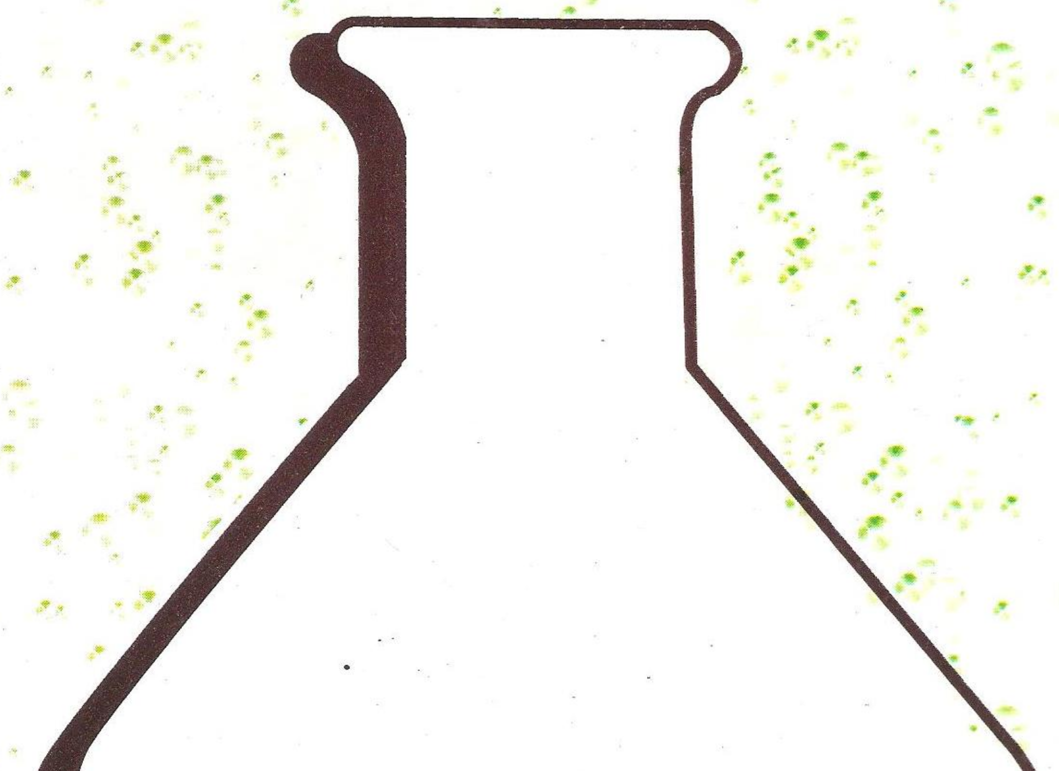

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Determination of Sugar and Some Trace Metals Content in Selected Brand of Fruit Juices

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ABSTRACT
Ten brands of commercial fruit juices were analyzed for pH, specific gravity, total solids, reducing sugar and total sugar trace metals contents. The pH was determined using a Hanna pH meter. Sugar content was determined using the Lane and Eynon method. Sodium and potassium were determined by flame photometry while calcium and magnesium by complexometric titration using EDTA and the other metals were determined by atomic absorption spectrophotometry. The fruit juices were found to have a pH range of 1.80 – 3.50, specific gravity of 1.001 – 1.053, total solids of 0.68 – 12.49 %, reducing sugar content of 0.36 – 8.24 % and total sugar content of 0.52 – 10.09 %. Metal content of calcium (0.01 – 1.25mg/L), magnesium (0.06 – 0.42mg/L), sodium (0.84 – 3.11mg/L), potassium (0.16 – 7.42mg/L), copper (0.26 – 5.06mg/L), zinc (0.01 – 0.10mg/L), chromium (0.03 – 0.09mg/L), manganese (0.11 – 6.96mg/L), cobalt (0.01 - 0.08mg/L), nickel (0.03 – 0.15mg/L), iron (0.45 – 0.50mg/L), cadmium (0.14 – 0.38mg/L), and lead (0.02 – 0.32mg/L). The Nigerian made juices had higher amount of added sugar. The Nigerian pineapple juice brand had very high concentration of iron and the presence of cadmium and lead in some of the samples is an indication of contamination. However the contamination level does not pose health threat to the consumers.

