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Proximate Composition, Storage Stability, and Sensory Properties of Table Spread Produced from African Elemi (*Canarium schweinfurthii*)

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Abstract

The proximate composition, storage stability and sensory properties of table spread produced from African elemi pear was evaluated. The fully ripened African elemi pear were purchased from a local market in Obolo, Enugu State, Nigeria and used in the production of table spread with varying quantity of guar gum- 0.5g (sample B), 1.0g (sample C) and 1.5g (sample D). African elemi pear produced without guar gum addition served as the control (sample A). Proximate composition results showed that moisture content of the table spread ranged from 51.69-54.25%, Ash content of the spreads ranged from 2.48-2.60%. Fat content of the samples ranged from 8.80-10.80%, Crude protein content ranged from 1.75-3.50%. Carbohydrate content of the samples ranged from 21.24-25.92%. There was significant difference ($p<0.05$) between samples in their moisture, fat, crude protein and carbohydrate contents. The initial free fatty acid (FFA) values of African elemi spread ranged from 3.91-5.73%. The African elemi pear spread during shelf storage at weeks 1 and 2, recorded FFA values ranging from 5.43-6.05% and 6.50-7.15% respectively, and ranged from 6.48-7.7.68% at week 3. At the end of the 4th week, the FFA value ranged from 7.35-8.15%. The initial peroxide value (PV) of the samples ranged from 4.49-8.98 mEq/kg. At weeks 1 and 2, the PV were observed to range from 5.43-10.65 mEq/kg and 5.50-9.60 mEq/kg respectively. At week 3, the PV ranged from 7.33-15.52 mEq/kg, and ranged from 8.27-19.74 mEq/kg at the end of the 4th week. Mean sensory scores of the table spread showed overall acceptability of the spreads ranging from 6.38-7.33, and there was significant difference ($p<0.05$) between samples. Microbial analysis result showed that the total bacterial and mould counts increased with storage. By week 3, the samples were above the 10^5 bacterial count for ready-to-eat foods. This study have shown that the incorporationof guar gumim the preparation of African elemispread decreased the moisture and fat content while increasing ash, crude protein and carbohydrate contents. This study therefore demonstrates the potential of African elemi for the production of healthy spread as well as the use of guar gum in improving the quality of the spread.

Keywords: *African elemi pear, Table spread, Storage stability, Guar gum*

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Introduction

A spread is a food that is literally spread, generally with a knife, onto food items such as bread or crackers (Lukins, 2012). A food spread is also oily material usually produced from plant and animal fat made largely from vegetable oils that has been hydrogenated or modified for proper spreading texture (Okparauka *et al.,* 2019). Spreads are added to food in order to enhance the flavor, texture and nutritional properties of the food. Salads, sandwiches and many other home recipes will be bland and unattractive without food spreads (Lukins, 2012). Common spreads include dairy spreads such as cheeses, creams, and butters; plant derived spreads such as jams, jellies and hummus. Food spreads are mostly used with baked foods and other moistened baked foods like bread; biscuits that are consumed instantly. The oils used are refined oils, the same as we buy in the supermarket. Some spreads include other liquid oils such as olive or avocado oils, but these oils are considerably more expensive (Meera and Anitha 2020). Functionality of fats and oils is an important consideration when formulating a spreads product. Features such as melting point, solid fat content, fatty acid profile, triglyceride content, and crystallization habits of fats and oils influence the functional aspects of the final food product. Fats can be modified to enhance specific desirable functional traits. Processing techniques such as hydrogenation, interesterification, and blending, as well as genetic modifications such as increasing specific fatty acids in crops, have been used to affect the functional characteristics of specific natural fats and oils (Kathleen, 2005).

