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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Sensory evaluation, nutrient composition and microbial load of cashew nut–chocolate spread

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Abstract: The purpose of the study is to evaluate the potential of cashew nut as a substitute in the production of chocolate spreads. Spread was produced from cashew nut slurry (CNS) and cocoa powder (CP). Formulations ranged from 75% to 95% CNS: 5% to 25% CP. Sensory evaluation was carried out on the samples. Two most preferred samples, B (90% CNS: 10% CP), E (75% CNS: 25% CP), and a control sample were re-analysed for their pH, total soluble solids (TSS), microbial load, proximate and mineral compositions. TSS and pH of samples ranged from 4.45 °Brix to 5.30 °Brix and 6.25 to 6.41, respectively. Protein content of the two samples was 10.36% and 12.47%, ash was 1.69% and 1.85% and fibre content was 0.15% and 0.11% for sample E and B, respectively, which were all significantly ($p < 0.05$) higher than the control sample. Fat content was highest in sample B (51.25%). Carbohydrate content ranged from 33.43% to 45.81%, with the control sample having the highest. The cashew nut spread samples had the highest mineral compositions. Magnesium ranged from 17.50 to 27.04 mg/100g, sodium from 5.00 to 26.00 mg/100g and potassium from 2.50 to 22.00 mg/100g. Total plate count of samples ranged from 250 to 350 cfu/g while yeast and mould were less than 10 cfu/g. Production of cashew nut/chocolate composite spread, would increase the food uses of cashew nuts and

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PUBLIC INTEREST STATEMENT

Cashew nut is consumed in Ghana but only roasted. In order to diversify its consumption and make available its nutrients to consumers, there is a need to identify some other uses for the nut. This study therefore developed a spread from a combination of cashew nut and cocoa. The product was well accepted and could add on to nut spreads on the market. Commercializing this product will encourage the utilization of cashew nuts in Ghana, preventing postharvest losses. Farmers will be encouraged to produce cashew nuts on a large scale to ensure that there is regular availability of the raw material for processing, resulting in increment in farmers' income, creation of employment, thereby reducing poverty. The country at large will have both nuts and a value added product from the raw material for export which will contribute greatly to foreign exchange.

encourage utilization of the nuts; thereby contributing to reducing postharvest losses as well as contribute to food security.

Subjects: Sensory Science; Food Analysis; Food Microbiology; Product Development

Keywords: Cashew nut slurry; cocoa powder; chocolate; healthy spreads; nutrition

1. Introduction

Cashew is an important commodity to the Ghanaian community. It has provided employment to over 8000 people in the Brong Ahafo region of Ghana (Sarpong, 2011). Though cashew is an important commodity crop with increasing cultivation in Ghana, the crop is challenged with problems such as, low and variable nut yields, low kernel out-turn percentage and susceptibility to insect pests and diseases (Dwomoh, Afun, & Ackonor, 2008; Topper et al., 2001). As a result many of the nuts deteriorate and have to be thrown away. The few that farmers are able to salvage receive low prices from buyers as they believe the nuts have lost their usefulness (Sarpong, 2011).

Farmers who cultivate cashew are gradually being discouraged from producing cashew nuts. In no time the industry may collapse if measures are not put in place to deal with the situation (Sarpong, 2011). The government of Ghana is supporting the cashew nut industry by exporting most of the nuts produced leaving just a few in the country for consumption by the Ghanaian people. Though this is a step in the right direction it is not enough to keep the industry running. Processing the nuts into finished goods that can be stored for a longer time and also exported to earn foreign exchange will go a long way to promote the use of cashew nut, hence encourage farmers to produce more nuts, preferably on a commercial scale so as to sustain the industry.

One area of processing of cashew nut which has not received much attention in Ghana is using them in breakfast products that can be used in many households. An example of such a product is the cashew nut-chocolate spread. A spread is a food that is literally smeared onto bread, crackers and other pastry products. It is often made from fruits, nuts, milk, fat, chocolate to obtain cheese, butter/margarine, jam/jellies and chocolate spread. Nut spreads are spreadable products made from nuts that are ground into paste (almond, cashew, hazelnut, peanut and walnut; Shakerardekani, Karim, Ghazali, & Chin, 2013).

