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Proximate, Mineral, Antinutritional Composition and Antioxidant Properties of Formulated Cocoa Spread Enriched with Date Palm Fruit (*Phoenix Dactylifera*) and Nuts

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ABSTRACT

This study was conducted to formulate and evaluate the proximate, mineral, antinutritional composition and antioxidant properties of cocoa spread enriched with date palm and commonly consumed nuts. Spread was produced from cocoa powder (25.0%), groundnut or cashew nut (73.6%) and date syrup (1.4%); and analyzed for proximate composition, antioxidants, antinutrients and sensory quality using standard procedures and compared with a Commercial Peanut Butter (CPB). Protein (25.56%; 24.86%) and ash (2.44%; 2.56%) for groundnut and cashew nut spreads, were higher ($P<0.05$) than CPB (21.60%; 2.33%), respectively. Fat (40.92%; 40.95%) and energy content (555.70 kCal/100g; 553.16 kCal/100g) were similar in groundnut and cashew nuts spread but lower compared to CPB (43.56%) and (569.77 kCal/100g). Spread produced from cocoa, dates and groundnut or cashew nuts blends are rich in flavonoids and phenolics. Flavonoids (9.90; 13.43 mg quercetin/100g) and 2,2-diphenyl-1-picrylhydrazyl radical (DPPH*) (17.57; 20.59%) were significantly different while phenolics (16.90; 16.22 mg gallic acid/100g) and Ferric ion reducing antioxidant potential (FRAP) contents (8.98; 8.29 mg Fe^{2+}/100g) in groundnut and cashew nuts samples, respectively. Phytate, tannins, oxalate and saponin compositions were 0.30-0.37, 3.21-5.92, 3.81-4.29 mg/100g and 0.10-0.26mg/g in groundnut and cashew nuts spreads, respectively. Although, CPB had the highest overall acceptability score, the formulated spreads using groundnut and cashew also had some level of acceptability that could be improved on in subsequent product development exercise.

Keywords: Bioresources, cocoa processing, healthy spreads, spread enrichment

1.0 Introduction

Consumption of good quality diets is impeded in both developed and developing countries following urbanization, busy work schedule and poor nutritional quality of some processed foods including spreads. There is the need to strengthen the food system to promote good health by improving on the nutritional composition of common foods and foods accompaniments. A spread is a food accompaniment like margarine, cheese, butter, jams, jellies, marmalades, vegemite and marmite smeared and added to food to enhance flavor or texture (Amevor *et al.,* 2018; Shakerardekani *et al.,* 2013).

Many of these spreads are energy-dense and nutrient-poor and therefore associated with rising incidence of diet-related non-communicable diseases. Also, increased awareness of diet-disease nexus has heightened consumers' demand for healthier products characterized by low refined sugar, salt, fat, and cholesterol (Alimi *et al.,* 2017). Therefore, a formulation of a spread low in sugar and salt, and rich in micronutrients and bioactive compounds is considered a step-forward in enriching the food system, reducing diet-related non-communicable diseases and thereby reducing health care cost and burden. Subsequently, the combination of cocoa and nuts (groundnuts or cashew nuts) following their high nutritional qualities with date palm fruits following its sweetening and thickening properties is considered a good choice.

Cocoa *(Theobroma cacao)* is widely cultivated in West Africa sub-region, however its application in foods remains limited to chocolates, cakes, biscuits, complementary foods, ice cream and sweets (Anvoh *et al.,* 2009). It constitutes a good source of macronutrients, essential minerals and flavonoids particularly flavan-3-ols and their oligomeric derivatives, procyanidins, and could therefore promotes cardiovascular health and optimum functioning of biologic systems (Steinberg *et al.,* 2003). Though cocoa is rich in lipids, stearic acid constitutes one-third of these lipids and exerts a neutral cholesterolemic response in humans (Kris-Etherton *et al.,* 1993).

Nuts are rich sources of plant protein, healthy oils, certain bioactive compounds and generally enhance flavors and tastes of foods (Ros, 2010; Ogunwolu *et al.,* 2015; Abubakar *et al.,* 2018). Groundnut (*Arachis hypogaea*) and cashew nuts (*Anacardium occidentale* L.) are widely grown in Nigeria; however, they are seldomly found in daily diets (Ogunwolu *et al.,* 2015).

