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Full-Length Research Paper

Physicochemical and sensory properties of fruit drink produced from African fan palm (*Borassus aethiopum)* in Kano metropolis

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ABSTRACT: A hot and cold extraction method was used to extract juice from African fan palm fruit, which was then combined with clove and ginger powders to create AFPHU (African fan palm juice hot extraction unspiced), AFPHS (African fan palm juice hot extraction spiced), AFPCS (African fan palm juice cold extraction unspiced), and AFPCU (African fan palm juice cold extraction spiced) fruit drinks, as well as increase to the utilization of this under-utilized fruit. To determine the quality and assess the highest preference, samples were analyzed for °Brix, pH, Titrable acidity, specific gravity, refractive index, viscosity, ascorbic acid (Vitamin C), and sensory properties. With the addition of spices, the °Brix decreased from 10.28 to 8.16, viscosity decreased from 11.40 to 4.40 mPas, specific gravity decreased from 1.040 to 1.020 g/cm^3, titrable acidity decreased from 0.29 to 0.22 percent, and vitamin C decreased from 11.80 to 10.50 mg/100ml, while the pH increased from 3.27 to 3.46, regardless of cold or hot extraction method. The sensory results showed that significant differences ($p < 0.05$) existed between the samples in the attributes of taste, appearance, mouth feel and overall acceptability and not in the attribute of aroma. Generally, the fruit drink had good consumer preference with the AFCU sample being the most preferred.

Keywords: African palm, drink, physicochemical, sensory, spices

INTRODUCTION

African fan palm (*Borassus aethiopum)* is a tropical plant used for food purposes and also in traditional medicines (Adjou, 2006; Kansolé, 2009; Gbesso *et al.*, 2013). It is a wide spread plant found in most West African countries such as Ghana, Nigeria, Togo and Guinea (Bolade and Bello, 2006). The fruits are consumed as food or in the form of food supplements (Ali *et al*., 2010). It is either consumed in its raw state or the sap cooked and eaten. Juice from the pulp can also be extracted and used for the production of fruit juice and wine.

The African fan palm, also known as Palmyra palm or toddy palm has been described as a palm tree with huge fan shaped leaves. The various ethnic groups in Nigeria identify it thus; the Hausas call it “Giginya”, the Yorubas call it “Agbon olodu”, the Igbos call it “Ubiri” and the Kanuri know it as “kemeletu”.

The fruit pulp has been used in traditional dishes and the sap, which is tapped from the flower part, has been used as a sweetener for diabetic patients (Masayuki *et al.,* 2007). Almost all parts of *Borassus aethiopum* are used, in producing food, oil, timber, wine and also as raw material (the leaves) for making mat and basket (Bullock, 2004). There is a reawakening of interest among Nigerians in the consumption of traditional non-alcoholic beverages (Adeyemi and Umar 1994; Osuntogun and Aboaba, 2004; Ade-Omowaye *et al.,* 2006). Traditional non-alcoholic beverages play vital roles in the lives of Nigerians as they are consumed for their thirst-quenching properties, stimulating effects and for ceremonial rites (Lawless and Heymann, 1998; Nilugin and Mahendran, 2010). Many types of traditional beverages are available in Nigeria but only a few like *kunun-zaki, braga soborodo* are popular among the populace. African fan palm drink is among those beverages which are yet to be widely exploited in Nigeria.

Though some fruit juices are produced locally in Nigeria, most of the fruit juices and drinks found in the market are imported (Dosumu *et al.,* 2009; Okorie *et al.,* 2009). African fan palms are highly recommended for consumption as they contain low anti- nutritional factors (Erdman, 2000). The season of availability of the African fan palm fruits are from July to September. Unfortunately, over 60% of the annual fruit yield is often lost within ten days after harvest due to rot in storage and hence there is need for fruit preservation technologies (Nikiema *et al.,* 2008). The aim of this study is to produce fruit drink from African fan palm and determine the physicochemical properties and consumer acceptability of the formulated drink.