Increasing search for healthier foods has led to the substitution of animal-based foods with plant-based foods (Chitarra & Chitarra, 2005). Consumers of today are looking for products that provide more health benefits and because of which a sharp increase in consumer awareness and interest about the health-enhancing roles of specific foods or food components has been observed (Jnawali, Kumar, & Tanwar, 2016). Many households use margarine as spread but due to concerns raised by health practitioners about the trans-fats in margarine, its consumption is being discouraged. Cashew nuts, on the other hand, are rich in macro- and micronutrients, phytochemicals, tocopherols and phenolic compounds. In addition, profiling the nutritional composition of nuts showed that they are rich in unsaturated fatty acids, fibre, minerals and proteins which makes them healthy foods (Chen, Lapsley, & Blumberg, 2006). Moreover, their consumption is associated with a reduced risk of cardiovascular diseases and diabetes which are on the rise in today's society (Heinig, 2006). They contain essential fatty acids which are necessary for the proper functioning of the body and play an important role in the regulation of several metabolic, transport and excretion processes (Soares et al., 2013).

The development of a nut spread has potential to improve the food uses of cashew nuts and introduce consumers to a healthier, breakfast or snack food (Shakerardekani & Karim, 2012). As obesity, diabetes and other lifestyle oriented diseases threaten the world, health aspects are dominating people's preference for food. In light of this, the production of a plant-based spread will give

people a healthier choice of spread to patronize (Kulkurani & Soni, 2014). Therefore, the aim of the study was to evaluate the potential of cashew nut as a substitute in the production of spread.

2. Materials and methods

2.1. Preparation of samples and sample formulation

Roasted cashew nuts were obtained from CRIG's (Cocoa Research Institute of Ghana, Tafo) sub-station at Koforidua and all other added ingredients (sugar, milk, vegetable oil and flavour) from the Madina market in Accra, Ghana. The roasted cashew nuts were milled using a kitchen blender into slurry. Cocoa powder (CP) usually used in the production of chocolate spread was substituted with cashew nut slurry (CNS) at the rate of 95%, 90%, 85%, 80% and 75%; and a total of five samples were prepared. The formulated spreads contained 35% cashew nut-CP composite, 29.4% sugar, 20% milk, 15% vegetable oil, 0.1% vanilla and 0.5% lecithin. The ingredients were weighed and ground with a melanger. Chocolate spread obtained from the market was used as a control.

2.2. Sensory evaluation of samples

The sensory analysis (preference test) was conducted at the sensory laboratory of the Department of Food Science and Technology, KNUST, between 12:00 pm and 4:00 pm Fifty (50) untrained panellists (25 males and 25 females), who were students, non-smokers, aged between 19 and 26 were asked to assess the coded cashew spread samples in terms of the following sensory attributes: colour, mouthfeel, spreadability, taste, aroma, aftertaste and overall acceptability using the 7-point hedonic scale. The sensory laboratories had adequate lighting from fluorescent tube bulbs and panellists were seated at individual booths. All 6 samples were served in white disposable plastic plates at the same time to panellists but order of serving changed from one panellist to another. Water was provided for panellists to rinse their mouth with in-between tasting of samples. The first three samples with the highest overall acceptability mean scores were selected for further analysis: total soluble solids (TSS), pH, proximate composition, mineral content and microbial load.

2.3. Physicochemical, proximate and mineral composition of samples

The pH metre (HI 9025C) was used to determine the pH of the samples while a digital refractometer (VEE GEE PDX—95) was used to determine the TSS of the samples.

The proximate composition of the samples including moisture, ash, fat, protein, fibre and carbohydrate was determined using the AOAC (1990) method. Determination of moisture, ash, fibre was by gravimetric assay, protein by the Kjeldahl method, fat by the soxhlet apparatus using petroleum ether as the extraction solvent and carbohydrate by difference. The minerals (Mg, K and Na) were determined by means of the Atomic Absorption Spectrometer (AAS—VGP 210 Model).

2.4. Microbial analysis

Microbial load, total plate count (TPC), yeasts and moulds analyses were conducted using methods by IOCCC (1990).

2.5. Statistical analysis

Data obtained, with the exception of the sensory data, were assessed for normality using the Shapiro-Wilk test, which is suitable for data sets less than 50. All data followed the normal distribution since $p > 0.05$, as shown in Table 6. Data were therefore analysed by means of one-way analysis of variance, while Tukey's test was used to discriminate among the means, at 95% confidence interval, using SPSS version 20.

