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Quality control of some fruit juices available in Nigeria

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Abstract

Quality control of products is generally a measure of the degree of excellence, which enables the determination of acceptability by consumers and to guarantee the safety of consumers. The purpose of this study is to ascertain the overall quality of some fruit juices available in the Nigerian market. Overall quality is made up of component characteristics like colour, texture, flavour, nutritional value, freedom from harmful microorganisms and undesirable substances. Each of these characteristics may be measured and controlled independently to ensure that the product is of good quality. The total quality control of fifteen (15) brands of fruit juices was determined using standard procedures. The results showed that all the physicochemical parameters, metal content and microbial loads of the products were within permissible ranges of the specification for fruit juices. Sample FM had the highest values for total solid (13.10%), total carbohydrate (12.30%) and ash content (0.30%), but the least in moisture content (86.89%). For all the fruit juices, no bacteria growth was observed but there was growth of moulds and yeast. The concentration of vitamin C in the fruit juices ranged from 0.72 – 71.48 mg/100ml of juice showing that some of the juices are rich in vitamin C. The fruit juices that were analyzed in this study are safe for consumption.

Keywords: Quality control; Fruit juices; Proximate analysis; Metal analysis; Microbiological analysis.

INTRODUCTION

Fruits are widely distributed in nature and have been of immense importance for their taste and contribution to health. Fruits constitute commercially and nutritionally important indispensable food commodity [1]. The perishable nature of fruits dictates immediate consumption before spoilage and this resulted to the evolution of means of extracting juice from the fruits by mechanically squeezing or macerating it. In urban and rural areas of Nigeria and the world in general, there have been a steady increase in the production and consumption of fruit juices. This is because fruit juices serve as food supplement to supply instant energy and contribute to dietary intakes, source of refreshment as well as a reservoir of minerals, vitamins and other nutrients like flavonoids and phytonutrients, which are all required for growth and development. Also, some fruit juices have medicinal values, help to boost immunity and to detoxify the body [2, 3].

Fruit juice is the aqueous unfermented but fermentable product obtained from a fruit of one or more kinds mixed together; purees of the edible part of one or more ripened and mature fruit or vegetable or any concentrates

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of such liquid, which is intended for consumption [4,5].

Unpasteurized (untreated) fruit juice can be prepared freshly for immediate consumption while pasteurized fruits are normally processed to extend the shelf life and packaged for storage and future use. Also, some fruit juices are concentrates which were reconstituted with water suitable for the purpose of maintaining the essential composition and quality factor of the juice with the addition of other ingredients. A blend of fruit juice(s) with other ingredients such as high-fructose corn syrup is known as nectar [6].

Currently, fruit juice combinations are readily more available than single fruit juices. It is important to note that the quality of fruit juices depends essentially on the quality of the fruit used. The combination of fruit juice material, the versatility of juices and the many blending options available to producers have led to increasing cases of adulteration because of economic gain. Adulteration of fruit juices occur when substandard fruit materials are used, cheaper and low quality juice material are added, use of contaminated materials and water, use of contaminated packaging material, microbial contamination, etc. However, the spoilage of fruit juices may be due to the introduction of microorganisms upon exposure to air and high moisture content [7].

The factors that influence the quality of fruit juices are the soluble solids, pH, acid to sugar ratio, the phenolic contents, and ascorbic acid content [8]. Fruit juice stability depends on the raw materials, processing conditions, packaging materials and storage conditions. Generally, fruit juices contain the juice from the fruit or its concentrate, water for dilution, sweetness and flavours as well as other fortifiers like vitamin C (ascorbic acid) and minerals. The ingredients are to be listed on the label [4].

There is need to monitor and control the levels of ingredients in consumables such as fruit juices, drinking water and most drinks [9]. This is because, when concentration at which some of the ingredients are present exceed a permissible or allowable limit, they cause acute and chronic poisoning leading to illness, decline in quality of health, and then death [10].