Date palm fruit *(Phoenix dactylifera)* is a crop of food security importance in Africa and is considered beneficial in the development of value-added healthy food products following its nutritional value and phenolic antioxidant contents (Sani *et al.,* 2016; Ashraf and Zohreh, 2011; Horowitz, 2013). It is rich in fiber and serves as an alternative to refined sugar in food development (Sani *et al.,* 2016).

These crops are considered complementary in their nutritional composition and could therefore lead to the development of healthier alternative of spread in West Africa sub-region. Hence, this study was designed to formulate and evaluate the proximate, mineral, antinutritional composition and antioxidant properties of cocoa-based spread enriched with date palm and common nuts (groundnut and cashew nut).

2.0 Materials and Methods

2.1 Materials

Date palm fruit, groundnut, cashew nuts, cinnamon powder and vinegar were procured from Bodija Market, Ibadan; and cocoa pods were obtained from a farm settlement in Apomu, Nigeria. All chemicals used were of analytical grade.

2.2 Methods

Cocoa beans were extracted and sun-dried on a wooden box at 28 °C, 40 % relative humidity for 2 h and then fermented for 5 days at 48 °C using the basket method (Ogunsina *et al.*, 2017). Fermented beans were air-dried for 7 days, sorted to remove extraneous materials and processed to powder using method of Ogunsina *et al.*, (2017).

Date palm fruits were cleaned, sorted, de-pitted and dried in an oven (Sanyo Gallenkamp PLC UK) at 60 ± 1 °C for 12 h. Dried samples were cooled, grounded using an electric blender (Philips HR7762 Model) for 2 min and then sifted in a steel mesh sifter (0.85 mm) to obtain fine homogenized date powder (Alsenaien *et al.*, 2015), and stored in a high density polyethylene bags at 25 ± 2 °C. Groundnuts and cashew nuts were separately pre-cleaned, shelled, graded and heated at 60 °C for 10–15 min using a kitchen hot plate (Amevor *et al.*, 2018; Gorrepati *et al.*, 2015). Roasted nuts were then sorted.

2.3 Preparation of Spread

Cocoa-date-cinnamon blends/Groundnut/Syrup ratio 25.0:73.6:1.4 (CGS) and Cocoa-date-cinnamon blends/Cashew-nut/Syrup ratio 25.0:73.6:1.4 (CCS) were prepared and compared to Commercial Peanut Butter (CPB) sample. For each sample, the nuts and mixture blends were weighed into a parchment lined baking sheet and syrup was added slowly until the nuts were evenly coated. Ingredients were thoroughly mixed, pre-heated at 175 °C in an oven for 5 min and then blended in a food processor (Philips HR7762 Model) to homogenize for 20 min. Spreads were then poured into sterilized storage containers pasteurized in a water bath at a temperature of 100 °C for 5 min, sealed and labeled accordingly.

2.4 Proximate analysis

The proximate composition (moisture, ash, protein, fat, crude fibre and carbohydrate) of the spreads was determined using the standard methods of the Association of Official Analytical Chemists (AOAC, 2005).

The energy value was determined by multiplying the proportion of protein, fat, and carbohydrate by their respective physiological energy values and taking the sum of the products (Eneche, 1999; Farzana and Mohajan, 2015).

2.5 Mineral Analysis

The minerals and trace element compositions were determined by the method described by AOAC (2005) (Method No 975.23). Calcium, selenium, iron and zinc contents were determined using Buck Scientific – 210VGP Atomic Absorption Spectrophotometer. The ash of each sample obtained was digested by adding 5 ml of 2 MHCL to the ash in the crucible and heat to dryness on a heating mantle. 5 ml of 2 MHCL was added to boil and filtered through a Whatman No. 1 filter paper into a 100 ml volumetric flask. The filtrate was then made up to mark with distilled water and made ready for reading of concentration, by aspirating the diluent into the AAS and reading each of the mineral elements at their respective wavelengths with their respective hollow of

Ibadan community, with basic knowledge of food sensory assessment and use of spread within the last two weeks. About 25 g of coded spread samples were randomly served alongside slices of bread in clear white disposable flat plates. Each panelist was provided with a glass of clean water to rinse their mouths between the evaluation sessions of 4 min interval. Evaluation was based on a 9-point hedonic scale from 1 = extremely dislike to 9 = extremely like (Lawless and Heymann 2010).