3. Results and discussion

3.1. Sensory evaluation

The preference of panellists for the cashew nut-chocolate spread samples is as shown in Table 1. Sample E (75% CNS: 25% CP) had the highest preference for colour with a mean value of 5.78. The

Table 1. Sensory evaluation of spread samples

| Sample | Colour | Mouthfeel | Spreadability | Taste | Aroma | Aftertaste | Overall Acceptability |
|--------|--------------------------|----------------------------|--------------------------|--------------------------|---------------------------|--------------------------|---------------------------|
| A | 3.86 ± 2.17 ^a | 4.34 ± 1.80 ^c | 5.36 ± 1.51 ^a | 4.68 ± 1.68 ^a | 4.26 ± 1.51 ^a | 4.06 ± 1.81 ^a | 4.80 ± 1.64 ^{ab} |
| B | 5.24 ± 1.85 ^b | 5.36 ± 1.55 ^{bc} | 5.70 ± 1.16 ^a | 5.14 ± 1.40 ^a | 4.64 ± 1.43 ^{ab} | 3.88 ± 1.69 ^a | 5.16 ± 1.43 ^{ab} |
| C | 5.24 ± 1.46 ^b | 5.10 ± 1.39 ^{abc} | 5.18 ± 1.61 ^a | 4.74 ± 1.51 ^a | 4.50 ± 1.52 ^a | 3.90 ± 1.88 ^a | 4.86 ± 1.40 ^{ab} |
| D | 5.46 ± 1.16 ^b | 4.88 ± 1.55 ^{ab} | 5.50 ± 1.27 ^a | 4.66 ± 1.42 ^a | 4.52 ± 1.36 ^a | 3.64 ± 1.69 ^a | 4.76 ± 1.22 ^a |
| E | 5.78 ± 1.28 ^b | 4.90 ± 1.64 ^{ab} | 5.42 ± 1.26 ^a | 4.68 ± 1.70 ^a | 4.58 ± 1.63 ^a | 3.80 ± 1.95 ^a | 4.94 ± 1.63 ^{ab} |
| M | 5.48 ± 1.76 ^b | 5.98 ± 1.20 ^c | 5.20 ± 1.50 ^a | 5.54 ± 1.76 ^a | 5.46 ± 1.58 ^b | 5.40 ± 1.82 ^b | 5.62 ± 1.60 ^b |

Notes: Data are represented as mean ± standard deviation

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

A - 95% Cashew nut slurry (CNS), B - 90% CNS, C - 85% CNS, D - 80% CNS, E - 75% CNS, M (control - cocoa liquor + groundnut paste)

7-point hedonic scale (1 - dislike very much, 2 - dislike moderately, 3 - dislike slightly, 4 - neither like nor dislike, 5 - like slightly, 6 - like moderately, 7 - like very much)

reference sample, M (main ingredients: cocoa liquor and groundnut paste), with a mean value of 5.48 was the second highest. There was a marked difference between the colour of sample A (95% CNS: 5% CP) and all other spreads made from cashew nut-CP composite. In addition, there was no significant difference between the preference of samples B (90% CNS: 10% CP), C (85% CNS: 15% CP), D (80% CNS: 20% CP), E (75% CNS: 25% CP) and reference sample M with regard to colour. Sample A (95% CNS: 5% CP) had the least preferred colour with a mean value of 3.86. Therefore, with regard to colour, an increase in CNS beyond 90% in the formulation provided may be undesirable.

In the case of spreadability, sample B (90% CNS: 10% CP) had the highest mean value of 5.70 and was followed by sample D (80% CNS: 20% CP) with 5.50. Sample C had the least value of 5.18 which was very close to 5.20 recorded for the reference sample (Table 1). Generally, cashew nut-CP composites were more spreadable than the reference sample as they had higher values. However, there was no significant difference ($p \geq 0.05$) between the preferences of all the samples with regard to spreadability (Table 1). 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. The underlying fat crystal network in nut butters influences many of the sensory attributes such as spreadability, mouthfeel and texture (Matsiko et al., 2014). In addition, since children are the most popular users 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 nut spreads are preferred (Shakerardekani et al., 2013).

On the other hand, with regard to mouthfeel, there were some significant differences ($p < 0.05$) observed amongst sample preferences. The mouthfeel is a textural sensory attribute that describes the smoothness or generally how the sample feels in the palate of the assessor. The reference sample (M) had the highest preference with a mean score of 5.98 (Table 1). Sample B (90% CNS: 10% CP) followed as the second highest with a score of 5.36 and sample A (95% CNS: 5% CP) had the least value of 4.34 (Table 1). There were significant differences ($p < 0.05$) amongst panellists' preference for these samples with regard to the mouthfeel. Again, as observed in the assessment of colour, beyond 90% CNS, the cashew nut-chocolate spread is not desirable in terms of mouthfeel and this could be attributed to the underlying fat crystal network in nut butters (Matsiko et al., 2014).