EXPERIMENTAL

Sample collection. Fifteen (15) different brands of fruit juices were purchased from different stores in Benin City, Edo State of Nigeria. Only samples within the expiry dates as stipulated on the labels by the manufacturers were selected for analysis. The fifteen (15) brands with their codes include 5-Alive Apple Splash (AA), California Mango (CM), Caprisone Orange (CO), Clover Tropika Orange (CT), Exotic Pineapple and Coconut (EP), Fandango Pineapple, Orange and Apple (FD), Frootyzy Apple (FA), Frutta Mango (FM), Happyhour Peach (HP), Mix-to-Drink Blackcurrant (MB), Orchard Apple (OA), Pops Orange (PO), Smarty Apple and Berries (SA), Soygood Pineapple (SP) and Yojus Strawberry (YS). Six packs or plastic bottles of each of the brands (with same batch number) were used in this study and analysed using standard methods [11].

Phytochemical and proximate analysis. The phytochemical and proximate characteristics of the fruit juices were determined using standard procedures. The parameters determined include colour, moisture content, ash content, total solid, pH, titrable acidity, specific gravity and crude carbohydrate.

Determination of concentration of metals. The amount of five (5) metals present in the fruit juices was determined using atomic absorption spectrophotometry (AAS).

Microbiological analysis. After shaking each sample, exactly 1 mL was taken and transferred into a Mac-Cartney bottle and diluted with 9ml of sterile (1/4 strength) Ringer's solution to obtain a 10^{-1} dilution. From this solution, a four-fold serial dilution was carried out and 0.1 mL from the final dilution was used to inoculate each of previously prepared Nutrient Agar and Sabouraud Dextrose Agar (SDA) media at aseptic conditions. The nutrient agar plates were incubated at 35ºC in a hot-air oven for 48 hr (Miles and Misra, 1978; ICMSF, 1994) while the SDA plates were incubated upside down at 25ºC for 7 days. Counts were made on plates showing evenly distributed and discrete colonies. Microscopic and macroscopic test for fungi mould and yeast were carried out using SDA.

RESULTS

The results obtained in this study show the physical and proximate characteristics, metal content and microbial load of fifteen (15) commercial fruit juices. The phytochemical characteristics and proximate parameters of the fruit juices are shown in Table 1. The results for the determination of the concentration of metals present in the fruit juices are shown in Table 2. The results of the microbial load are shown in Table 3.

DISCUSSION

Proximate analysis involves the separation of nutrients and non-nutrients into categories based on their common chemical properties. Although proximate do not give the entire nutritional assay, there are inexpensive way to track deviations from the quality of foods. All the analyses were carried out using standard procedures [11].

From the results of the physicochemical and proximate analysis, the moisture content was lowest in FM (86.89%) and highest in PO (98.99%). All the fruit juices had high moisture content, which may enhance microbial growth [12] and hence encourage the addition of preservatives.

TABLE 1: Physicochemical and proximate characteristics of the fruit juices

Juice sample	Fruit type	Moisture Content (%)	Total Solids (%)	Ash Content (%)	Total Carbohydrate (%)	pH at 20ºC	Specific Gravity (g/L)	Titrable acidity (g/L)	Vitamin C content (mg/100mL)
AA	Apple	89.44	10.88	0.12	10.20	3.96	1.0502	0.0149	12.27
CM	Mango	90.74	9.36	0.10	9.10	3.86	1.0427	0.0129	54.87
CO	Orange	89.18	11.10	0.10	10.10	3.89	1.0494	0.0142	15.88
CT	Orange	90.36	9.54	0.12	8.94	4.43	1.0388	0.0152	19.99
EP	Pineapple	88.41	12.00	0.18	11.09	4.13	1.0483	0.0145	11.05
FD	Pineapple, Orange & Apple	91.50	8.62	0.10	8.10	3.93	1.0487	0.0139	32.39
FA	Apple	88.56	11.32	0.14	10.95	3.88	1.0574	0.0187	0.72
FM	Mango	86.89	13.10	0.30	12.30	4.37	1.0455	0.0113	1.95
HP	Peach	89.11	11.24	0.15	10.19	4.13	1.0502	0.0067	8.88
MB	Blackcurrant	90.65	9.58	0.14	9.00	3.73	1.0542	0.0652	0.50
OA	Apple	96.97	2.98	0.03	2.40	3.83	1.0182	0.0239	1.16
PO	Orange	98.99	1.02	0.01	1.00	3.87	1.0083	0.0178	3.61
SA	Apple & Berries	89.02	11.36	0.18	10.30	3.92	1.0534	0.0187	3.25
SP	Pineapple	92.49	7.50	0.09	7.26	4.38	1.0309	0.0132	71.48
YS	Strawberry	88.14	12.34	0.24	11.31	3.92	1.0471	0.0139	3.39

