MedCrave
Step into the World of Research

MOJ Food Processing & Technology

Research Article

Open Access

CrossMark

The preservative effect of *Aframomum danielli* spice powder on the chemical, microbial and sensory properties of groundnut butter

Abstract

The effect of natural preservative (*Aframomum danielli)* on the chemical, microbiological and sensory properties of stored groundnut butter was investigated. Raw groundnut seeds were processed traditionally into a paste (butter) and *Aframomum danielli* powder was added at the concentration levels of 0.20%, 0.40% and 0.60% and labeled as samples B, C and D, respectively while sample A (without *Aframomum danielli* powder) was prepared as control. The samples were stored at ambient temperature and evaluated at 1, 10 and 20 days for proximate composition, peroxide value, microbial and sensory properties. The moisture and crude protein content increased with increase in concentration of *Aframomum danielli* powder on day 1 and decreased on day 10 and 20 with sample D having the least values. Crude fat and crude fibre content increased significantly ($p<0.05$) as the concentration increased but decreased as storage day increased, with sample D having the highest value. Increase in *A. danielli* powder also increased the ash content of the treated samples and decreased the carbohydrate content. Peroxide value decreased with increase in concentrations with sample D having the least peroxide value. Bacterial and fungal count decreased significantly ($p<0.05$) as the concentration increased, with sample D having the least microbial count. All the samples were judges as acceptable but sample D was most preferred. *A. danielli* when used at 0.60% is more effective as a natural preservative in groundnut butter without objectionable attributes in sensory properties.

Keywords: groundnut butter, storage, *aframomum danielli,* preservative, peroxide, fat, microbial

Volume 8 Issue 2 - 2020

Florence A. Bello, Linus S. Ndah, Jessica A. Irem-Oka

Department of Food Science and Technology, University of Uyo, Nigeria

Correspondence: Florence A. Bello, Department of Food Science and Technology, University of Uyo, P. M. B. 1017, Nwaniba Road, Uyo, Akwa Ibom State, Nigeria, Tel +234803-857-8180, E mail florenceabello@uniuyo.edu.ng

Received: May 14, 2020 | **Published:** June 17, 2020

Introduction

Groundnut (*Arachis hypogea*) also known as peanut belongs to *Fabaceae* family. It is an edible annual crop originating in South America and now cultivated in several region of the world including Nigeria. It is one of the major indigenous edible nuts consumed in Nigeria.[1] It provides an inexpensive source of high quality dietary protein and important source of edible oil for millions of people living in the semi tropic region.[2,3] Groundnut usually consumed after roasting or boiling, they have many value-added products that have been developed with a number of applications in bakery, confectionery and the general consumer market. It can be processed into different forms such as groundnut butter, flour, oil, candy, chocolate, cake and others.[4–7]

Groundnut butter is the most important product utilized in the western part of the world as extremely nutritious spread as well as delicacy in porridge, cookies, cakes and ice cream.[8] The locally produced Nigerian groundnut butter is a smooth spicy version made with salt, oil, pepper and calabash nutmeg. It is a popular food paste amongst the people of the Eastern Nigeria (the Igbo's) served during ceremonies and other public functions specifically with garden eggs. It can also be eaten with cucumber or straight from the jar as a snack. Groundnut butter is considered healthier alternative to butter and margarine because it mostly consists of plant based unsaturated fats with negligible amount of trans-fats.[9] Peanut butter has been utilized successfully for treatment of malnourishment in impoverished countries by World Health Organization.[10] It is a semi-perishable product that is subject to a number of chemical, microbial and physical deteriorative changes, which affect the final quality of the finished product.[2] The oxidative and/or hydrolytic rancidity might be equally the limiting factor to the shelf life of groundnut butter. The shelf life of groundnut butter and other groundnuts derived products is greatly limited by rancidity that results from the oxidation of mainly unsaturated fatty acids.[11] Lipid oxidation is a main factor that lowers the quality of oil. Peroxide value is the widely used parameter for expressing the extent of lipid oxidation.[12]