Similarly, for taste and aroma, the reference sample: M, had the highest value of 5.46 for aroma and 5.54 for taste (Table 1). With regard to taste, sample D (80% CNS: 20% CP) had the least preference score of 4.66, however, no significant differences ($p > 0.05$) were observed amongst all samples. This could mean that panel members could not detect any differences in the samples with regard to taste. In terms of aroma, however, a significant difference ($p < 0.05$) was observed between the reference sample, M which had 5.46, and all the cashew nut-chocolate spread. More so, no significant difference ($p > 0.05$) was observed between sample B (90% CNS: 10% CP) and the reference sample; indicating that sample B (90% CNS: 10% CP) is preferred as much as the reference sample in terms of aroma.

In terms of aftertaste, the reference sample had the highest score of 5.40 and was significantly different ($p < 0.05$) from all the cashew nut spread samples. However, no significant differences ($p > 0.05$) were observed amongst the cashew nut spread samples. With regard to overall acceptability, the reference sample, M, was the most preferred but it was not significantly different from samples E (75% CNS: 25% CP), C (85% CNS: 15% CP), B (90% CNS: 10% CP) and A (95% CNS: 5% CP; Table 1). Sample B (90% CNS: 10% CP) had the second highest overall acceptability of 5.16 with sample E (75% CNS: 25% CP) being the third highest with a mean value of 4.94 (Table 1).

From data obtained on the sensory evaluation of samples using the hedonic scale used, spreads made from cashew nut-CP composites will be accepted when introduced into the market.

3.2. TSS (°Brix) and pH

Sample E (75% CNS: 25% CP) had the highest TSS of 5.30°Brix (Table 2). The control sample and sample B (90% CNS: 10% CP) had the least TSS values of 4.46 and 4.45°Brix, respectively (Table 2). A significant difference ($p < 0.05$) was also observed between sample E (75% CNS: 25% CP) and the other samples (B and control sample). Since the sugar content used in all samples, except the control sample, M, were all the same, the difference in TSS could be attributed to the CNS added. Spreads are prepared using high concentrations of sugar, which functions as a preservative (Vaclavik & Christian, 2008). Therefore, the high level of sugar present in confectionery products makes them less prone to microbial spoilage. However, the TSS obtained in the spreads produced were very low compared with over 68°Brix in Jack-Passion spread produced by Chakraborty et al. (2011) and 38.65°Brix in a red flesh dragon fruit spread produced by Barcelon et al. (2015). The cashew nut spread will therefore have less sugar contributing to calories in the product.

pH of samples differed significantly and ranged from 6.25 to 6.41. Sample E (75% CNS: 25% CP) had the least pH (6.25) and sample B (90% CNS: 10% CP) had the highest (6.41). The reference sample (M) had a pH value of 6.39 which was not significantly different from sample B (90% CNS: 10% CP) as shown in Table 2. The pH values were higher than 4.90 in the fruit spread produced by Barcelon et al. (2015). Fruits are more acidic than nuts and seeds (such as cocoa and cashew nut) and will therefore be the reason for the relatively higher pH values obtained.

3.3. Proximate analysis of selected most preferred spreads

The results of the proximate composition of the selected sample spreads showed that sample M (control) had a significantly ($p < 0.05$) higher moisture content of 1.4% compared with that of samples B (90% CNS: 10% CP) and E (75% CNS: 25% CP; Table 3). For samples made from cashew nut-CP composites, sample E which contained 75% CNS and 25% CP had the highest moisture content of 1.0% while sample B (90% CNS: 10% CP) had the least (0.9%; Table 3). These results were however not significantly different ($p \geq 0.05$).

Sample B (90% CNS: 10% CP) had the highest ash content of 1.85% while sample M (control) had the least, 1.31% (Table 3). Sample E (75% CNS: 25% CP) had an ash content of 1.69% which was not significantly different from samples B (90% CNS: 10% CP) and M (control; Table 3). The above results indicate that the ash content of samples made from cashew nut-CP composites decreased with the increased substitution of the CNS with CP. According to Akinhanmi, Atasie, and Akintokun