Keywords: Fruit Juice, Reducing Sugar, **S**ugar Content, Trace Metals

Introduction

The good quality of food is sum of its physical and chemical quality. According to a study in the journal of the American Dietetic Association, children and adolescents can benefit health – wise from drinking 100% fruit juices Slavin (2008). A lot of people of all age groups drink fruit juice foreign or indigenous. To this extent, it is very necessary to have a continuous monitoring of the quality of commercial juice drinks, as adulteration, which is the substitution of cheaper ingredients for authentic products with the intent to defraud the buyer, occurs around the world with many commodities including fruit juices (Jeanette, 1983). A product labeled fruit juice may in fact consist of little or no actual fruit components, thus the development of standard for fruit juices is incorporated into many country's regulatory codes. These regulations include the processing method employed, and the amount of fruit contents required for various fruits designations within that country. Most consumers bought fruit juice due to its taste and nutritional value. Fruit juice were also suggested to serve as a good medium for probiotics (Turiola and Cardello 2002). Heavy metals contamination of fruits, vegetables and other crops are a major concern since their accumulation in food crops in high concentrations could cause serious risks to human health if the crops are consumed (Vousta *et al.*, (1996); Ashworth and Alloway, (1996)). Such accumulation has been reported by Okoronkow *et al.* (2005). Although heavy metals do not play any significant role in the body of the plant due to physiological functions. The essential elements are very important because they are involved in many enzymes in the human body. However, high concentrations are toxic (Miller *et al*., 2000).

The major component of any fruit juice is water (Esminger *et al.,* 1986), and this can range from 90% in some wild berries to 70% in over ripe grapes, while less than 50% in fruits drying naturally on the plant. The non-aqueous portion contains literally hundreds of identified compounds which include natural sugars and/or sugar polymers such as glucose, fructose, starch, cellulose, hemicelluloses and pectin usually representing the majority of the solids. The solids are categorized as soluble, if they are readily expressed in the juice. The insoluble solids consist primarily of the press residue and can range from 3 to 25%. Other macro components such as the fruit acids are responsible for the taste and low pH of many fruits. Principal organic acids are citric, tartaric, malic, lactic, acetic and ascorbic acids These range from trace amounts to over 3%. Protein is usually less than 1%. Phenolic compounds ranging from anthocyanins or carotenoid pigments to tannins are usually far less than 1%. Lipids are usually absent except in avocado, oil palm fruits etc. The absence of lipids is reflected in the reasonably low calorie value of the fruit juices. High lipid fruits are not good for fruit juice production. Vitamins and minerals are in the range of trace to 0.2% while dietary fibre can be present up to 15% Yapo and Koffi (2008). Chemical contamination of fruit juices can occur from the environment. The unauthorized or excessive use of pesticide chemicals is the most common but an avoidable source Zihadi and Watson (2003). Even trace amounts of innocuous substances present in water or wind drift can cause contamination of fruit juices. Although the health hazard is trivial, the analytical sensitivity ensures detection. Unlabeled lethal white powders have been mistaken for food ingredients and are added to juice resulting in fatal poisoning (Morris *et al.,* 2001). The use of non-food grade equipment in the processing line is a relatively minor safety concern that still impacts juice quality. Metals such as copper, aluminium and iron mobilized from galvanized steel (except stainless), due to attack by fruit acids; contribute to metal ions in fruit juices Adesina and Adeyeye (2012). The aim of this study is to estimate the amount of added sugar and measure its concentration as well as trace metal level in some selected brand of fruit juices.

Sampling and Sample Preparation

Ten different brands of fruit juice samples were purchased from Mubi and Jimeta markets, Adamawa State Nigeria. Six samples were made in Nigeria while four were foreign made. The foreign juices were in metal cans and the Nigerian made juices were in paper and plastic packs. All the fruit juice samples were stored in the refrigerator to prevent deterioration.

Materials

Hanna pH meter model No.02895, specific gravity bottle, zinc acetate, potassium ferrocyanide, conc. HNO_3, sodium hydroxide, phenolphthalein indicator, perchloric acid (BDH chemicals Ltd Poole, England),, EDTA, flame analyzer and Atomic absorption spectrophotometer.