The decline in animal fat consumption coincides with the dramatic rise in the consumption of vegetable oils. In the late 1800's and early 1900's, animal fats such as butter, lard, and tallow were used for cooking, baking, and spreading. Inventions of margarine and the technique of partial hydrogenation coupled with soaring butter prices led to the decline of animal fat consumption since it's been being linked to growing awareness of coronary heart disease, obesity, etc. People are now shifting from fat-rich dairy products to low-fat spreads/dietetic dairy products (Kathleen, 2005). Saturated fatty acids have been attributed to an increase in the risk of coronary heart disease. The American Heart Association guidelines suggest that not more than 7% of total dietary fat be from saturated fats. Numerous studies have shown that the consumption of saturated fats increases LDL levels correlating strongly with increased risk of heart disease (White 2009). Palmitic and stearic acids are commonly consumed in palm oil and butterfat, respectively. Both are saturated fatty acids. Stearic acid is unique among saturated fats in that numerous studies have shown that it has a neutral effect on serum cholesterol levels. In recent times, the hype around saturated fatty acids in the diet has died down somewhat as consumer interest has shifted to the dangers of consuming trans fats (White 2009).

African Elemi (*Canarium schweinfurthi*) belongs to the family of *Burseraceae Kunth* consisting of 18 genera and about 700 species of tropical trees (Anyaloubu *et al.,* 2020). The seeds are embedded in a purplish green pulp which is oily and edible, with a desirable sweet but not too sugary taste similar to that of avocado pear. It can be eaten raw or softened in warm water to improve palatability (Orisa *et al.,* 2023). The pulp oil is about 71% palmitic acid and 18% oleic acid (Maduelosi and Angaye, 2015). *Canarium schweinfurthii* is traditionally used in African traditional medicine as insecticide or against dysentery, gonorrhea, coughs, chest pains, pulmonary affections/*Mycobacterium tuberculosis*, stomach complaints, food poisoning, etc. (Kuete *et al.*, 2015). Ngbede *et al.* (2008) reported that, chemical screening of *Canarium schweinfurthii* revealed the presence of secondary metabolites such as saponins, tannins, cardiac glycosides, steroids and flavonoids.

Materials and Methods

Sample collection

Fully ripened African elemi fruits (*Canarium schweinfurthii*), were purchased from Obolo in Enugu state, Nigeria while sugar, iodized salt and vanilla essence were bought from Mile 3 Market in Port Harcourt, Rivers State. Chemicals such as food grade citric acid, vinegar, ascorbic acid, guar gum etc. were of analytical grade and obtained from the Food Analysis Laboratory, Department of Food Science and Technology, Rivers State University, Port Harcourt, Rivers State.

Figure 1: African elemi pear.

African elemi pulp preparation

African elemi fruits were washed under running potable water and deseeded manually to obtain the fruit pulp. The pulps were thereafter pulverized using a food blender (Binatone 5080 MP, UK) at speed 4 and stored in plastic container pending further use.

Formulation of table spread from African elemi pulp

The method described by Akusu *et al.* (2018) with slight modifications was used for the formulation of African elemi spread. The pulps were placed in a clean bowl and the ingredients such as sugar, salt, sodium benzoate as preservative, ascorbic acid, and varying concentrations of guar gum (Table 1). This was then homogenized in a hand mixer (Binatone CA 3090, UK) starting at speed 1 and accelerating to speed 5. Vanilla essence and vinegar were thoroughly mixed and added to the puree. Mixing continued until a smooth paste is achieved. The product was scooped into cleaned transparent glass bottles and stored until required for analysis.

Determination of proximate composition

The moisture, crude protein, crude fibre, crude fat and total ash contents of samples were analysed using the method described by Association of Official Analytical Chemists (AOAC, 2012). Moisture was obtained gravimetrically after drying to a constant weight at 70ºC in a hot air oven (DHG 9140A). Fat was determined using soxhlet extraction method with ethyl ether. Kjeldahl method and a nitrogen conversion factor of 6.25 was used for crude protein determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550°C for 2 h. Enzymatic gravimetric method was utilized in the determination of crude fibre. Carbohydrate was calculated by difference {100 **-** (Crude protein + crude fibre + ash + fat)}.