The use of natural preservatives is a promising alternative to chemical methods in extending shelf life of products.[13] Spice such as *Aframomum danielli* have been identified as one of the potential sources of natural preservatives with many beneficial physiological effects in which their hypolipidemic and antioxidant properties have far-reaching health implications.[14] *Aframomum danielli* also known as alligator pepper is a large robust perennial plant of the family *Zingiberaceae* which grows in central and West African countries.[15] It has also been investigated for its food preservation potentials.[16,17] Its use in the right proportion can extend the shelf life as well as flavour of groundnut butter while still contributing to the nutritional benefit of the consumer. The objective of the study was to evaluate the effect of *Aframomum danielli* spice powder on chemical, microbial and sensory properties of groundnut butter during storage.

Materials and methods

Sample collection

Raw groundnut, dry pepper, *Aframomum danielli* (alligator pepper), calabash nutmeg, salt and groundnut oil were purchased from Itam main market, Uyo Akwa Ibom State. The reagents were of analytical grade.

Preparation of groundnut butter

The shelled groundnuts were sorted, 400g matured seeds were washed with distilled water to remove impurities, soaked in salted water (2% w/v) for 10 min, drained and sundried in a tray for 1h. The groundnut was then roasted in a hot pan containing hot fine sand with intermittent stirring. After roasting, the groundnut was separated from the sand using a plastic sieve/screen, and then allowed to cool. The peel was removed manually and 376g (94% w/w) of sound roasted peeled groundnut seeds were grinded to a smooth paste using a corona hand mill. 12 ml of oil (3% w/w) was added and mixed thoroughly till a smooth groundnut butter was obtained. 4g of pepper (1% w/w) and 2g of calabash nutmeg (0.5% w/w) were ground to powder using Q link electric blender and 6g of table salt (1.5% w/w) was added into the butter to taste. The groundnut butter was packaged in an airtight glass container, labeled and stored at ambient temperature.

Preparation of *Aframomum danielli* powder

The *Aframomum danielli* (alligator pepper) seeds were sorted, washed with water and oven dried. The seeds were dry milled using a blender and sieved to pass through 425µm aperture screen. The powdery substance obtained was packaged in an air tight container and labeled.

Preparation of *Aframomum danielli*-groundnut butter

The groundnut butter was divided into four equal portions weighed and coded. To the first portion, no *Aframomum danielli* powder was added, to the second, 0.2% w/w of the *Aframomum danielli* powder was added, to the third, 0.4% w/w and to the fourth 0.6% w/w of *Aframomum danielli* powder was added. The choice of concentration was based on Fasoyiro.[18] Each of them was mixed thoroughly. Each of the four samples were then further divided and packaged in small air tight glass containers and labeled accordingly. The samples were stored at ambient temperature (28±2 ºC) for 20 days and analysis was carried out on a 10-day interval.

Determination of proximate composition of groundnut butter samples

Determination of moisture content

The moisture content was determined according to the method as described by AOAC.[19] Petri dishes were washed and dried in a conventional air oven (model pp, 22 US, Genlab, England) at 80ºC. They were then removed and cooled in a desiccator and weighed (W_1). Two (2) g of the groundnut butter samples were then weighed and placed in the weighed petri dishes, and the weight taken as (W_2). The petri dishes containing the sample were placed in an oven at 105ºC and reweighed until a constant weight was obtained. This was recorded as (W_3). The moisture content was calculated as;