KEY**:** 5-Alive Apple Splash (AA); California Mango (CM); Caprisone Orange (CO); Clover Tropika Orange (CT); Exotic Pineapple and Coconut (EP); Fandango Pineapple, Orange and Apple (FD); Frootyzy Apple (FA); Frutta Mango (FM); Happyhour Peach (HP); Mix-to-Drink Blackcurrant (MB); Orchard Apple (OA); Pops Orange (PO); Smarty Apple and Berries (SA); Soygood Pineapple (SP); Yojus Strawberry (YS)

Table 2: Concentration of metals in the fruit juices

Juice sample	Fruit type	CONCENTRATION (mg/L)				
		Arsenic	Copper	Iron	Lead	Zinc
AA	Apple	0.000	0.420	7.315	1.990	4.480
CM	Mango	0.000	0.345	8.530	0.925	0.990
CO	Orange	0.009	1.090	4.125	2.040	3.135
CT	Orange	0.000	0.720	13.340	2.130	2.440
EP	Pineapple	0.000	0.545	8.245	1.535	2.830
FD	Pineapple, Orange & Apple	0.000	0.625	7.480	1.200	4.155
FA	Apple	0.000	0.775	10.350	1.585	4.710
FM	Mango	0.000	0.445	8.295	1.850	1.625
HP	Peach	0.000	0.555	4.445	1.540	2.935
MB	Blackcurrant	0.009	0.520	8.855	2.080	4.060
OA	Apple	0.000	0.320	7.005	0.855	0.920
PO	Orange	0.000	0.455	6.625	0.615	1.545
SA	Apple & Berries	0.000	0.445	13.255	0.920	1.225
SP	Pineapple	0.000	0.480	7.225	1.885	2.750
YS	Strawberry	0.000	0.895	9.465	1.430	4.850

KEY: 5-Alive Apple Splash (AA); California Mango (CM); Caprisone Orange (CO); Clover Tropika Orange (CT); Exotic Pineapple and Coconut (EP); Fandango Pineapple, Orange and Apple (FD); Frootyzy Apple (FA); Frutta Mango (FM); Happyhour Peach (HP); Mix-to-Drink Blackcurrant (MB); Orchard Apple (OA); Pops Orange (PO); Smarty Apple and Berries (SA); Soygood Pineapple (SP); Yojus Strawberry (YS)

TABLE 3: Microbial load of fruit juices (x 10^3 cfu/ml)

Juice samples	Mean bacterial counts	Mean fungi counts
AA	ND	ND
CM	ND	3.3
CO	ND	9.5
CT	ND	ND
EP	ND	3.0
FD	ND	6.5
FA	ND	ND
FM	ND	ND
HP	ND	ND
MB	ND	ND
OA	ND	ND
PO	ND	8.1
SA	ND	4.7
SP	ND	ND
YS	ND	7.2

ND – Not Detected

The ash content of the fruit juices ranged from 0.01 – 0.30%. The percentage ash is the inorganic content of the sample after water and organic matter have been removed and it produces a measure of the total amount of minerals [13]. Samples with high ash content are expected to have high concentrations of various minerals, which are expected to speed up metabolic processes as well as improve growth and development [14]. High percentage ash value may be due to ecological factors (i.e. environment, soil and species of the fruit) as well as the addition of high amount of minerals during processing.

