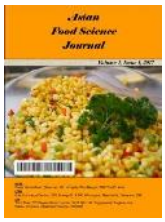

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Spreadability, Acceptability and Compositional Properties of Table Spreads Produced from African Pear (*Dacryodes edulis*) Pulp

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Authors' contributions

This work was carried out in collaboration between all authors. The first author OMA is the chief supervisor to the M.Sc. student while the second author GOW is the supporting supervisor. Both of them jointly designed the study and guided the student throughout the research process. The last author CO is the M.Sc. student who conducted the research, managed the literature searches and the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

African pear (*Dacryodes edulis*) pulp was processed and spread samples were produced from pulp treated with different levels of food grade additives and labelled as samples A (with 0.045% potassium sorbate), B (0.035% potassium sorbate), C (0.01% butylated hydroxyl toluene), D (0.005% butylated hydroxyl toluene), E (0.008% citric acid), F (0.005% citric acid), G (0.025% potassium sorbate and 0.005% BHT), H (0.005% BHT and 0.008% citric acid) and I (no preservative). The analysis was carried out to determine the compositional properties on both the pulp and the treated spread samples, as well as the spreadability and acceptability of the spread samples. The result showed that proximate compositions of the pulp had the values of 18.66, 4.45, 9.50, 48.93, 0.55, 4.82 and 62.20% for carbohydrate, protein, fat (wet based), fat (dry weight), ash, crude fiber and moisture, respectively. Spreadability of the spread samples ranged from 0.117 – 0.217mm/sec at chilled temperature (14±2°C) and 0.117 – 0.232 mm/sec at ambient temperature (28±2°C), with sample E giving the highest spreadability value of 0.217 mm/sec (chilled temperature) and 0.232 mm/sec at ambient temperature. The sensory result indicated that samples I, A and E attracted high overall acceptability with 4.25, 4.00 and 3.95 scores, respectively. The peroxide value of the spreads ranged from 4.35 – 4.79 mEq/kg, free fatty acid

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(2.91 – 3.27%) and vitamin C (8.14 mg/100 g – 9.25 mg/100 g). All the samples were relatively acidic with pH values ranging from 4.15 to 4.75. This study showed that table spreads rich in protein and other essential nutrients with acceptable color, taste and spreadability can be manufactured from the pulp of African pear (*Dacryodes edulis*).

Keywords: Spreadability; acceptability; compositional properties; African pear pulp.

1. INTRODUCTION

Vegetable spreads are a spreadable product having at least 90% ingredients from nuts and pulps used in various forms, such as paste and slurry [1,2]. Vegetable spreads like the commercially available butter can be produced from almond, cashew, hazelnut, macadamia nut, peanut, pecan, pistachio and walnut [3]. The vegetable spread is popular and widely accepted by consumers due to its flavor, good nutritional values and suitability for consumption either alone or in combination with a variety of other foods.

African pear pulp has potentials for spread production. The African pear tree (*Dacryodes edulis*) is a tropical oleiferous fruit tree that possesses enormous potential in Africa [4]. Various parts of the tree are used in traditional medicine [5,6]. The wood serves for firewood and carpentry [7]. The entire tree is used in Agro-forestry systems for soil conservation [8]. *Dacryodes edulis* fruit is popular in the diets of many Africans. It can either be eaten raw, roasted, boiled in hot water or used in garnishing cooked or roasted maize. It could also be used as butter to eat bread [6]. The pulp of African pear when cooked and seasoned serves as a spread (Cameroon recipe) [9]. According to Ayuku et al*.* [10], *D. edulis* has a potential to improve nutrition and food security. During the last three decades, more and more studies have been conducted on *D. edulis*, essentially the tree and its fruit. The scientific researches on *D. edulis* focused on the characterization of propagation techniques of *D. edulis* tree [11], the nutritive value of its pulp and its oil [12] and the oil extraction processes [13]. These studies revealed excellent nutritional qualities of fruit pulp and interesting food processing properties of the oils extracted from the pulp and kernel safou [14]. These have also revealed the importance of this fruit nutritionally, therapeutically and in cosmetic. The pulp which is the only edible part of the fruit is rich in lipids [15]. This is an indication that *D. edulis* is an important source of oil. Besides lipids, *D. edulis* pulp contains substantial amounts of many other nutrients including proteins, carbohydrates, minerals, vitamins and fibres [14]. Since the most important characteristic of nut spread is spreadability, it is of utmost importance that the product should have a soft texture and be easily spreadable to avoid tearing the bread or crumbling the crackers. In addition, since children are the most popular user of nut spread, soft and spreadable product characteristics will help to facilitate the application of nut spread by this age group without assistance from their parents. For this reason, creamy and smooth vegetable spreads are preferred. Hence, the aim of this study was to produce table spread from the pulp of African pear, ascertain its spreadability, acceptability and compositional properties.