$$\%\text{Moisture} = \frac{W_2 - W_3}{W_2 - W_1} x100$$

Determination of crude protein content

The crude protein content was determined using Kjeldahl method as described by AOAC.[19] One (1) g of the flour samples was accurately weighed into a standard 250 ml Kjeldahl flask containing 1.5 g $CuSO_4$ and 1.5 g of Na_2SO_4 as catalyst and then 5 ml concentrated H_2SO_4 was added for digestion. The flask was placed in an inclined position in a fume chamber and heated gently until frothing ceased and a clear solution was obtained. At the end of digestion, the flask was allowed to cool and the sample quantitatively transferred into a 100 ml standard flask and made up to the mark with distilled water. A 20 ml volume of the diluted digest was made alkaline with 20 ml of 40% mixed solution of NaOH. The NH_3 evolved was steam distilled into a 100 ml conical flask containing 10 ml solution of saturated boric acid to which 2 drops Tashirus indicator (double indicator) has been added. The tip of the condenser was rinsed with a few millilitres of distilled water in the distillate which was then titrated with 0.1M HCl until a purple pink end point was observed. The blank determination was also carried out in the similar manner as described above except for the omission of the sample. The % nitrogen (N) and crude protein per sample were calculated as;

$$(\text{sample titre value} - \text{blank titre value}) \text{ x}$$

$$\%\text{N} = \frac{0.1\text{M HCL x } 0.014 \text{ x } 20}{\text{weight of sample x } 20} x100$$

$$\%\text{Crude protein} = \%\text{N x } 6.25$$

Determination of crude fat content

The crude fat content was determined using the solvent extraction method as described by AOAC.[19] The extraction thimble and two round bottom flasks was washed and dried in the oven. Two (2) g of butter sample (W_1) was placed into the thimble and fixed into the Soxhlet extraction unit, plugged lightly with cotton wool. 150 ml petroleum ether (boiling point 60-80ºC) was poured into a 250 ml capacity round bottom flask. Also the Soxhlet extractor was fitted into the round bottom flask which was placed on a heating mantle. The heating mantle was then switched on and the cold water circulation also put on while solvent refluxing was adjusted at a steady rate. Extraction was carried out for about 4 h. The dried beaker was then weighed (W_2) and the extract poured into the beaker. The thimble was rinsed with a little quantity of the ether and poured backed to the beaker. The beaker was then heated in the oven to drive off the excess solvent after which the beaker was cooled in a desiccator and weighed (W_3). The extracted lipid content of the sample was calculated as;

$$\%\text{Crude fat} = \frac{W_3 - W_2}{W_1} x100$$

Determination of ash content

The ash content was determined by the method as described by AOAC.[19] A clean crucible with lid was ignited in a muffle furnace at a temperature of 105 ºC for 1 h. It was then transferred to a desiccator to be cooled and weighed as (W_1). Five (5) g of the butter samples were placed in the crucible and the crucible was reweighed (W_2). To char crucible with the sample, it was transferred to the Bunsen flame in a fume cupboard, to drive off most of the smoke (until the smoking ceased), then transferred to the muffle furnace where it was heated at (500-600 ºC) and left for about 4 h to burn off all the organic matter, about this time it had turned to white ash. The crucible containing the ash was then removed, cooled and placed in a desiccator then weighed as (W_3). Ash content was calculated as;

$$\%\text{Ash} = \frac{W_3 - W_1}{W_2 - W_1} x100$$

Crude fibre determination

The crude fibre for the butter samples was determined by the method as described by AOAC.[19] Two (2) g of the sample (W_1) was accurately weighed into flask and 100 ml of 1.25% H_2SO_4 was added.

The mixture was heated under reflux for 30 min. The hot mixture was filtered through a fibre muslin cloth and then washed with hot water until it was no longer acidic. The residue was transferred to the beaker which 100 ml of 1.25% NaOH was added and heated for another 30 min. The final residue was filtered and washed with hot water several times until it was base free. The residue was finally washed twice with ethanol, qualitatively transferred into a pre-weighed crucible. The crucible and the residue were oven dried at 105ºC overnight to evaporate the moisture. The oven dried crucible containing the residue were then cooled in a desiccator and later weighed to obtain the W_2. The crucible with the weighed sample was incinerated in a furnace for ashing at 550ºC for 2 h. The crucible containing the ashed sample was cooled in the desiccator and weighed to obtain (W_3). The crude fibre was calculated as the loss in weight on ashing as;

$$\%\text{Crude fibre} = \frac{W_2 - W_3}{W_1} \text{x} 100$$

Determination of carbohydrate content

This was determined by difference method as described by Ihekoronye and Ngoddy.[20] It was quantified based on the percentage difference of the other proximate indexes as;

$$\%\ \text{CHO} = 100 - [\%\text{moisture} + \%\text{crude protein} + \%\text{crude fat} + \%\text{ash} + \%\text{crude fibre}]$$