Methods

The pH was determined using a Hanna pH meter model No.02895.Specific gravity was determined with a 25cm^3 specific gravity bottle. Total solids were determined by evaporating 100 cm^3 of fruit juice to dryness in a pre-weighed evaporating dish and weighing the contents to constant weight.

Reducing and total sugar levels were determined by the Lane and Eynon method. For the reducing sugar determination, 20cm^3 sample of the fruit juice was clarified with 5cm^3 of 10% zinc acetate (BDH chemicals Ltd Poole, England), while 5cm^3 of 5% potassium ferrocyanide (BDH chemicals Ltd Poole, England), was used for the total sugar determination. A 50cm^3 volume of the clarified sample solution was inverted with 20cm^3 of concentrated HNO_3 (BDH chemicals Ltd Poole, England), and neutralized with 50% sodium hydroxide (LAB TECH chemicals) solution using phenolphthalein indicator (Merck Germany) (Smith, 1993).

Volumes of the samples equivalent to 100cm^3 of samples were prepared for determination of metals by wet digestion using 6 cm^3 perchloric acid (Sigma Aldrich Rledel-de-Haen GmBH) and 12cm^3 nitric acid (FAO, 1992). Sodium and potassium were determined by flame photometry using a Gallenkamp flame analyzer, calcium and magnesium were determined by EDTA titrimetry and the trace metals were determined by atomic absorption spectrophotometry using Alpha 4 serial No 4200 with air acetylene flame.

Results and Discussion

The results obtained are shown in Tables 1 and 2 while national and international standards are for the fruit juices (FAO, 1992; SON, 1997) are presented in Table 3. From the results obtained, all the samples were acidic, with pH ranging from 1.8 – 3.4. This falls within the range of the allowed limits by the Standard Organization of Nigeria, which is 1.4 – 4.0. It is suspected that the samples were acidic due to the addition of acids during the production, which is often the case. For instance freshly squeezed mango juice generally has pH range from 4.5 – 5.0, but on acidification with citric acid during the processing, the pH will be less than 4.0 (Morris *et al., 2001*).

The specific gravity of all the juices were between 1.001 – 1.053. The orange and black currant juice samples analyzed had the lowest specific gravity of 1.001 and 1.005 respectively. These were expected because both are fruit drinks. Their fruit contents or solid contents are usually below 10%. The composition of such drinks is mainly water, colouring matter and sugar. The total solid content of the orange and black currant samples were 0.67 % and 0.76%, which were very low in comparison with the rest of the samples, which ranged from 3.97% in lime juice to sample to 12.49% in the mango sample.

Out of the ten samples provided only three of the juice samples (mango, mixed fruits and pineapple) conformed to the expected standard of a minimum of 10% total solids content. From the sugar analysis, the black currant juice brand had the lowest % total sugar (0.52) followed by orange juice brand (0.65). The juice brands were not really sweet, and it shows that there was just little or no water was added. Others low in sugar content were lime and apple brands. These were Nigerian made drinks. The amount of sugar added can be estimated from the difference between the reducing sugar and the total sugar contents. The Nigerian made mango and pineapple juice drinks showed the highest amount of sugar content. None of the total sugar content of the fruit juice samples exceeded the 14% maximum permissible limit by FAO/WHO and only three of the brands had total sugar between 7 – 14% Sizer (1999).

The Table 2 shows that all the samples except one of the guava juice contained lower copper than the limit set for the metal. All the samples had concentrations of zinc well below the maximum level. The iron concentrations were below the limit of 15ppm in all the samples except for the pineapple, which showed a concentration of 50mg/L. This could be due to many reasons such as the fact that the fruit juice brand was acidic and the fruit acids could pick up the metal from the equipment during the processing or storage. As minerals are soil and species dependent, the fruit acids might also have picked up iron and other metals from the soil during the growth period. Iron could also have been added for fortification. Calcium, Magnesium, Sodium and Potassium were obviously absent in all the samples. This was expected as most of the property labeled samples had 0% for Calcium and Magnesium while some had trace amounts of Sodium. Studies have shown that the fresher the juice, the higher the quality, so standard for excellence is freshly prepared juice (Sizer and Balasubramaman, 1999).