The carbohydrate content ranged from 1.00 – 12.30%. This shows that most of the fruit juices are moderate sources of sugars [15]. Carbohydrates are polyhydroxy aldehydes (e.g. glucose) or ketones (e.g. fructose) and are referred to as hydrates of carbon. In the analysis of crude carbohydrate content, perchloric acid is used to digest the food sample so as to hydrolyse starch and other carbohydrates before it is determined spectrophotometrically as percentage glucose at 630 nm [11]. Samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets.

The total solid content was lowest in PO (1.02%) and highest in FM (13.06%). These values conform to the standard specifications stated by SON [16]. Total solids are the materials left after evaporation and dryness of water and it refers to suspended or dissolved matters. It is related to specific conductance, turbidity and amount of soluble solid referred to as Brix value. Total solid is considered as a reliable index in judging the harvest maturity of many fruits and their juices [17].

The pH values were low and ranged between 3.73 and 4.38. These values conform to standards set for acid foods [18, 19], which is pH 3.00 – 4.60. The result of the pH values in this study, compare well with the results obtained by Brain and Allan [20]. These low acidic values can be attributable to the amount of acids contained in the juices and it helps to inhibit microbial growth. In alkaline or neutral pH, food bacteria are more dominant in spoilage and putrefaction [20].

Titrable acids include citric acid, malic acid, tartaric acid, etc, which are common acids found in fruits. The titrable acid which was determined as the citric acid levels ranged from 0.0067 – 0.0625, conforming to the specifications as stated in NIS [21] and SON (16). The orange juices had the highest values for titrable acid. Total acid content generally reaches a maximum during growth and decreases during ripening. Therefore, organic acids are necessary to determine fruit maturity and spoilage in food products [22].

The specific gravity of the fruit juices ranged from 1.0083 – 1.0574. This is due to the differences in the nature of the constituting fruit(s) of the juices. Specific gravity is an important criterion of the soundness of fruit juice [23].

The fruit juices were found to be rich in their vitamin C content with highest values of 71.48 mg/100ml in sample SP. Majority of the juices had low values of vitamin C, and to be able to meet the recommended daily allowance (RDA) of 30-60 mg/day as has been set by various national and international agencies, more quantity of the fruit juice will need to be consumed. The concentration of vitamin C obtained in this study agrees with those of Shamsul [24] who noted that both fresh fruits and juices made from apple were lower than those of other fruits (guava and mango). Apple is known to contain little amount of vitamin C, while pineapple and citrus fruits like orange contain high content of vitamin C [25]. It is also important to state that vitamin C is prone to degradation in aqueous medium and increase temperature [26, 27] Vitamin C has many health benefits such as protection against scurvy and its anti-oxidant properties [25].

From the microbiological studies, the results show that coliform was not present as aerobic mesophilic bacteria did not grow in the sample after culturing for 48 hours. The lack of growth of bacteria in the samples may be due to the high concentration of preservative, limitation of air necessary for growth or the acidic pH ($pH < 4.6$) of the fruit juices [28]. On the other hand, moulds and yeast were detected, although the counts were still within the specification for fruit juices [29]. Moulds and yeast are common environmental contaminants, which are tolerant to acidic conditions and low water activity; hence, they are a major cause of spoilage of fruits and vegetables [30-32].The results of the metal analysis shows that arsenic (though at very low levels) was detected in two of the fruit juice samples. The samples contained varying amounts of copper, iron, lead and zinc, which were within the permissible or allowable limits.

Conclusion. From the study, the physicochemical and proximate parameters of all the samples analyzed, conformed to standards set for fruit juices. Some of the fruit juices are a good source of vitamin C and some minerals like iron and zinc. The microbiological quality of the fruit juices is satisfactory and so all the fruit juices analyzed in this study are safe for consumption.

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