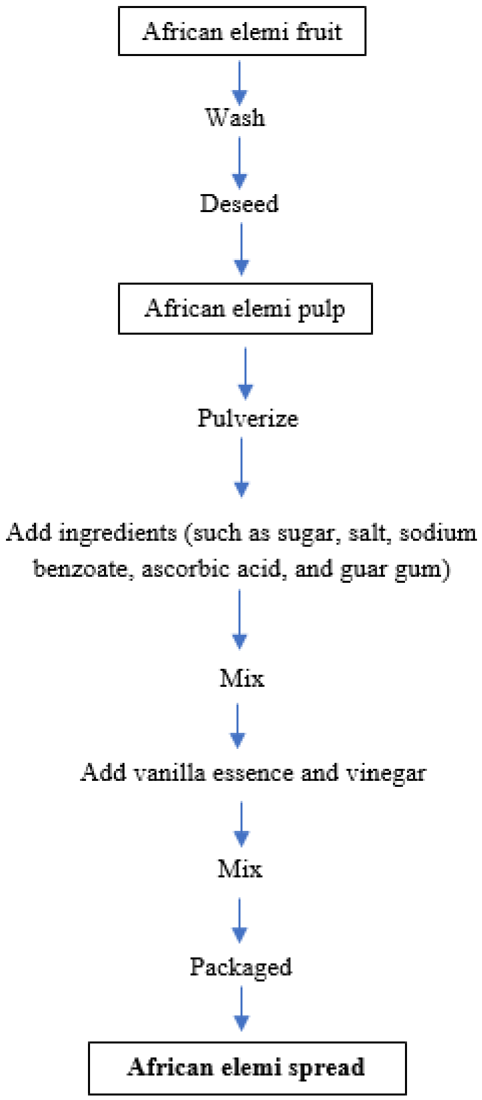

Figure 2: Production of African elemi spread.
Source: Akusu *et al*. (2020) with slight modification

Table 1: Formulation of African elemi spread containing different levels of guar gum

Ingredients	A	B	C	D
African elemi pulp (g)	50.0	50.0	50.0	50.0
Guar gum (g)	-	0.5	1.0	1.5
Vinegar (ml)	4.0	4.0	4.0	4.0
Sugar (g)	5.0	5.0	5.0	5.0
Salt (g)	1.0	1.0	1.0	1.0
Sodium benzoate (g)	1.0	1.0	1.0	1.0
Ascorbic acid (g)	1.0	1.0	1.0	1.0
Vanilla essence (teaspoon)	1.0	1.0	1.0	1.0

Source: Eke-Ejiofor and Pollyn (2020) with modification

Storage stability determination
The samples were packaged in containers and stored at room temperature (29°C) for 4 weeks. Microbiological, free fatty acid (FFA) and peroxide value (PV) analysis were performed on the samples on the first day of production (initial), week 1, week 2, week 3 and week 4.

Microbial analysis
Microbial analysis was carried out using the method described by Jideani and Jideani (2006). Total bacteria counts were determined using nutrient agar (NA) while Saboraud dextrose agar (SDA) was used for the enumeration of total mould counts.

Determination of FFA and PV
The FFA (as oleic) and PV of the spread were determined using titration method as described by AOAC (2012).

Sensory evaluation
A twenty-member semi-trained panelist consisting of students of the Department of Home Science and Management, Rivers State University, Port Harcourt, Nigeria will be used for sensory evaluation. Criteria for selection will be that panelists are above 15 years of age and regular consumers of table spread such as margarine, butter, peanut paste etc. The African elemi spread were evaluated for colour, taste, texture, flavor, spreadability and overall acceptability. Each attribute was rated on a 9-point hedonic scale of 1 to 9 with 1 = disliked extremely while 9 = liked extremely (Iwe, 2010).

Statistical analysis
All the analysis were carried out in duplicate. Statistical analysis was performed using Statistical Package for Service Solution (SPSS), version 26. Data obtained were subjected to Analysis of Variance (ANOVA) and difference between means were compared using Turkey's Multiple comparison tests with 95% confidence level.

Results and Discussion

Proximate composition of table spread produced from African elemi pear
Table 2 shows the proximate composition of table spread produced from African elemi pear with varying quantities of guar gum.
Moisture content of the table spread ranged from 51.69-54.25% with sample D (African elemi spread + 1.5g guar gum) having the lowest while sample A (African elemi spread + 0g guar gum) recorded the highest. There was a significant ($p<0.05$) difference in the moisture content of the samples. Increased in the concentration of guar gum led to a significant ($p<0.05$) decrease in the moisture content of the samples. The decrease in the moisture content could probably be due to the ability of guar gum to increase the viscosity of the samples. The results for moisture content were higher than the values (62.06-62.20%) reported by Akusu *et al*. (2018) for table spreads produced from African pear pulp. The low moisture content in the guar gum spreads indicates a good shelf life for the product, since moisture content affects its stability and overall quality (Folake and Bolanle, 2006).
Ash content of the spreads ranged from 2.48-2.60% with sample a recording the lowest value while sample C (African