2.6 Statistical Analysis

All analyses were carried out in triplicates and data obtained were subjected to One Way Analysis of Variance (ANOVA), using Statistical Package for Social Sciences (SPSS version 20.0 Inc. Chicago, Illinois, and U.S.A). Values were expressed as percentage and mean ± SD. Duncan's New Multiple Range Test (DNMRT), was used to separate means at 5 % level of significance.

3.0 Results and Discussion

3.1 Proximate Composition of the spread samples

The proximate composition of the spread samples is presented in Table 1. The moisture content of the formulated samples ranged from 5.96 – 6.30 %, compared to 7.56 % in commercial peanut butter. The protein content was 25.56 % and 24.86 % in groundnut and cashew nut based cocoa spreads and higher than 21.60 % in commercial peanut butter. These values are indicative of high protein content in the samples. Fibre content was higher in cocoa spread with cashew nut (4.08 %) than cocoa spread with groundnut (3.84 %), however, both formulations had significantly higher fibre content than the commercial peanut butter (2.11 %). cathode lamps.

3.2 Determination of antioxidant

Total phenol content (TPC) was determined using the Folin-Ciocalteu's reagent method reported by Pyrzynska and Pekal (2014) by mixing 1 ml of the sample was with 1 ml (10 %)

Table 1 Proximate composition of spread samples

Proximate composition	CGS	CCS	CPB
Moisture (%)	5.96 ± 0.38^a	6.30 ± 0.37^a	7.56 ± 0.87^b
Crude fat (%)	40.92 ± 0.36^a	40.95 ± 0.46^a	43.56 ± 0.06^b
Crude protein (%)	25.56 ± 0.12^c	24.86 ± 0.15^b	21.60 ± 0.15^a
Crude fibre (%)	3.84 ± 0.55^b	4.08 ± 0.43^b	2.11 ± 0.20^a
Ash (%)	2.44 ± 0.05^a	2.56 ± 0.11^a	2.33 ± 0.29^a
Crude carbohydrate (%)	21.28 ± 0.10^a	21.28 ± 0.19^a	22.84 ± 0.36^b
Energy (kcal/100 g)	555.70 ± 3.24^a	553.16 ± 2.92^a	569.77 ± 1.17^b

Spread formulations from Cocoa-date-cinnamon blends/Groundnut/Syrup (CGS), Cocoa-date-cinnamon blends/Cashew-nut/Syrup (CCS) and Commercial Peanut Butter (CPB)

Data are represented as means of triplicate determinations ± standard deviation

*Wet weight basis

Means in the same row with the same superscript are not significantly different at ($p \geq 0.05$)

of Folin-Ciocalteu phenol reagent. After 5 min, 5 ml of 7 % sodium carbonate was added, followed with 5ml of distilled water. The mixture was left in the dark at room temperature for 90 minutes and the absorbance was measured at 750 nm and the TPC was evaluated from gallic acid (GAE) standard curve.

For total flavonoid content determination (TFC), 0.3 ml (1mg/ml) of the sample was mixed with 3.4 ml of (30 %) methanol, 0.15 ml of (0.5 M) sodium nitrite and 0.15 ml of (0.3 M) aluminium chloride consecutively. After 5 mins, 1 ml of 1M sodium hydroxide was added to the reaction mixture and the absorbance was measured at 506 nm. TFC was evaluated from quercetin (QUE) standard curve (Pyrzynska and Pekal 2014).

2,2-diphenyl-1-picrylhydrazyl radical (DPPH*) was determined and calculated according to the method described by Pyrzynska and Pekal (2013), by adding the samples to the DPPH* solution at the final concentration of 1 mg/ml. After incubation at 37 °C for 30 min, the activity was monitored by a decrease in an absorbance at 520 nm.