MATERIALS AND METHODS

Source of raw materials

Ripe African fan palm (*Borassus aethiopum)* fruits, cloves *(Eugenia carryophyllata)* and ginger *(Zingiber officinale)* and sugar were obtained from Rimi market, Kano, Nigeria.

Sample preparation

Fruit drink was processed from African palm fruit and spices (ginger and cloves). The African palm fruits was washed, peeled and sliced to obtain the fruit pulp of one thousand grams (1000 g). The fruit pulp was then divided into two parts (500 g each) for hot and cold extractions. Ginger was dry cleaned, diced and milled into powder while clove was cleaned and also milled into powder.

Hot extraction

Five hundred grams (500 gm) of the pulp was weighed into an aluminum pot and two liter of water added. The mixture was boiled for one hour, allowed to cool to ambient temperature and then filtered using muslin cloth with portable water make up to four liter juice (Figure 1).

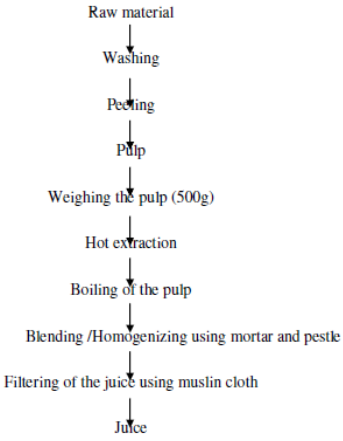

Figure 1: Flow chart of the hot extraction of fruit juice from African fan palm.

Cold extraction

Five hundred grams (500g) of the pulp was blended and small amount of water added at a time for easy blending. The water was added continuously until the pulp became smooth. It was then filtered with muslin cloth to remove the residue (Figure 2).

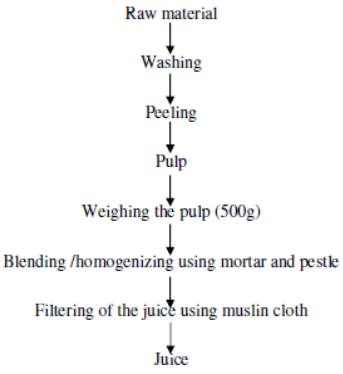

Figure 2: Flow chart of the cold extraction of fruit juice from African fan palm.

Table 1: Formulations used for preparing fruit drink.

INGREDIENTS	AFPCU	AFPCS	AFPHU	AFPHS
JUICE (liter)	2.0	2 .0	2.0	2.0
SUGAR (gram)	215	21 5	175	175
GINGER (gram)	_	10	_	10
CLOVES (gram)	_	5	_	5

AFPCU: African fan palm juice cold extraction unspiced
AFPCS: African fan palm juice cold extraction spiced
AFPHU: African fan palm juice hot extraction unspiced
AFPHS: African fan palm juice hot extraction spiced

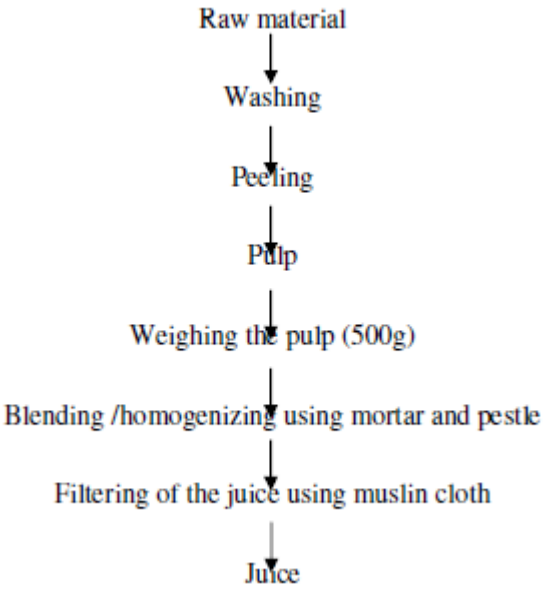

Figure 3: Flow chart of the cold extraction of fruit juice from African fan palm.