2. MATERIALS AND METHODS

2.1 Material Acquisition

Mature and good quality fruits from the African pear (*Dacryodes edulis*) were purchased from the fruit market. Peanut butter was purchased from Spar superstore, all in Port Harcourt, Rivers State, Nigeria and used as product control to evaluate acceptability and spreadability.

2.2 Extraction of African Pear Pulp

African pear fruits were sorted and washed with tap water and sodium chloride solution and rinsed thoroughly, roasted at 60^0C for 4min in a hot air oven (model QUB 305010G, Gallenkamp, UK). The roasted fruits were allowed to cool for 10min, the thin bluish-black epicarp was gently removed and discarded while the soft pulps were scraped off and recovered in sterile stainless steel plates. The pulp was then extracted using the modified traditional method of pear roasting. The extracted pulp was pasteurized by heating at 100^0C for 5 min in a stainless put as shown in Fig. 1.

2.2.1 Formulation of African pear spread

The pasteurized pear pulp was treated with different levels of recommended food preservatives [16], as shown in Table 1. The mixture was properly homogenized for 20 min at

250 rpm using a laboratory stirrer (model JKL 2145, REMI Motors, India). The spreads produced were stored in sealed glass containers.

2.3 Physicochemical Analysis

Chemical analysis of the African pear pulp and the treated spreads was performed to determine the protein, fat, ash, crude fiber and moisture content using the AOAC [17] standard method while carbohydrate was determined using the Clegg Anthrone reagent method as described by Osborne and Voogt [18]. The peroxide value, free fatty acid, vitamin C and pH content were also determined using the AOAC [17] method.

2.4 Spreadability

Spreadability of the African pear spreads at room (28±2°C) and chilled (14±2°C) temperature was measured using laboratory consistometer, according to the method of Endecotts [19].

In the instrument, reservoir was placed 100g of pear spread, behind the gate of the consistometer. As the gate is released by pressing the lock release lever, the spring action ensures it opens instantaneously. As the fluid flows down the instrument, its progress was accurately measured using the graduated scale.

Spreadability (mm/sec) = d/s

d =distance covered

s =time taken

2.5 Sensory Evaluation

The Spread samples were evaluated by 20 randomly selected panelists from the Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria. The sensory attributes of the treated spread samples including color, taste, aroma, spreadability and overall acceptability were evaluated using a 5 – point hedonic scale with 1 representing the least score and 5 the highest score (dislike and like extremely, respectively) as described by Iwe [20]. All evaluations were conducted at room temperature on the same day.

2.6 Statistical Analysis

All experiments and analysis were carried out in duplicates and the mean standard deviation values were calculated. Data were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0, software 2011. Means were separated using Duncan's New Multiple Range test and significance accepted at $p \leq 0.05$ level probability as described by Wahua [21].

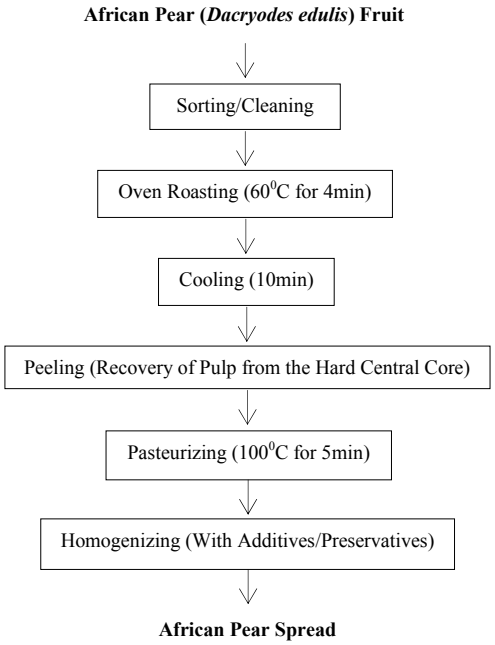

Fig. 1. Flow chart for the production of African pear spread

Table 1. African pear spread formulations

Samples	Pear pulp (g)	H_2O (g)	PS (E200) (g)	BHT (E321) (g)	CA (E330) (g)
A	100	15	0.045		
B	100	15	0.035		
C	100	15		0.01	
D	100	15		0.005	
E	100	15			0.008
F	100	15			0.005
G	100	15	0.025	0.005	
H	100	15		0.005	0.008
I	100	15			