Peroxide value determination of groundnut butter samples

This was determined using the titrimetric method as described by Pearson.[21] One (1) g of the groundnut butter was weighed into a clean dry boiling tube to which 1 g of powdered KI and 20 ml mixture of CH_3COOH-$CHCl_3$ in the ratio 2:1 were added. The tube was held in boiling water for 30 s after which the contents were transferred into a 250 ml conical flask containing 20 ml of 5% KI solution. This was titrated against 0.002 M sodium thiosulphate ($Na_2S_2O_3$) using 1 ml of starch as indicator. A blank titration was also made till a colourless end point was achieved, and the results were reported as the number of 0.002 M per gram of sample as;

$$\%\text{Peroxide value} = \frac{1000\ (V_1 - V_2)T}{M}$$

Where V_1 = Titre value of sample

V_2 = Titre value of blank

T = Normality of $Na_2S_2O_3$

M = Weight of the sample taken

Microbiological determination of groundnut butter samples

Total mesophilic (total viable bacterial counts) and fungi counts (yeast and mould counts) were carried out on the butter samples following the method as described by APHA.[22] Groundnut butter samples were homogenized, 1 g of each sample was weighed out, added to 9 ml of sterile water (deionized) which was shaken vigorously for 1 min using the vortex shaker. This was carried out to dislodge the microbiota and randomly distribute the microbes. Each treated sample was serially diluted using 10-fold dilution up to factor 2 (10^{-2}). 1 ml from each last dilution 10^{-2} was aseptically transferred into sterile petri dishes that were labeled accordingly. The total heterotrophic bacterial count was determined using pour plate method for bacterial isolation and spread plate method for fungal isolation. The media used for the isolation were Nutrient agar (NA), MacConkey agar (MCA), Sabouraud Dextrose agar (SDA), Salmonella Shigella Agar (SSA), Manitol Salt agar (MSA), Thiosulphate Citrate Bile Salt agar (TCBS). These were used to check the presence of bacteria, coliform, fungi, salmonella or *shigella* sp., *staphylococcus* sp. in the groundnut butter samples. The bacterial plates were incubated at 28ºC for 24 h using Gallerkamp incubator and fungal plates at room temperature for 5-7 days. Microbial colonies that emerged on the incubator plates after incubation were enumerated with the aid of colony counter. The morphological and biochemical characteristics of the pure isolates obtained from these cultures were determined using standard identification manuals. Fungal isolates were identified using standard methods for fungal identification.

Sensory evaluation of groundnut butter samples

The organoleptic properties of the coded peanut butter samples were assessed on a 10-day interval by a semi-trained twenty member's panelist from the Department of Food Science and Technology, Faculty of Agriculture, University of Uyo, Uyo. Using a nine-point Hedonic scale, where 1= dislike extremely, 5= neither like nor dislike and 9= like extremely. The food samples were prepared in identical sample containers and coded with alphabets. The randomized order of the sample was presented one at a time to each panelist. Questionnaire for entering scores and potable water for mouth rinsing between tasting were made available to the panelists.

Statistical analysis

Data were collected in triplicate and subjected to statistical analysis using one-way analysis of variance (ANOVA). The means were then separated with the use of Duncan's New Multiple Range Test (DNMRT) using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, USA) version 20.0 software.