Preparation of fruit drink

The final volume of the juice extracted using the hot and cold methods was four 4.0 litres respectively. 350 grams of sugar was added to the hot extracted juice while 430 grams of sugar was then added to the cold extracted juice. The juice extracted using the hot and cold methods were further divided into two parts each. 15grams of mixed spices were added to one part and the other part was left unspiced, giving a total of four samples. The four samples were coded as AFPHU (African fan palm juice hot extraction unspiced), AFPH (African fan palm juice hot extraction spiced), AFPCS (African fan palm juice cold extraction unspiced) and AFPCU (African fan palm juice cold extraction spiced). The formulated drink was then filled into bottles (P.E.T.) pasteurized and stored in a refrigerator for further analysis (Table 1 and Figures 3 and 4).

Analysis

Sensory analysis

Sensory characteristics of the formulated fruit drink were evaluated for different sensory attributes by a panel of 20 panelists. Samples were assessed using a nine point hedonic scale. Sensory attributes assessed are appearance, aroma, taste, mouth feel, and overall acceptability for all samples.

Physicochemical analysis

The method described by AOAC (2010) was used to determine titrable acidity, acid value, refractive index, total soluble solid content (^{o}Brix), viscosity and Vitamin C

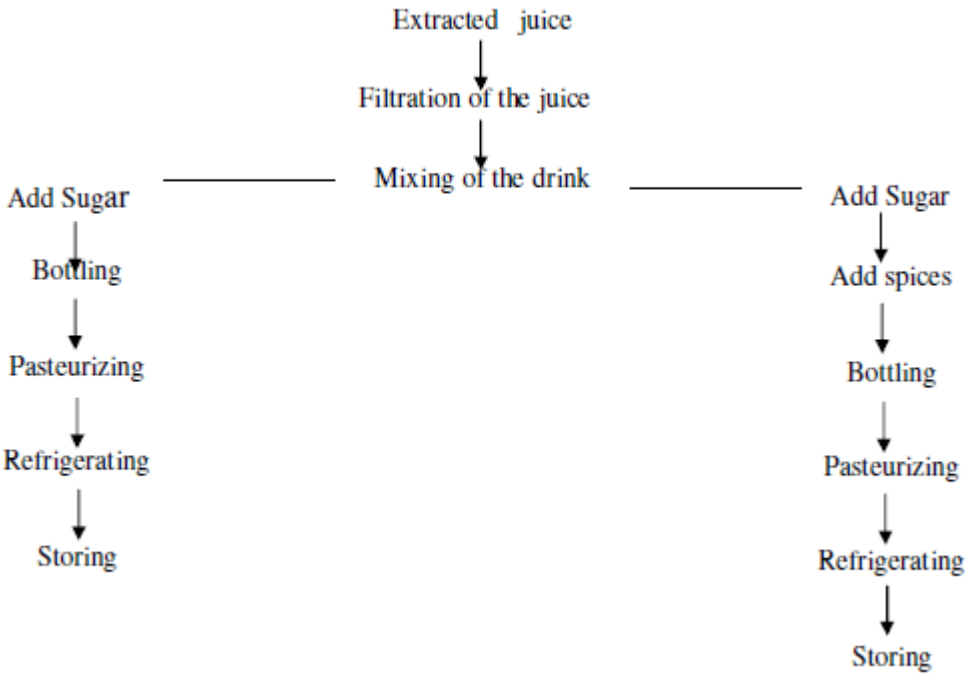

Figure 4: Flow chart for the production of fruit drink from African fan palm.

while, specific gravity and pH was determined by method described by AOAC (2005). The sweetness and astringency indexes were calculated as the ratio of soluble solids to acidity and vice versa (Wardy *et al.,* 2009).