elemi spread + 1g guar gum) had the highest value. There was an increase in the ash content of the samples as the concentration of guar gum increased. The results were comparable to the values of 2.60-2.90% reported by Afolabi *et al*. (2018) for peanut butter. It is also within the range of values (2.20-3.56%) obtained by Nwosu *et al.* (2014) for cashew nut and peanut spreads. The result from this study therefore shows that the African elemi table spreads are good sources of dietary minerals needed for most of the physiological processes taking place in the body.

Fat content of the samples ranged from 7.78-10.80% with sample D recording the lowest value, and sample A recording the highest. A significant ($p<0.05$) decrease in the fat content of the table spreads was observed as the concentration of guar gum increased. The decrease in fat content as concentration of guar gum increased could be due to the polysaccharide nature of the gum which is characterized by a high proportion of carbohydrates (Lin *et al*., 2022). The decrease in the fat content is desirable as the potential of rancidity is low. This is a healthy development in the spread world as fat-based spreads from hydrogenated and saturated sources have health implications such as elevated blood cholesterol levels and cardiovascular diseases (Eke-Ejifor and Pollyn, 2020). This means that the African elemi spreads produced may reduce the incidences of fat spread related health challenges.

Crude protein content ranged from 1.75% in sample A to 3.50% in sample B (African elemi spread + 0.5g guar gum). Increase in the concentration of guar gum resulted in a significant ($p<0.05$) increase in the protein content of the samples. The result obtained in this study are lower than 22.92-27.42% reported by Boli *et al*. (2013) for peanut butter sold in retail markets in Cote d'Ivoire. Also, the results were lower than 27.53% reported by Adjou *et al*. (2012) for 100% peanut butter. This could be as a result of difference in raw material.
Crude fibre content of the samples ranged from 9.47% to 9.60% with the lowest value recorded in sample D while sample B had the highest value. There was a decrease in the crude fibre content of the samples as the concentration of guar gum increased. Significant difference ($p<0.05$) however did not exist between the samples. Crude fibre in this study was high when compared to that of cashew nut-chocolate spread (0.10-0.15%) reported by Amevor *et al.* (2018). Crude fibre is the amount of indigestible sugars present in a food sample which has the physiological role of adding bulk to stool, and thus contribute to the maintenance of internal distensions for a normal peristaltic movement (Akinyele and Oloruntoba, 2013).

Carbohydrate content of the samples ranged from 21.24-25.92% with the lowest value recorded in sample A while sample D had the highest value. There was a significant ($p<0.05$) increase in the carbohydrate content of the samples as the concentration of guar gum increased. This may be due to the polysaccharide nature of the gum which is characterized by a high proportion of carbohydrates. The result was comparable to the finding of Asibuo *et al.* (2008) whose carbohydrate content for peanut butter ranged from 20-32%.

Table 2: Proximate Composition (%) of Table Spreads Produced from African Elemi

Samples	Moisture	Ash	Fat	Crude Protein	Crude Fibre	Carbohydrate
A	$54.25^{a}\pm1.65$	$2.48^{a}\pm0.41$	$10.80^{a}\pm0.00$	$1.75^{c}\pm0.00$	$9.57^{a}\pm0.41$	$21.24^{b}\pm0.47$
B	$52.43^{b}\pm1.06$	$2.50^{a}\pm0.56$	$9.67^{ab}\pm0.41$	$3.50^{a}\pm0.00$	$9.60^{a}\pm0.00$	$22.31^{b}\pm1.37$
C	$53.47^{c}\pm2.00$	$2.60^{a}\pm0.56$	$8.80^{bc}\pm0.86$	$2.84^{b}\pm0.31$	$9.54^{a}\pm0.57$	$22.76^{b}\pm1.49$
D	$51.69^{d}\pm1.41$	$2.52^{a}\pm0.31$	$7.78^{c}\pm0.03$	$2.63^{b}\pm0.00$	$9.47^{a}\pm0.41$	$25.92^{a}\pm2.09$