Keywords: PS= Potassium Sorbate, BHT= Butylated hydroxytoluene, CA= Citric Acid

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of African Pear Pulp

The composition of food nutrients in African pear pulp are shown in Table 2. Carbohydrate, protein, fat, ash, crude fibre and moisture content were 18.66%, 4.45%, 9.50% (wet based), 0.55%, 4.82% and 62.20%, respectively. Carbohydrate content of 17.03% and 16.07% have been reported by earlier researchers [22,6]. The protein content of 4.45% agreed with 4.35% and 5.13% reported by Ogoloma et al. [23] and Duru et al. [6], but higher than 1.93% reported by Ajayi and Adesanwo [22]. Slight difference in proximate composition of African pear pulp under study with those reported by earlier researchers is probably due to varietal differences and environmental effects. The fat content of 48.93% (dry weight) and carbohydrate content of 18.66% indicates that *Dacryodes edulis* pulp is a rich source of energy. Protein is the major structural component of cells and is responsible for the building and repair of the body tissues. The protein content of 4.45% present African pear pulp as a good source of the bodybuilding nutrient. Thus, with increased consumption, the serious problem of protein deficiency can be mitigated. The high fiber content of *Dacryodes edulis* pulp showed that the product is a good source of dietary fiber, needed for healthy colon activities and enhanced digestion.

Table 2. Proximate composition of African pear pulp

Parameters	Composition (%)
Carbohydrate	18.66±1.60
Protein	4.45±0.62
Fat (Wet Based)	9.5±2.18
Fat (Dry Weight)	48.93±0.26
Ash	0.55±0.35
Crude Fibre	4.82±0.07
Moisture	62.2±1.15

Values are means ± standard deviation of duplicate samples

3.2 Spreadability of African Pear Spread

Result for spreadability of African pear spreads is presented in Fig. 2. The values ranged from 0.029mm/sec for the peanut butter to 0.208mm/sec for sample I (African pear spread without preservative). Significant difference ($P<0.05$) were noticed in spreadability of samples kept at ambient temperature (28±2°C) and those kept at chilled temperature (14±2°C) for samples G, F, E, A and J, however, samples B, C, D, H and I were observed to show similar spreadability both at chilled and ambient temperature. Sample E gave the highest spread factor while peanut butter gave the least spreadability. Spreadability is an extremely important attribute of semi-solid food texture. Spreadability is a subjective term related to how easy a sample is uniformly distributed over a surface [24]. Spreadability is of utmost importance, the product should have a soft texture and be easily spreadable to avoid tearing the bread or crumbling the crackers.

3.3 Sensory Evaluation

Sensory characteristics, including color, aroma, taste, and texture are used by consumers to make purchasing and consumption decisions related to foods [25]. Trained panelists describe a product's behavior in their mouth in terms of quality and quantity through its mechanical, geometrical, and other sensory characteristics from the first bite through complete mastication [26].

Sensory evaluation of African pear spreads as shown in Table 3, indicates that spreads with zero preservatives (sample I), spreads with 0.008% citric acid (sample E), spreads with 0.045% potassium sorbate (sample A) and the control peanut butter (sample J) had equal acceptability with respect to colour. Acceptability score of taste and aroma for the spreads, on a 5 point scale ranged from 3.05 – 3.95, and 3.20 – 4.40, respectively.

Samples I, A and E attracted high overall acceptability with 4.25, 4.00 and 3.95 scores, respectively while sample J (control sample) had the highest score for taste (3.95) and aroma (4.40). This was likely due to the fact that consumers are used to peanut butter which is widely sold in the local markets. Spreadability scores for the pear spreads (3.85 – 4.05) were significantly ($P<0.05$) higher than that of the peanut butter (2.60), indicating that African pear spreads gave better spreadability on bread than peanut butter. Gills and Resurreccion [24] reported that descriptive attributes spreadability highly correlated with consumer attribute spreadability. The pear spreads and peanut butter were given equal overall acceptability, except sample C which recorded significantly ($P<0.05$) low overall acceptability.