RESULTS AND DISCUSSION

The results of the physicochemical properties and results of the sensory evaluation of the formulated African palm fruit drinks are shown in the (Tables 2 and 3). The results of the physic-chemical properties of the samples showed that the pH of the drinks ranged from 3.30 – 3.46 for samples AFPCU (African fan palm juice cold extraction unspiced) to AFPHS (African fan palm juice hot extraction with spices) as presented in (Table 2). There was no significant difference ($p<0.05$) in the pH values for samples AFPCS and AFPHS (3.27 and 4.46), respectively. The pH value for sample AFPHU (5.27) was significantly higher while sample AFPCU (3.30) was significantly low compared to other samples. Several researchers have reported fruit juices with varying pH values. Adubofuor *et al.,* (2010) reported a range of 4.82 – 4.99 for cocktail juices while, Ndife *and* Abbo, (2009) observed a range of 3.23 – 4.08 for different brands of orange juices, as well as 4.1 reported by Emelike and Ebere (2015) for fresh cashew-apple juice. A reverse in values was observed for titrable acidity values with sample AFPCU having the highest value of 0.29% and AFPHS with the lowest value of 0.21%. The difference may be due to the anti-oxidant effect of each spice on the formulated drink (Ndukwu and Ben-Nwadibia, 2005). Ndife *and* Abbo, (2009) also observed the same reversed case between pH and acidity values. Meanwhile, a significant difference ($p>0.05$) was observed in the values for titrable acidity of all the juice samples. According to FAO (2005), the juices containing more than 1.2% acid are sour, independent of °Brix/Acid (Bates *et al.,* 2001). Food acids dictate the dominant microflora in foods and to a large extent will determine the shelf stability of the juice (Ezeama, 2007). The more acidic the juice, the less susceptible to bacterial action but the more susceptible to the action of yeasts and moulds (Jay and James 2000). Anvoh *et al.* (2009) reported that fruit acids influence colour, flavor and gustative characteristics of the juice produced. The pH 5.79 and titrable acidity 2.30% of *Kunnu* were found to be higher than that of the African palm drink (test samples). The pH of *Sobo* drink 3.25 was found to be within that of the test samples which ranged from 3.30 – 5.27 while the titrable acidity of *Sobo* drink of 2.40% was higher than that of the test samples (0.21–0.29%) (Osuntogun and Aboaba, 2004; Bolade and Bello, 2006 ; Fasoyiro *et. al.*, 2005).

The specific gravity for the African palm drink ranged from 1.03 – 1.05, with sample AFPCU recording the

Table 2: Physicochemical properties of the African fan palm fruit drinks.

	AFPCU	AFPCS	AFPHU	AFPHS
ACIDITY (%)	0.29±0.001	0.29±0.002	0.217±0.058	0.23±0.07
TSS (^{o}Brix)	10.25±0.217	10.28±0.246	9.41±0.382	8.16±0.175
R INDEX	1.32±0.001	1.31±0.005	1.37±0.054	1.31±0.01
S.G (g/cm^3)	1.04±0.02	1.04±0.08	1.04±0.06	1.02±0.16
VISCOSITY (mPas)	11.40±0.2	10.50±0.15	5.70±0	4.40±0.3
pH	3.30±0.2	3.40±0.26	3.27±0.02	3.46±0.01
Vitamin C (mg/100ml)	3.98±1.04	11.80±0.50	11.77±0.45	10.5±5.27
S. INDEX	35.81±1.91	36.33±1.99	45.14±12.75	35.14±35.23
A.I	0.002±0.009	0.26±0.017	0.02±0.002	0.02±0.009

AFPCU: African fan palm juice cold extraction unspiced
AFPCS: African fan palm juice cold extraction with spices
AFPHU: African fan palm juice hot extraction unspiced
AFPHS: African fan palm juice hot extraction with spices