Mean values are of duplicate determinations. Mean values within a column with different superscripts are significantly different at ($p <0.05$).
Keys:
A= African elemi spread + 0g guar gum
B= African elemi spread + 0.5g guar gum
C= African elemi spread + 1.0g guar gum
D= African elemi spread + 1.5g guar gum

Changes in Free fatty acid of African elemi spread during storage

Table 3 shows the changes in free fatty acid (FFA) values of African elemi spread during storage. Initial FFA of the samples recorded 5.73%, 4.60%, 4.21% and 3.91% for samples A, B, C, and D, respectively. The lowest value was recorded in sample D while sample A had the highest value. At weeks 1 and 2, FFA values to range from 5.43% (sample B) to 6.05% (sample A) and 6.50% (sample A) to 7.15% (sample B) respectively. At week 3, FFA ranged from 6.48-7.7.68% with the lowest value recorded in sample D while sample A had the highest value. At the end of the 4th week, FFA recorded 8.10%, 8.15%, 7.35%, and 7.83% for samples A, B, C and D respectively. The lowest value was recorded in sample C while sample B had the highest value. There was no significant ($p>0.05$) difference in the FFA of the samples A, B across the storage weeks. Increase in FFA is an indication that oxidative breakdown occurred in the samples during storage, and this breakdown was high after three weeks of storage. The FFA is the primary quality attribute for edible grade oil/fat (Akusu *et al*., 2018). The Purified Food and Adulteration Act specify a maximum acceptable limit of FFA as 3% for milk fats, margarine ≥ 80% and fat spread <80% (Ranganna, 2005).

Changes in Peroxide value of African elemi spread during storage

Table 4 shows the changes in peroxide value (PV) of African elemi spread during storage. Initial PV of the samples were 8.60 mEq/kg, 4.49 mEq/kg, 8.98 mEq/kg and 6.90 mEq/kg for samples A, B, C, and D, respectively. The lowest value was recorded in sample B while sample C had the highest value. At weeks 1 and 2, PV values range from 5.43 mEq/kg (sample D) to 10.65 mEq/kg (sample B) and 5.50 mEq/kg (sample B) to 9.60 mEq/kg (sample A) respectively. At week 3, the PV ranged from 5.70 mEq/kg (sample D) to 15.52 mEq/kg (sample A), and on the 4th week, the PV recorded were 19.74 mEq/kg, 11.49 mEq/kg, 8.27 mEq/kg, and 8.55 mEq/kg for samples A, B, C and D, respectively. There was an increase in the PV of the spreads during storage with sample A observed to increase sharply. At the end of the storage period, PV of sample A (control sample) was significantly ($p<0.05$) different from all other samples. There was also a significant ($p<0.05$) decrease in the PV as the concentration of guar gum increased. Peroxide value is a useful biomarker of the preliminary stages of rancidity, thus the greater the PV, the faster the oxidation of the fat occurring (Eke-Ejiofor and Pollyn, 2020). Peroxide value for samples C and D during the storage period was less than 10 mEq/kg, indicating that these samples were safe and not prone to oxidative rancidity. According to Akusu *et al*. (2018), rancid taste begins to be noticeable when fat/oil has PV of 10-20 mEq/kg.

Table 3: Changes in Free fatty acid (%) of African elemi spread during storage

Samples	Storage period (Weeks)				
	0	1	2	3	4
A	5.73^{a}±0.84	6.05^{a}±0.65	6.50^{a}±2.04	7.68^{a}±0.31	8.10^{a}±0.24
B	4.60^{ab}±0.23	5.43^{a}±0.56	7.15^{a}±0.23	6.49^{b}±0.17	8.15^{a}±0.21
C	4.21^{b}±0.17	5.75^{a}±0.17	6.88^{a}±0.31	6.52^{b}±0.29	7.35^{b}±0.02
D	3.91^{b}±0.09	5.47^{a}±0.21	6.89^{a}±0.26	6.48^{b}±0.17	7.83^{a}±0.11

Mean values are of duplicate determinations. Mean values within a column with different superscripts are significantly different at ($p<0.05$).