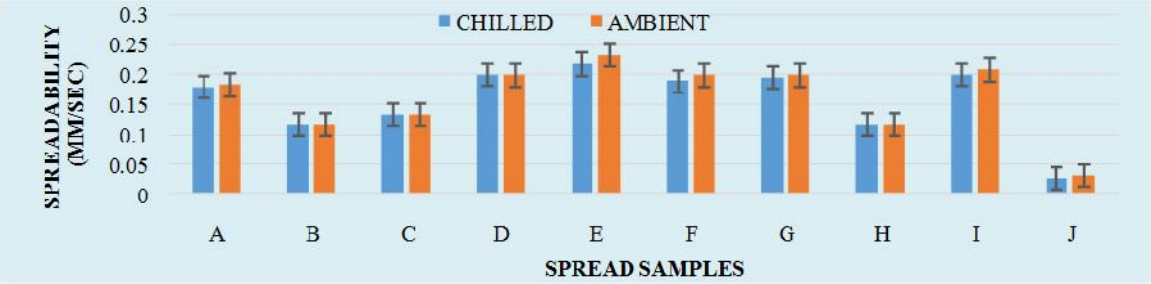

Fig. 2. Spreadability of African pear spreads at ambient and chilled temperature

Keywords:
A = African pear spread treated with potassium sorbate (0.045%)
B = African pear spread treated with potassium sorbate (0.035%)
C = African pear spread treated with BHT (0.01%)
D = African pear spread treated with BHT (0.005%)
E = African pear spread treated with citric acid (0.008%)
F = African pear spread treated with citric acid (0.005%)
G = African pear spread treated with BHT (0.005%) and potassium sorbate (0.025%)
H = African pear spread treated with citric acid (0.008%) and BHT (0.005%)
I = African pear spread without preservative
J = Peanut butter

Table 3. Sensory evaluation of African pear spreads treated with different levels of preservatives

Samples	Colour	Taste	Aroma	Spreadability	O. Accept.
A	3.90^{a}±0.718	3.80^{b}±1.056	3.85^{ab}±0.988	4.05^{a}±0.826	4.00^{ab}±0.726
B	3.75^{ab}±0.716	3.25^{ab}±0.787	3.70^{ab}±0.865	4.15^{a}±0.745	3.90^{ab}±0.788
C	2.95^{c}±0.999	3.05^{b}±0.759	5.50^{ab}±0.889	4.05^{a}±0.759	3.45^{b}±0.945
D	3.35^{abc}±0.745	3.35^{ab}±1.182	3.20^{b}±1.005	3.85^{a}±0.875	3.50^{ab}±0.688
E	3.80^{ab}±0.696	3.75^{ab}±0.716	3.55^{ab}±0.686	4.05^{a}±0.759	3.95^{ab}±0.686
F	4.00^{a}±0.918	3.40^{ab}±0.995	3.80^{ab}±0.894	4.00^{a}±0.973	3.60^{ab}±0.883
G	3.05^{bc}±0.759	3.15^{ab}±0.875	3.45^{b}±0.945	3.80^{a}±0.894	3.75^{ab}±0.716
H	2.85^{c}±0.813	3.30^{ab}±0.865	3.75^{ab}±1.020	3.90^{a}±0.912	3.60^{ab}±0.883
I	3.95^{a}±0.826	3.75^{ab}±0.786	3.90^{ab}±0.788	4.00^{a}±0.918	4.25^{a}±0.716
J	3.95^{a}±0.510	3.95^{a}±0.510	4.40^{a}±0.883	2.60^{b}±0.681	4.25^{a}±0.444

^{a,b,c} Mean values bearing different superscripts in the same column differ significantly ($p<0.05$).
Values are means ± standard deviation of twenty responses.
Keywords:
O. ACCEPT = Overall Acceptability
A = African pear spread treated with potassium sorbate (0.045%)
B = African pear spread treated with potassium sorbate (0.035%)
C = African pear spread treated with BHT (0.01%)
D = African pear spread treated with BHT (0.005%)
E = African pear spread treated with citric acid (0.008%)
F = African pear spread treated with citric acid (0.005%)
G = African pear spread treated with BHT (0.005%) and potassium sorbate (0.025%)
H = African pear spread treated with citric acid (0.008%) and BHT (0.005%)
I = African pear spread without preservative
J = Pea nut butter

3.4 Physicochemical Properties

Data on the chemical properties of African pear spreads treated with different levels of preservatives is presented in Table 4. The peroxide value (PV) ranged from 4.52 mEq/kg in sample A to 4.79 mEq/kg in sample I (spread without preservative). There was no significant difference (P>0.05) in the PV of all the samples treated just as expected based on the fact that all the products were freshly produced. Peroxide value (PV) gives an indication of the degree of fat oxidation [27,28]. It is the milliequivalent (mEq) of oxygen per kg of fat. The PV of the products was