Results

Proximate composition of groundnut butter samples

The result of proximate composition of the fresh and preserved groundnut butter samples is shown in Table 1. Significant ($p<0.05$) increase was observed in the moisture content on day 1. It ranged from 2.81-2.87% with increase in *A. danielli* powder, but there was no significant ($p>0.05$) difference between samples A and B.

On day 10 and 20, moisture content significantly decreased from 2.41-2.19% and 2.21-2.06%, respectively with sample D having the least moisture content. Addition of *A. danielli* significantly ($p<0.05$) increased the crude protein content of the fresh groundnut butter on day 1 from 18.87-18.93%. Decrease in crude protein content was observed on day 10 and 20 from 17.41-16.91% and 16.91-15.70%, respectively. Crude fat content of the fresh groundnut butter (day 1) significantly ($p<0.05$) increased from 40.84-41.63%, with samples A and B having no significant ($p>0.05$) difference. On day 10 and 20, It increased from 37.35-39.95% and 33.01-35.00%, respectively with all the samples being significantly ($p<0.05$) different from each other. Addition of *A. danielli* significantly ($p<0.05$) increased the crude fibre content from 3.57-3.87%, 3.11-3.37% and 2.00-2.34%

for day 1, 10 and 20, respectively. *A. danielli* significantly ($p<0.05$) increased the ash content of the samples on day 1 and it ranged from 2.89-2.98%. Increase in ash content was also observed on day 10 and 20 from 3.09-3.28% and 3.15-3.27%, respectively. Carbohydrate content significantly ($p<0.05$) decreased with increase in *A. danielli* concentration from 31.00-29.72%, 36.63-34.30% and 42.69-41.65% for day 1, 10 and 20, respectively.

Table 1 Proximate composition (%) of groundnut butter samples

Parameters	Day	A	B	C	D
Moisture	1	2.81±0.07^{c}	2.81±0.00^{c}	2.83±0.01^{b}	2.87±0.01^{a}
	10	2.41±0.02^{b}	2.31±0.07^{c}	2.51±0.02^{a}	2.19±0.01^{d}
	20	2.21±0.07^{a}	2.15±0.00^{c}	2.10±0.02^{c}	2.06±0.00^{d}
Crude protein	1	18.87±0.07^{c}	18.88±0.07^{c}	18.91±0.01^{b}	18.93±0.01^{a}
	10	17.41±0.07^{a}	17.14±0.00^{b}	17.00±0.02^{c}	16.91±0.01^{d}
	20	16.91±0.02^{a}	16.68±0.07^{b}	16.01±0.01^{c}	15.70±0.01^{d}
Crude fat	1	40.84±0.07^{c}	40.86±0.02^{c}	41.32±0.01^{b}	41.63±0.01^{a}
	10	37.35±0.07^{d}	38.02±0.07^{c}	38.75±0.01^{b}	39.95±0.01^{a}
	20	33.01±0.02^{d}	33.10±0.07^{c}	34.80±0.01^{b}	35.00±0.00^{a}
Crude fiber	1	3.57±0.07^{c}	3.84±0.07^{b}	3.83±0.00^{b}	3.87±0.01^{a}
	10	3.11±0.07^{d}	3.22±0.02^{c}	3.30±0.00^{b}	3.37±0.01^{a}
	20	2.00±0.02^{d}	2.30±0.00^{b}	2.27±0.01^{c}	2.34±0.01^{a}
Ash	1	2.91±0.07^{d}	2.89±0.07^{c}	2.94±0.00^{b}	2.98±0.01^{a}
	10	3.09±0.07^{d}	3.15±0.00^{c}	3.25±0.00^{b}	3.28±0.01^{a}
	20	3.18±0.07^{c}	3.15±0.00^{c}	3.27±0.01^{a}	3.25±0.01^{b}
Carbohydrate	1	31.00±0.03^{a}	30.72±0.04^{b}	30.17±0.01^{c}	29.72±0.03^{d}
	10	36.63±0.02^{a}	36.16±0.04^{b}	35.19±0.03^{c}	34.30±0.04^{d}
	20	42.69±0.02^{a}	44.77±0.07^{b}	41.55±0.04^{c}	41.65±0.02^{d}