Table 4: Peroxide value (mEq/kg) of African elemi spread during storage

Samples	Storage period (Weeks)				
	0	1	2	3	4
A	8.60^{a}±0.65	9.61^{a}±1.41	9.60^{a}±0.28	15.52^{a}±0.27	19.74^{a}±0.37
B	4.49^{b}±0.70	10.65^{a}±0.91	5.50^{c}±0.42	11.42^{b}±0.41	11.49^{b}±0.16
C	8.98^{a}±0.86	7.04^{b}±0.07	6.49^{b}±0.14	7.33^{b}±0.22	8.27^{c}±0.17
D	6.90^{a}±0.99	5.43^{b}±0.21	8.49^{d}±0.43	5.70^{d}±0.28	8.55^{c}±0.22

Mean values are of duplicate determinations. Mean values within a column with different superscripts are significantly different at ($p<0.05$).

Changes in the Total Bacteria Count of Table Spreads Produced from African elemi

Table 5 shows the changes in total bacterial counts (TBC) of African elemi spread during storage. Initial TBC of the samples were 2.50×10^{4} cfu/g, 1.00×10^{4} cfu/g, 3.00×10^{4} cfu/g and 5.00×10^{4} cfu/g for samples A, B, C, and D, respectively. At weeks 1 and 2, TBC were observed to range from 1.05×10^{5} cfu/g (sample B) to 2.85×10^{5} cfu/g (sample C) and 4.00×10^{5} cfu/g (sample A) to 7.00×10^{5} cfu/g (sample D) respectively. At week 3, TBC ranged from 8.50×10^{5} cfu/g to 2.75×10^{6} cfu/g with the lowest value recorded in sample B while sample C had the highest value. At the end of the 4th week, TBC recorded 2.35×10^{6} cfu/g, 1.20×10^{6} cfu/g, 2.20×10^{6} cfu/g and 2.90×10^{6} cfu/g for samples A, B, C and D, respectively. There was an increase in the TBC of the spreads during storage. At the end of storage period, all the samples had bacteria count of 10^{6}cfu/g. The samples at week 4 was above the microbial limit of $<10^{5}$cfu/g for ready to eat food products (ICMSF, 2002). Thus, the finding of this study showed that samples were within the acceptable limit at week 2 of storage and therefore, the products can only be stored for 2 weeks.

Table 5: Total bacteria count (cfu/g) of African elemi spread during storage

Samples	Storage period (Weeks)				
	0	1	2	3	4
A	2.50×10^{4}	2.35×10^{5}	4.00×10^{5}	1.55×10^{6}	2.35×10^{6}
B	1.00×10^{4}	1.05×10^{5}	4.00×10^{5}	8.50×10^{5}	1.20×10^{6}
C	3.00×10^{4}	2.85×10^{5}	6.00×10^{5}	1.23×10^{6}	2.20×10^{6}
D	5.00×10^{4}	2.10×10^{5}	7.00×10^{5}	2.75×10^{6}	2.90×10^{6}

Mean values are of duplicate determinations. Mean values within a column with different superscripts are significantly different at ($p<0.05$).

Changes in the Total Mould Count of Table Spreads Produced from African elemi

Table 6 shows the changes in total mould counts (TMC) of African elemi spread during storage. Initial TMC of the samples recorded no growth for samples A and B and 1.00×10^{5} cfu/g and 1.50×10^{5} cfu/g for samples C and D, respectively. There was no mould growth at week 1. At week 2, only samples C and D recorded mould growths of 5.00×10^{2} cfu/g and 1.00×10^{3} cfu/g, respectively. At weeks 3 and 4, TMC ranged from 5.00×10^{2} cfu/g (sample B) to 4.00×10^{3} cfu/g (sample A) and 5.20×10^2 cfu/g (sample B) to 6.00×10^3 cfu/g (sample A) respectively. There was increase in the total mould count of the samples during storage. At the end of the storage, the control sample had higher mould count. The low mould count for the samples containing guar gum as compared to control could be due to the ability of guar gum to reduce moisture content in the samples. For food products, the number of moulds must not exceed 10^3 cfu/g (Larissa *et al.,* 2018). Thus, the finding of this study showed that all the samples were within the acceptable limit. The high mould count in the control sample may be due to the presence of residual moisture which provides conducive environment for their growth. Mould growth has been associated with the formation of heat stable mycotoxins which are a major concern of food safety (Dalie *et al.*, 2010).