Table 2. Total soluble solids (TSS; °Brix) and pH of the most preferred spread samples

| Sample | TSS (°Brix) | pH |
|---------------------|--------------------------|--------------------------|
| M (Control) | 4.46 ± 0.00 ^a | 6.39 ± 0.00 ^a |
| B (90% CNS: 10% CP) | 4.45 ± 0.07 ^a | 6.41 ± 0.01 ^a |
| E (75% CNS: 25% CP) | 5.30 ± 0.14 ^b | 6.25 ± 0.03 ^b |

Note: Data are represented as mean ± standard deviation
 Means in the same column with the same superscript are not significantly different at ($p \geq 0.05$)

Table 3. Proximate composition of spread samples

| Sample | Moisture | Ash | Fat | Protein | Fibre | Carbohydrate |
|--------|--------------------------|---------------------------|---------------------------|---------------------------|--------------------------|---------------------------|
| E | 1.00 ± 0.00 ^a | 1.69 ± 0.10 ^{ab} | 41.95 ± 0.35 ^a | 10.36 ± 0.00 ^a | 0.15 ± 0.00 ^b | 44.85 ± 0.45 ^b |
| B | 0.90 ± 0.14 ^a | 1.85 ± 0.02 ^b | 51.25 ± 0.35 ^b | 12.47 ± 0.93 ^b | 0.11 ± 0.01 ^a | 33.42 ± 1.42 ^a |
| M | 1.40 ± 0.00 ^b | 1.31 ± 0.16 ^a | 41.25 ± 0.35 ^a | 10.13 ± 0.10 ^a | 0.10 ± 0.01 ^a | 45.81 ± 0.42 ^b |

Notes: Data are represented as mean ± standard deviation
 B (90% CNS: 10% CP), E (75% CNS: 25% CP), M (control)
 Means in the same column with the same superscript are not significantly different at ($P \geq 0.05$)

(2008), defatted cashew kernel could have an ash content of 2.8% while that of flour processed from whole nuts could have ash content of 2.5% (Owiredu, Laryea, & Barimah, 2014).

With regard to the fat content, sample B (90% CNS: 10% CP) had the highest fat content of 51.25% (Table 3). This was observed to be significantly different from the fat content of sample M (control) and sample E (75% CNS: 25% CP). The fat content of sample E (75% CNS: 25% CP) was also not significantly different ($p \geq 0.05$) from the control sample (sample M). The high fat content could result in increased calories of the spread but will also help with the consistency of the spread, increasing palatability and satiety.

The protein content of sample B (90% CNS: 10% CP) was the highest with a mean value of 12.47% (Table 3). Sample E (75% CNS: 25% CP) had 10.36% while that of the control (sample M) had 10.13% (Table 3). It could therefore be realized that increased CNS resulted in a relatively higher protein content in the spread produced (Table 3). Fibre content decreased with increase in CNS (Table 3). Sample E (75% CNS: 25% CP) had a significantly higher ($p < 0.05$) fibre content (0.15%) compared with 0.11% in sample B (90% CNS: 10% CP) and 0.10% in the control sample (sample M) (Table 3). Although fibre found in this study was less than one, fibre is known to help with digestion and lowers the risk of constipation and even colon cancer. A higher fibre content may affect the functionality, which is the spreadability of the spread.

Finally, though carbohydrate content of the control sample (sample M) was higher with a mean value of 45.81%, it was not significantly different ($p \geq 0.05$) from sample E which had 44.85%. Sample B (90% CNS: 10% CP) had the least carbohydrate content of 33.42% (Table 3).

3.4. Mineral analysis of selected most preferred spreads

The cashew nut–chocolate spreads had higher mineral (Mg, Na and K) contents than the control sample. Sample E (75% CNS: 25% CP) had the highest magnesium content of 27.04 mg/100g while the control sample had the least of 17.50 mg/100g. A significant difference ($p < 0.05$) was observed in the magnesium content between the cashew nut–chocolate spreads: sample B and sample E (Table 4). With regard to sodium and potassium, sample E (75% CNS: 25% CP) had the highest contents of 26 and 22 mg/100g, respectively (Table 4). Sample B followed with 17 and 18 mg/100g for sodium and potassium contents, respectively, while the control sample recorded the least. Significant differences ($p < 0.05$) were observed amongst samples (Table 4). Sample E (75% CNS: 25% CP) had relatively lower CNS but contained the highest quantity of minerals determined (Mg, Na and K).