Table 3: Sensory analysis of fruit drink

	Appearance	Aroma	Taste	Mouthfeel	Acceptability
AFPCU	8.25±0.69	7.25±1.21	8.1±1.0911	7.8±1.11	8.5±0.59
AFPCS	7.25±0.82	7±1.30	6.75±1.51	6.6±1.74	6.95±1.79
AFPHU	8±1.092	7.4±1.59	6.2±2.24	6.7±1.61	7.4±1.59
AFPHS	6.6±1.46	6.95±1.37	6.7±1.89	6.15±1.58	6.85±1.26

Values are mean ± standard deviation of 20 panelists
AFPCU: African fan palm juice cold extraction unspiced
AFPCS: African fan palm juice cold extraction with spices
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lowest value of 1.03. This falls within the recommended value of 1.01 – 1.03 by the FAO for all beverages (non alcoholic (including soft drinks and juices) and fruit drinks (low calories and undiluted) (FAO, 2011) and 1.02 to 1.08 by Kareem and Adebowale, (2007). The specific gravity of a juice is often determined by the quantity of sugar or fruit present in that juice – the more sugar or fruit present in a juice, the denser the juice becomes (Science Bob, 2010). Fruit is one of the best low dense foods because of its high water content, which provides high volume and weight. To stay within low density guidelines, it is important to either consume fruit juice or whole fruit that has not been dehydrated than to eat whole fresh and processed fruits that do not contain added sugar (Ashley, 2011).

The Brix values of African palm drink ranged from 8.2 to 10.4°Brix. Sample AFPHS had the lowest ^{o}Brix of 8.0. The ^{o}Brix values of orange juices should be between 4 - 9 (Kareem and Adebowale, 2007). Total soluble solids (°Brix) are used as indicators of the drink content which ranged from 14.2 to 18.3 in the fruit drink sample reported by Egbekun and Akubor (2007).The °Brix of AFPCU (10.4), AFPCS (10.2), AFPHU (9.4) and AFPHS (8.2), reduced with addition of spices. Spices (especially clove, ginger, cinnamon, mace, anise, cardamom, and nutmeg) could reduce or eliminate sugar as reported by Hertzler (2011).

The refractive indexes of the samples at 20^{o}C were considerably close to each other with AFPCU and AFPHS having the same value of 1.31 while AFPCU and AFPHU had 1.32, and1.37 respectively. These values are similar to the refractive index for Tequila (1.35±0.00015) by Flood and Puagsa, (2000) and those reported for orange, grapes and tomato juices by Tresler (1971).

The values of viscosity obtained during this research for African fan palm drinks are presented in (Table 2).Viscosity is a highly relevant parameter; it determines the acceptability, processing and handling of foods (Ozt'urk *et al.,* 2013). The mean viscosity values of the formulated African fan palm drink were 11.40, 10.50, 5.70, and 4.40 for AFPCU, AFPCS, AFPHU and AFPHS respectively, were higher compared to the result of pineapple and water melon drink (1.15-1.30,-1.46) (Ravi *et al.,* 2012). The viscosity of apple juices, determined by Will *et al*., (2008), ranged from 1.74 to 2.15 mPa.s. Ascorbic acid content of fruit juices is the most prominent quality index of fruit juices due to its health significance as a vitamin and cellular antioxidant (Landon, 2007).There were significant difference ($p < 0.05$) in the ascorbic acid (vitamin C) contents of the formulated drink.