Table 6: Changes in Total mould count (cfu/g) of African elemi spread during storage

Samples	Storage period (Weeks)				
	0	1	2	3	4
A	NG	NG	NG	4.00×10^3	6.00×10^3
B	NG	NG	NG	5.00×10^2	5.20×10^2
C	1.00×10^3	NG	5.00×10^2	2.50×10^3	1.50×10^3
D	1.50×10^3	NG	1.00×10^3	3.50×10^3	3.50×10^3

Mean values are of duplicate determinations. Mean values within a column with different superscripts are significantly different at ($p < 0.05$).

Sensory Properties of Table Spreads Produced from African elemi

Table 7 shows the mean sensory scores of table spread produced from African elemi. Mean scores for colour of the samples ranged from 6.35-7.80 with sample B as the least liked while sample C was most liked. There was no significant ($p > 0.05$) difference in the colour of samples A, B and D. Taste and flavor of the samples ranged from 5.80 (sample A) to 7.35 (sample C) and 6.00 (sample D) to 6.95 (sample C) respectively. Texture and spreadability of the samples ranged from 6.30 (sample A) to 7.10 (sample C) and 6.90 (sample A) to 7.50 (sample D) respectively. Overall acceptability of the spreads recorded 6.38, 6.53, 7.33 and 6.60 for samples A, B, C, and D respecitively. Sample A was least preferred while sample C as most preferred. Taste of sample C was significantly ($p < 0.05$) different from the control sample. There was an improvement in the colour, taste, flavor, texture and spreadability of the samples as the concentration of guar gum increased. However, increased guar gum did not significantly ($p > 0.05$) increase the texture, flavor and spreadability of the table spreads. This might be due to the properties of guar gum that is odourless and its addition in the food product does not affect the flavour of the product (Featherstone, 2015). The improved texture and spreadability of the table spreads as the concentration of guar gum increased could possibly be due to the thickening and viscosity effect it gave to the samples. An increase in the mean scores for overall acceptability was also observed on as the concentration of guar gum increased. However, no significant ($p > 0.05$) difference was recorded between samples A, B and D. The result from this study therefore showed that the incorporation of 1% guar gum into African elemi spread were acceptable to the panelists and hence can be adopted during the preparation of African elemi spread.

Table 7: Mean sensory scores of African elemi spread

Samples	Colour	Taste	Flavour	Texture	Spreadability	Overall Acceptability
A	6.35^b±2.00	5.80^b±1.94	6.55^a±1.54	6.30^a±2.00	6.90^a±1.29	6.38^b±1.08
B	6.30^b±1.45	6.20^{ab}±1.51	6.50^a±1.79	6.65^a±1.66	7.00^a±1.81	6.53^{ab}±1.10
C	7.80^a±1.10	7.35^a±1.04	6.95^a±1.82	7.10^a±1.02	7.45^a±1.28	7.33^a±0.77
D	6.95^{ab}±1.82	6.00^{ab}±2.20	6.00^a±2.29	6.55^a±1.70	7.50^a±1.50	6.60^{ab}±1.35

Mean values within a column with different superscripts are significantly different at ($p < 0.05$) (n=20)

Conclusion

The result of this study showed that the incorporation of guar gum in the preparation of African elemi spread decreased the moisture and fat content while increasing the ash, crude protein and carbohydrate content. There was an increase in the free fatty acid and peroxide values of the spreads during storage while increase in the concentration of guar gum led to decrease in these parameters. At the end of storage, all the samples had free fatty acid values above 0.20% which is the allowable limit for free fatty acids. On the other hand, peroxide values of samples incorporated with 1.0 and 1.5g guar gum were within the acceptable limit during storage. Total bacterial count was above the recommended standard after storage; however, it was below limit up to the 3rd week of storage. Mould after 14 days of storage were within the recommended standard. The control sample had higher mould count than the samples incorporated with guar gum. The incorporation of guar gum also improved the colour, taste, texture, spreadability and overall acceptability of the samples. This was significant for samples incorporated with 1g guar gum. This study therefore demonstrated the potential of African elemi for the production of an acceptable and healthy spread as well as the use of guar gum in improving the quality of the spread.

Competing interests

The authors report no conflicts of interest.

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