Ferric ion reducing antioxidant potential (FRAP) was determined according to the method reported by Benzie and Choi (2014). The FRAP working reagent was freshly prepared by mixing solutions of 25 ml acetate buffer, 2.5 ml TPTZ solution, and ferric chloride in ratio 10:1:1 and warmed at 37 °C before use. Samples (0.2 ml) were mixed with 2.80 ml of the FRAP reagent and the mixtures were kept in the dark for 30 min at room temperature. The absorbance was read at 593 nm and FRAP was evaluated from ferrous sulphate standard curve and expressed as (mg Fe^{2+}E/100g).

3.3 Determination of anti-nutrients

Phytate was determined by the method of Reddy and Love (1996). Two gram (2 g) of samples were soaked in 100 ml of 2 % HCl for 3hrs and then filtered. The filtrate (25 ml) was placed in a 100 ml conical flask with 5ml of 0.03% NH_4SCN solution as indicator. About 50ml of distilled water was added to give it the proper acidity. This was titrated with ferric chloride solution containing 0.005mg of Fe^{3+} per ml. The phytate content in mg/100g was calculated. Oxalate was determined according to the method of Munro (2000) and saponin was by the method of Makkar and Becker (1996). Tannin content was determined by the modified method of Jaffe (2003), by adding 0.5 ml of 0.5 M ferric solution to 0.5 ml of the sample and allowing it to stand for 30 min for colour development. The absorbance was read at 760 nm and the amount of tannin was calculated from a tannin standard calibration curve.

3.4 Sensory evaluation

Ethical clearance was obtained prior to sensory evaluation. The study was approved by the University of Ibadan/University College Hospital, Ibadan Ethics Committee (UI/EC/19/0644)..The spreads were coded and sensory attributes including colour, aroma, taste, mouth feel, spread-ability, aftertaste, and overall acceptability were evaluated by thirty untrained panelists drawn from the University

Likewise, ash was highest in cocoa spread with cashew nut (2.56 %), compared to 2.44 % and 2.33 % in cocoa spread with groundnut and commercial peanut butter, respectively. Carbohydrate content of the samples were significantly different ($p < 0.05$), though slightly lower in formulated samples when compared to the commercial product. The energy value of the samples varied from 553.16 kcal/100 g for CCS to 569.77 kcal/100 g for CPB and was significantly different ($p < 0.05$) when compared to the commercial spread.

Moisture content affects physical and chemical properties of a food including the structure, appearance and taste. In addition, it is important in determining the food's susceptibility to spoilage, shelf life and the processing and packaging conditions required. High moisture content in spreads favours the growth and proliferation of microorganisms and may cause rancidity and off-flavours (Shakerardekani *et al.,* 2013). The lower moisture content in the formulated samples suggests a better storability and longer shelf life than the commercial peanut butter. The high protein content of the samples could be attributed to the addition of nuts to the blends. The protein contents of groundnuts and cashew nuts were 23.68 g and 18.2 g per 100 g, respectively and are noted to contain essential amino acids necessary for normal body growth and metabolism (Emilio, 2010; Settaluri, 2012). The high protein content of the spread could contribute in filing some of the gaps in dietary protein in various population age groups in developing countries like Nigeria and prevent malnutrition (El Hassan *et al.,* 2004; Shetty, 2006). Fibre is known to enhance digestion and reduce the risk of constipation and colon cancer (O'Keefe, 2019). The increase in fiber can be attributed to the presence dates in the mixture; since dates are known to possess significant fibre contents (Ashraf and Zohreh, 2011). Ash refers to the inorganic residue remaining after oxidation of organic matter in a food sample and is a measure of the total amount of minerals present, explaining the significant increase observed in mineral contents of the samples.

Cocoa has been reported to be an excellent source of many essential minerals especially calcium, manganese, magnesium, phosphorus, potassium, copper, iron and zinc that are of public health importance (Robert, 2009). The reduction in carbohydrate contents of the formulated samples may be largely due to the utilization of date palm fruits; a more healthy alternative, in place of added refined sugars which are associated with higher risk of cardiovascular diseases (Briggs *et al.,* 2017). The formulated spreads turned out to be energy-reduced products. The results of this study suggest that formulated spreads are good source of protein and fibre with reduced energy value.