Table 4. Physicochemical properties of African pear spreads treated with different levels of preservatives

Samples	PV (mEq/kg)	FFA (%)	Vitamin C (mg/100 g)	pH	Moisture (%)
A	4.52^{a}±0.270	3.10^{a}±0.403	8.33^{a}±0.000	4.55^{ab}±0.071	62.16^{a}±0.071
B	4.69^{a}±0.154	3.19^{a}±0.120	8.29^{a}±0.057	4.35^{bc}±0.071	62.20^{a}±0.007
C	4.35^{a}±0.024	3.03^{a}±0.559	8.39^{a}±0.304	4.15^{c}±0.071	62.15^{a}±0.064
D	4.65^{a}±0.127	2.91^{a}±0.191	8.06^{a}±0.276	4.15^{c}±0.071	62.19^{a}±1.160
E	4.79^{a}±0.014	3.27^{a}±0.085	9.25^{a}±0.488	4.15^{c}±0.071	62.18^{a}±0.035
F	4.62^{a}±0.141	3.13^{a}±0.347	9.25^{a}±0.438	4.20^{c}±0.000	62.08^{a}±0.106
G	4.67^{a}±0.149	3.02^{a}±0.325	8.14^{a}±0.276	4.20^{c}±0.000	62.19^{a}±0.007
H	4.48^{a}±0.163	3.18^{a}±0.177	9.06^{a}±0.163	4.20^{c}±0.000	62.06^{a}±0.007
I	4.79^{a}±0.021	3.07^{a}±0.361	8.64^{a}±0.431	4.75^{a}±0.071	62.60^{a}±1.153

^{a,b,c} Mean values bearing different superscripts in the same column differ significantly (p<0.05).
Values are means ± standard deviation of duplicate samples.
Keywords:
A = African pear spread treated with potassium sorbate (0.045%)
B = African pear spread treated with potassium sorbate (0.035%)
C = African pear spread treated with BHT (0.01%)
D = African pear spread treated with BHT (0.005%)
E = African pear spread treated with citric acid (0.008%)
F = African pear spread treated with citric acid (0.005%)
G = African pear spread treated with BHT (0.005%) and potassium sorbate (0.025%)
H = African pear spread treated with citric acid (0.008%) and BHT (0.005%)
I = African pear spread without preservative

much lower than 10 mEq/kg, which is the maximum allowable peroxide value for edible fats and fat based products [16]. The free fatty acid (FFA) content ranged from 2.19% in sample D to 3.27% in sample E. These values agreed with the percentage FFA of 2.82 reported by Ajayi and Adesanwo [22]. No significant difference (P>0.05) was observed in FFA of all the samples.

Vitamin C content was 8.06 mg/100 g in sample D and relatively high (9.25 mg/100 g) in sample E, these values were, however, not significantly different (P>0.05) from 8.64 mg/100 g recorded in sample I (control), but higher than 3.36 mg/100 g recorded by Kadji et al. [9]. Vitamin C, also known as ascorbic acid, is necessary for the growth, development and repair of all body tissues. It's involved in many body functions, including the formation of collagen, absorption of iron, the immune system, wound healing, and the maintenance of cartilage, bones, and teeth [29]. The relatively high content of vitamin C (ascorbic acid), posit African pear spread as a good source of this essential nutrient.

The pH value of a food is a direct function of the free hydrogen ions present in that food. Acids present in foods release these hydrogen ions, which give acid foods their distinct sour flavor. Thus, pH may be defined as a measure of free acidity. More precisely, pH is defined as the negative log of the hydrogen ion concentration [30]. The pH of the African pear spread ranged from 4.15 in samples C, D and E to 4.75 in sample I (control). The pH of the control (sample I) was significantly different (P<0.05) from those of the treated samples, with least pH recorded in samples C, D and E. These range of pH showed that African pear spread is relatively acidic, which will enhance its storability. The moisture content of the spreads ranged from 62.02% to 62.20%, these values were not significantly different (P>0.05).

4. CONCLUSION

The findings from this study showed that African pear pulp is rich in fats, protein and other essential nutrients. Table spreads formulated from it gave acceptable color, taste and spreadability. The pH value and peroxide value will enhance the storage properties. However, changes in the physicochemical properties and microbiological quality of table spread produced from African pear pulp shall be investigated in the next study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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