AFPCU, AFPCS, AFPHU and AFPHS. Sample AFPHU had 11.77 mg/100 ml of ascorbic acid followed by AFPCS (8.47 mg/100 ml), AFPCU (8.40 mg/100 ml), and AFPHS (8.11 mg/100 ml) respectively. The amount of ascorbic acid in the unspiced fruit drinks slightly decreased with amount of spices; however, these were significantly lower than the value for guava juice (80.1 mg/100 g),and passion fruit juice (39.1 mg/100 g) and almost similar to the value for lemon juice (10.5 mg/100 g) (Suntornsuk *et al.,* 2002). The sweetness indexes for samples AFPCU, AFPCS, AFPHUand AFPHS were 35.86, 36.33, 45.86 and 35.14, respectively. Sweetness index (SI) and the astringency index (AI) are used for the prediction of flavours in juices (Wardy *et al*., 2009; Adeola and Aworh, 2010). The ratio of sugars to acids and vice-versa gives an accurate prediction of the tartness and sweetness of acid foods which affects organoleptic perception (Wardy et al., 2009; Averbeck and Schieberle, 2010). Fruit juices with sweetness index greater than 19 are regarded as sweet and with less acid by taste (Wardy et al., 2009).

The sensory attributes of the formulated drink samples are presented in (Table 2). The statistical analysis revealed that there was significant difference ($p>0.05$) in the appearance between the cold and hot extraction samples. Sample AFPCU scored 8.25, AFPHU 8.00, AFPCS 7.25, and AFPHS 6.00, in terms of appearance of the African palm drinks. Samples AFPCU with the score of 8.25 is an indication that panelist prefer the appearance and the sensory scores for the appearance is in close agreement with the report of Ndife and Abbo, (2009), who reported a range of 5.14 – 8.35 for different brands of orange juice samples. The average score of the aroma of the formulated African palm drink were 7.25 for sample AFPCU, 7.40 for sample AFPHU, and a slight variation in sample AFPCS (7.00), while sample AFPHS scored 6.95. There was no significant difference at ($p<0.05$ and 0.01) in the aroma the samples.

The taste score of the four formulated samples AFPCU, AFPCS, AFPHU and AFPHS recorded 8.10, 6.75, 6.20 and 6.70 respectively. There was no difference in the taste of AFPCS, AFPHU, and AFPHS but, sample AFPCU was significantly different ($p<0.05$ and 0.01) from the other samples. The taste of the fruit drink is considered by the amount of sugar contained in it. Increase in the amount of sugar beyond the optimum amount may reduce the taste ratings thus requiring optimization (Jain and Nema 2007). Sweetness rating may also depend on the type of the fruit and may also vary during storage (Ashaye *et al.,* 2005). The mouth feel average score for the formulated fruit drink produced from African fan palm were 7.80, 6.70, 6.60 and 6.15 for samples AFPCU, AFPHU, AFPHS and AFPCS respectively. There was no significant difference ($p<0.05$ and 0.01) among the samples except sample AFPCU which was most preferred by the panelist.

In terms of general acceptability, sample AFPHU, AFPCS, AFPHS scored 7.40, 6.95, and 6.80 respectively while sample AFPCU recorded the highest score of 8.50showing significant difference from other samples. The sample AFPCU was the most accepted in all the sensory attributes. This may be related to the freshness of the drink formulated. Some fruit juices that have been produced locally and reported by researchers to obtain high sensory value are cashew apple juice with sensory score range of 3.50 – 4.56 on a 5 – point hedonic scale as reported by Emelike and Ebere (2015) and soy/carrot/beetroot with the acceptable range of 6.05 – 7.80 on a 9 – point hedonic scale reported by Banigo *et al.* (2015). The formulated drink with the highest rating of sensory score can be prepared for commercial purpose to serve as a special drink with similar constituents as other already existing commercial beverages.

Conclusion

The findings of the study showed that the formulated drink sample AFPCU (African fan palm juice cold extraction unspiced) was most preferred sample based on the organoleptic point of view. AFPCU (African fan palm juice cold extraction unspiced) was also found to contain optimum levels of Titrable acidity, total soluble solids and pH which fall within the standard recommendations for fruit drinks. So fruit drink with acceptable sensory and physicochemical properties can be produced from the African fan palm.

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