3.5 Mineral and bioactive compounds of the spread samples

The mineral composition of the samples (Table 2) showed that iron and calcium were the most abundant elements in the samples, showing higher values than the commercial peanut butter spread in all the minerals. The result reflects that spreads are poor sources of minerals and this requires re-evaluation considering the widespread of micronutrients deficiencies in developing countries. The importance of calcium in bone and teeth development is well-known (Oladele and Aina, 2007). Inadequate intakes of iron, zinc and selenium have been associated with severe malnutrition, increased disease conditions, and mental/ cognitive impairment (Wardlaw, 2004; Mannay *et al.,* 2015).

The formulated samples are richer in antioxidants such as phenolics and flavonoids, DPPH* radical scavenging activity and FRAP than in the commercial peanut butter. Phenolics was higher in cocoa spread with groundnut (16.9 mg GAE/100 g) and cashew nut (16.2 mg GAE/100 g) than in the commercial peanut butter; flavonoids was highest in cocoa spread with cashew nut (13.4 mg QUE/100 g) than cocoa spread with groundnut (9.9 mg QUE/100 g) and commercial peanut butter (4.7 mg QUE/100 g).

The cocoa spread with groundnut (20.6 %) had higher DPPH* scavenging activity than both cocoa spread with cashew nut (17.6 %) and peanut butter (10.5 %). Similar trend was observed for FRAP, higher in cocoa with groundnut (9.0 mg Fe^{2+}/100 g) than cocoa with cashew (8.3 mgFe^{2+}/100 g) and commercial peanut butter (1.4 mg Fe^{2+}/100 g). An exceptional antioxidant activity could be related to the high amounts of antioxidative compounds contained in cocoa powder, which is a rich source of polyphenols and flavonoids. These results are important because oxidative processes that are precursors of several chronic non-communicable diseases can be avoided by the use of antioxidant substances that have the property of preventing or reducing the triggering of unwanted reactions (Dillinger *et al.*, 2000).

Table 2 Minerals composition and antioxidant capacities of spread samples

Property	CGS	CCS	CPB
Selected mineral composition (%)			
Zinc	0.003 ± 0.0005^b	0.005 ± 0.0005^c	0.001 ± 0.0005^a
Iron	0.240 ± 0.0057^c	0.181 ± 0.0057^b	0.140 ± 0.0057^a
Iodine	0.020 ± 0.0005^b	0.021 ± 0.0001^c	0.013 ± 0.0001^a
Selenium	0.009 ± 0.0001^b	0.010 ± 0.001^c	0.002 ± 0.0001^a
Calcium	0.092 ± 0.0001^b	0.101 ± 0.0001^c	0.045 ± 0.0001^a
Antioxidant capacities			
Phenolics (mg GAE/100 g)	16.90 ± 0.62^b	16.22 ± 0.32^b	12.27 ± 0.49^a
Flavonoids (mg QUE/100 g)	9.90 ± 0.59^b	13.43 ± 0.55^c	4.72 ± 0.65^a
DPPH* (%)	20.59 ± 0.51^c	17.57 ± 1.37^b	10.46 ± 1.02^a
FRAP (mg Fe^{2+}/100 g)	8.98 ± 0.24^b	8.29 ± 0.49^b	1.38 ± 0.24^a

Spread formulations from Cocoa-date-cinnamon blends/Groundnut/Syrup (CGS), Cocoa-date-cinnamon blends/Cashew-nut/Syrup (CCS) and Commercial Peanut Butter (CPB)

Data are represented as means of triplicate determinations ± standard deviation

Means in the same row with the same superscript are not significantly different at ($p \geq 0.05$)

Cocoa spread with groundnut and cashew nuts could contribute to dietary intake of these minerals. A hundred gram may contain 20 g polyphenolics, (mostly anthocyanidins, proanthocyanins, and other catechin derivatives); and theobromine of about 2 - 3 g (Badrie *et al.*, 2015).