Cadmium was more widespread, occurring in seven brands with values of 0.14 – 1.38mg/L. Lead occurred in four brands with range 0.11 to 0.32mg/L. Only the foreign made apple juice brand with the lead content of 0.32mg/L exceeded the maximum level of 0.3mg/L. The limit for cadmium was not stipulated but compared with the limit and for lead (since they are both non-nutritive elements), the foreign made guava brand and the pineapple brand may be considered high in cadmium (Abdallah *et al.,* 2013).

Table 1: Physical Parameters, Reducing Sugar and Total Sugar in Fruit Juice Samples.

Samples	pH	Specific gravity	Total solids %	Reducing sugar %	Total sugar %
Lime	1.80	1.020	3.97	1.84	2.69
Orange	2.30	1.001	0.68	0.62	0.65
Mango	3.30	1.052	12.49	1.92	10.09
Guava*	3.00	1.048	9.11	3.59	5.80
Guava*	3.50	1.045	8.43	4.86	5.20
Black currant	2.40	1.005	0.76	0.36	0.52
Mixed fruit*	2.20	1.053	11.70	6.50	7.04
Apple*	2.20	1.044	8.96	8.24	8.52
Apple	2.60	1.044	9.02	1.04	1.70
Pineapple	2.80	1.052	10.10	0.82	5.42

*Foreign Fruit Juice

Table 2: Concentrations (mg/L) of Metals in Fruit Juice Samples

Samples	Mean Concentrations (mg/L)												
	Ca	Mg	Na	K	Cu	Zn	Cr	Mn	Co	Ni	Fe	Cd	Pb
Lime	055	0.20	2.03	2.02	1.02	0.01	0.06	0.11	0.03	0.07	0.90	<0.002	<0.004
Orange	0.11	0.08	2.54	0.28	0.26	0.04	<0.002	0.18	<0.005	0.12	3.56	<0.02	0.11
Mango	0.44	0.42	1.76	5.48	<0.001	<0.08	<0.002	0.66	<0.005	<0.05	8.40	0.14	<0.004
Guava*	1.25	0.20	2.16	3.75	5.06	<0.006	<0.002	0.42	<0.005	0.13	3.30	0.26	<0.004
Guava*	0.39	0.14	2.58	2.78	3.99	<0.006	<0.002	0.66	0.05	0.03	11.80	0.36	<0.004
B/currant	0.18	0.23	3.11	0.16	0.66	0.06	0.03	0.25	<0.005	<0.05	<0.003	0.15	0.13
Mixed fruit*	0.48	0.06	0.84	2.76	0.64	0.04	<0.002	0.42	0.08	<0.05	7.76	<0.002	<0.004
Apple*	0.07	0.20	1.24	1.80	0.66	0.01	<0.002	0.18	0.01	<0.05	0.45	0.26	0.32
Apple	0.44	0.06	1.50	5.28	0.58	0.10	<0.002	0.13	<0.005	0.03	2.96	0.25	<0.004
Pineapple	0.38	0.20	1.10	7.42	0.60	0.01	0.09	6.96	0.04	0.15	50.00	0.38	0.02

Note: B/currant represent Black - currant juice

Table 3: Permissible Levels of Determined Parameters in Fruit Juice Samples

*Foreign Fruit Juice	Maximum level/Permissible levels (mg/L)
pH	1.4 – 4.0
Total sugars	7 – 14%
Total solids	10% minimum for fruit juices and 10% maximum for Fruit drinks
Magnesium	< 8
Copper	5
Zinc	5
Iron	15
Lead	0.3

Sources: Standard Organization of Nigeria (1997) and FAO/WHO (1992).

Conclusion

The results obtained shows that most of the Nigerian made fruit juice brands had higher amount of added sugar. The pineapple drink brand had very high concentration of iron and the presence of cadmium and lead in some of the samples is an indication of contamination either from the soil where the fruits were grown or from the vessels and equipment used in the production or storage. However, the samples analyzed cannot at the levels of contamination, present health hazards to the consumers due to their presence but there is need for continuous monitoring of fruit juices sold on the market.

Recommendations

- There is need to involve NAFDAC in continuous monitoring of both Nigerian and Foreign fruit juice quality.
- Equipment and vessels used in the fruit processing be checked regularly and properly.

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