The high mineral content of cashew nut–CP composite spread samples as compared to the reference sample (made from cocoa liquor and groundnut paste) may have been due to the different raw materials used in their preparation. Generally, there was a significant increase in magnesium, sodium and potassium contents as the level of substitution of CP with CNS decreased. This is because CP contains high amount of minerals (DezaanTM Cocoa and Chocolate Manual, 2009), hence as the CP content increased the mineral content also

Table 4. Mineral content of spread samples

| Sample | Mg (mg/100g) | Na (mg/100g) | K (mg/100g) |
|---------------------|---------------------------|---------------------------|---------------------------|
| M (Control) | 17.50 ± 0.00 ^a | 5.00 ± 1.41 ^a | 2.50 ± 0.14 ^a |
| B (90% CNS: 10% CP) | 23.38 ± 0.08 ^b | 17.00 ± 1.41 ^b | 18.00 ± 0.57 ^b |
| E (75% CNS: 25% CP) | 27.04 ± 0.25 ^c | 26.00 ± 2.83 ^c | 22.00 ± 0.57 ^c |

Note: Data are represented as mean ± standard deviation
 Means in the same column with different superscripts are significantly different ($p < 0.05$)

increased. Potassium is required in the body to aid muscle control, normal function of nerves and the regulation of body fluid. It has also been reported that magnesium is an activator for many enzyme systems and helps maintain the electrical potential in the nervous system (Nieman, Butter, & Nieman, 1992). Inorganic mineral elements such as potassium play important roles in the maintenance of normal glucose-tolerance and in the release of insulin from beta cells of islets of Langerhans, thereby making mineral analyses nutritionally important (Adubofuor, Amofo Mensah, & Dabri, 2012).

3.5. Microbial analysis

Microorganisms such as bacteria, mould and yeast multiply at a high water activity and since most confectionery products have a very low water activity (< 0.75), they are stable against microbial spoilage and could be said to be ambient-stable products (Subramaniam, 2000).

The microbial load of the most preferred spread samples (B, E and M) was within acceptable standards for chocolate confectionary according to FDA (2013). TPC ranged from 250 to 350 cfu/g which was lower than 1000 cfu/g reported in the FDA standards (Table 5). Yeast and mould for the samples were also less than 10 cfu/g (Table 5). The considerably low levels of TPC and yeast and moulds of samples are indicative of proper handling of raw materials used and satisfactory processing conditions which yielded high hygienic quality of samples (Marriot, 1997). The samples are therefore safe to consume.

Table 5. Microbial load of spread samples

| Sample | TPC (cfu/g) | Yeast and mould (cfu/g) |
|---------------------|-------------|-------------------------|
| M (Control) | 350 | <10 |
| B (90% CNS: 10% CP) | 350 | <10 |
| E (75% CNS: 25% CP) | 250 | <10 |
| Acceptable levels* | 1000 | 10 |

Notes: Acceptable levels* are from the Food and Drugs Authority (FDA) in Ghana
 TPC – Total plate count

Table 6. Test for normality

| Parameters | Shapiro-Wilk | | |
|--------------|--------------|----|-------|
| | Statistic | df | Sig. |
| Moisture | 0.827 | 6 | 0.101 |
| Ash | 0.903 | 6 | 0.393 |
| Fat | 0.803 | 6 | 0.066 |
| Protein | 0.820 | 6 | 0.103 |
| Fibre | 0.849 | 6 | 0.154 |
| Carbohydrate | 0.817 | 6 | 0.079 |
| TSS | 0.831 | 6 | 0.109 |
| pH | 0.830 | 6 | 0.107 |
| Mg | 0.852 | 6 | 0.163 |
| Na | 0.936 | 6 | 0.628 |
| K | 0.805 | 6 | 0.066 |

Note: Data follow a normal distribution if “sig” value is greater than 0.05; $p > 0.05$

4. Conclusion

Spread samples produced from cashew nut-CP composite were generally liked by panellists even though the reference sample was better accepted. Cashew nut-CP composite spread gave a better spreadable product compared to the reference sample. The formulated spreads contained relatively higher amounts of ash, fat, protein and fibre than the control sample. Mineral contents (Mg, Na and K) of the spreads were relatively higher than the control sample. The microbiological investigation also showed that the products were of satisfactory bacteriological quality, because microbial load of samples were within acceptable levels for chocolate confectionary. Therefore, cashew nut can be used in the production of acceptable spreads with relatively higher nutrient contents than chocolate spreads, on the Ghanaian market. This product when adopted will provide an alternative use for cashew nuts and encourage its utilization in Ghana. Increased utilization will contribute to the reduction in postharvest losses of cashew nut in Ghana and contribute to food security.

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Competing Interests

The authors declare no competing interests.

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