Furthermore, dates are good sources of antioxidants and possess free phenolic compounds, which are retained and increase significantly even after sun drying fresh dates (Ashraf and Zohreh, 2011). These attributes may have contributed to the significantly higher antioxidant content in the samples when compared to commercial peanut butter. This is in line with the findings of Ackar *et al.* (2013). The high antioxidant activities of the enriched spread samples support the claims that cocoa-rich products may be regarded as functional foods and could enrich human diets with certain bioactive compounds. The results obtained for phenolics (measured by the *Folin Ciocalteau* method), revealed high contents in the developed spread, when compared to commercial product. This indicates that the inclusion of constituents for the production of the developed spreads and exclusion of constituents may have reduced the presence of phenolic compounds in the commercial spread product. This is in agreement with the study by Campidelli *et al.*, (2020) and this could largely be due to the drying process of oilseeds, which provides exposure and increases in the availability of these phenolic compounds (Lemos *et al.*, 2012), as well as the connection with other substances such as cocoa, which stands out for its considerable presence of polyphenols (Giacometti *et al.*, 2016), may contribute to the increase in these molecules. The results presented in this study are in agreement with previously reported data. It has been proposed that antioxidant capacity of cocoa correlated to a high degree with the content of its main catechin (Miller et al., 2009). According to Hernández- Hernández *et al.*, (2018), the presence of phenolic compounds in cocoa conferred the antioxidant properties, and reduced the formation of free radicals which are viable in the process of development of non-transmissible chronic degenerative diseases. The high presence of these substances in foods is therefore important because they attribute health benefits due to the broad spectrum of medicinal properties they present and from this study, it can be noted that spreads processed using the constituents and method stated can be considered food sources of phenolic compounds. The high antioxidants composition suggest that the spreads could be beneficial in reducing the risk of cerebrovascular flow (CBF) dementia (Francis *et al.*, 2006), stroke (Fisher *et al.*, 2006), alzheimer's disease (Sorond *et al.*, 2008), and increase blood flow and blood oxygenation level-dependent response (Patel *et al.*, 2008).

3.7 Antinutrient content of the spread samples

Phytate content was 0.37 mg/100 g (Table 3) in cocoa spread with groundnut and similar in cocoa spread with cashew nut (0.30 mg/100 g) and commercial peanut butter (0.30 mg/100 g) (Table 3). Tannins and oxalate were highest in cocoa spread with groundnut (5.92; 4.29) compared to cocoa spread with cashew nut (3.21; 3.81 mg/100 g) and commercial peanut butter (4.65; 3.39 mg/100 g).

The antinutrients values in this study are lower than a total permissible content of 386 - 714 mg/100 g, 1.8 – 18 mg/100 g, 106 – 170 mg/100 g and 40 – 490 mg/100 g, for phytate, tannins, saponins and oxalates respectively for nuts (Kumari, 2018). Antinutrients are valuable active compounds in foods and are found in plant-based foods. When at low levels, phytate, and saponins have been shown to reduce blood glucose and /or plasma cholesterol and triglycerols (Popova and Mihaylova, 2019). Nuts are nutrient-dense, containing useful amounts of fatty acids, vitamins, minerals, and a number

Table 3 Antinutrient composition of spread samples

Property	CGS	CCS	CPB
Antinutrient composition			
Phytate (mg/100 g)	0.37 ± 0.07[a]	0.30 ± 0.03[a]	0.30 ± 0.04[a]
Tannins (mg/100 g)	5.92 ± 0.72[c]	3.21 ± 0.53[a]	4.65 ± 0.21[b]
Saponins (mg/g)	0.10 ± 0.01[a]	0.26 ± 0.01[b]	0.10 ± 0.03[a]
Oxalate (mg/100 g)	4.29 ± 0.23[b]	3.81 ± 0.23[ab]	3.39 ± 0.34[a]

Spread formulations from Cocoa-date-cinnamon blends/Groundnut/Syrup (CGS), Cocoa-date-cinnamon blends/Cashew-nut/Syrup (CCS) and Commercial Peanut Butter (CPB)

Data are represented as means of triplicate determinations ± standard deviation

Means in the same row with the same superscript are not significantly different at ($p \geq 0.05$)

Also, it was reported that tannin-rich cocoa products can be considered as functional food which effectively antagonizes adverse effects of arsenic intoxication (Chandranayagam *et al.*, 2013). The tannins observed in considerable amounts in all the spreads indicated that the type of oleaginous seed (nuts) contributed to the presence of these molecules.

According to Efraim *et al.* (2011) and Campidelli *et al.* (2020), nuts and cocoa, which were the major ingredients in all the spreads, are considerable sources of minerals. Cocoa seeds contain a complex series of procyanidins, formed from the condensation of individual units of catechins or epicatechins (called monomers) which are responsible for the formation of tannins in this food (Efraim *et al.*, 2011). Tannin compounds are considered a potent antioxidant and have antimutagenic and anticancer properties (Chu *et al.*, 2016) and are therefore beneficial when consumed in correct dosages. However, since oilseed consumption generally does not occur in natural form (mainly due to the sensorial aspect it presents in this condition), the process of drying them (which was the primary stage of processing) becomes an important step in the development of sensory aspects and reduction in unhealthy substances. The toxicity of oxalates and phytates for humans is set at 2 – 5 g/day and the consumption of diet rich in these antinutrients may result in kidney disease. The antinutrient levels of the spread in this study are negligible and hence, regarded as safe for human consumption.

3.8 Sensory properties of the optimized and control spread samples

The result of the sensory evaluation as shown in Table 4 depicts the preference of the panelists for the spread samples. Commercial peanut sample had the highest preference for colour, with a mean value of 7.00 and was significantly different ($p < 0.05$) from CCS (6.63) and CGS (6.60). Aroma of the formulated CGS (7.00) and CCS (6.86) spread were better than commercial peanut butter. Panelists did not observe any significant difference among the taste, mouth feel, aftertaste and overall acceptability of different samples. On the other hand, significant differences ($p < 0.05$) were observed amongst sample preferences for spreadability. The average spreadability score ranged between 5.73 and 6.76.

The aroma of the formulated spreads can be attributed to the aromatic properties and strong fragrance of cocoa and cinnamon (Rao and Gan, 2014). Furthermore, the roasted nutty flavor is a major attribute used to characterize the typical roasted nut flavor in nut products (Grosso and Resurreccion, 2002). The essential aroma components of roasted peanut are given by compounds such as the furanthiol and pyrazine derivatives (Kaneko *et al.*, 2013).

The basic fat molecular crystal network in spreads with added nuts influenced many of the sensory attributes such as spreadability, texture and mouth feel (Matsiko *et al.*, 2015). The scores observed for spreadability was in agreement with the report of Shakerardekani *et al.*, (2013) and Amevor *et al.*, (2018) that easily spreadable products are preferred. From the result obtained on the sensory evaluation of the spread samples, formulated spreads will have high acceptability when introduced into the market.

4.0 Conclusions

The cocoa, groundnut or cashew nut formulated spreads had higher proximate, selected minerals, flavonoids and total phenolic compositions than the commercial peanut butter. Also, the DPPH radical scavenging activity and ferric ion reducing antioxidant potential were higher than that of the commercial peanut butter. Therefore, the addition of cocoa enhanced the concentration of antioxidants in the formulated spreads. The formulated spread samples were also generally acceptable by panelists though commercial pea nut spread had higher general acceptability. It is hereby recommended that in subsequent product development exercise, the formulated spreads should be improved upon to find additional food application for cocoa, groundnut, cashew nut. The adoption would enhance the utilization of these local bioresources.

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Table 4 Sensory acceptability of the spread samples

Sample	Colour	Aroma	Taste	Mouth feel	Spreadability	Aftertaste	Overall Acceptability
CGS	6.60 ± 1.19^{ab}	7.00 ± 1.23^{b}	6.76 ± 1.30^{a}	6.72 ± 1.53^{a}	5.73 ± 1.91^{a}	6.40 ± 1.40^{a}	6.87 ± 1.16^{a}
CCS	6.63 ± 1.31^{a}	6.86 ± 0.86^{b}	6.50 ± 1.63^{a}	6.63 ± 1.40^{a}	6.30 ± 1.11^{ab}	6.40 ± 1.28^{a}	6.73 ± 1.31^{a}
CPB	7.00 ± 1.05^{b}	6.13 ± 1.45^{a}	6.96 ± 1.18^{a}	6.96 ± 0.96^{a}	6.76 ± 1.13^{b}	6.80 ± 1.21^{a}	7.20 ± 0.92^{a}

Spread formulations from Cocoa-date-cinnamon blends/Groundnut/Syrup (CGS), Cocoa-date-cinnamon blends/Cashew-nut/Syrup (CCS) and Commercial Peanut Butter (CPB)

Data are represented as means of triplicate determinations ± standard deviation

Means in the same row with the same superscript are not significantly different at ($p \geq 0.05$)

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