Values are means ± S.D of triplicate determination, means in the same row with different superscripts are significantly different at ($p<0.05$). A=Groundnut butter + 0% *A. danielli* (Control), B=Groundnut butter + 0.2% *A. danielli*, C=Groundnut butter + 0.4% *A. danielli*, D=Groundnut butter + 0.6% *A. danielli*

Peroxide value of groundnut butter samples

Table 2 shows the result of peroxide value (PV) of the fresh and preserved groundnut butter. *A. danielli* significantly ($p<0.05$) decreased the PV from 1.89-1.25 meq/kg, 2.05-1.30 meq/kg and 2.40-1.36 meq/kg for day 1, 10 and 20, respectively with sample D having the lowest value. There was significant ($p<0.05$) difference among all the samples with increase in *A. danielli* concentration.

Table 2 Peroxide value (meq/kg) of groundnut butter samples

Day	A	B	C	D
1	1.89±0.02^{a}	1.55±0.02^{b}	1.50±0.00^{c}	1.25±0.01^{d}
10	2.05±0.02^{a}	1.67±0.01^{b}	1.57±0.03^{c}	1.30±0.02^{d}
20	2.40±0.01^{a}	1.80±0.02^{b}	1.65±0.03^{c}	1.36±0.02^{d}

Values are means ± S.D of triplicate determination, means in the same row with different superscripts are significantly different at ($p<0.05$). A= Groundnut butter + 0% *A. danielli* (Control), B= Groundnut butter + 0.2% *A. danielli*, C= Groundnut butter + 0.4% *A. danielli*, D= Groundnut butter + 0.6% *A. danielli*

Microbial counts and isolates in groundnut butter samples

The result of microbiological analysis of the fresh and preserved groundnut butter samples is presented in Table 3a. All the samples contained a certain number of viable count on day 1, 10 and 20. The control sample had the highest total viable counts on day 10 and 20. Significant ($p<0.05$) reduction was observed in the total heterotrophic bacterial count (THBC) as the *A. danielli* concentration increased. THBC ranged from 1.00-1.60 $x10^2$ cfu/g on day 1. THBC decreased significantly ($p<0.05$) from 2.00-1.30$x10^2$ cfu/g and 2.60-0.40$x10^2$ cfu/g on day 10 and 20, respectively. Staphylococcal count significantly reduced from 0.5-0.1$x10^2$ cfu/g, 0.9-0.3$x10^2$ cfu/g and 1.2 $x10^2$ cfu/g to Nil in samples A and B for day 1, 10 and 20, respectively. Samples C and D had no staphylococcal count all through the storage period. *A. danielli* had no significant ($p>0.05$) effect on the fungal count (FC) of samples A, B and C on day 1, while sample D had no count. *A. danielli* drastically reduced the FC from 1.60$x10^2$ cfu/g (A) to 1.00$x10^2$ cfu/g (D) and 2.10 $x10^2$ cfu/g (A) to 0.30 $x10^2$ cfu/g (D) for day 10 and 20, respectively.

The bacteria and fungi were isolated from fresh and preserved groundnut butter samples (Table 3b). *Bacillus subtilis* was found in samples B and C on day 1, samples A, B and C on day 10, and samples A, B, C and D on day 20. It was absent in sample A and D on day 1, and sample D on day 10. *Staphylococcus aureus* was present in samples A and B for day 1 and 10, and in sample A on day 20. *Lactobacillus* sp was found in sample B and D on day 1 and absent in all the samples on day 10 and 20. *Staphylococcus albus* was found in sample A on day 1, 10 and 20. It was absent in all the other samples throughout the period

of storage. *Pichia* sp was found in A, B and C on day 1, but it was present in all the samples on day 10 and 20. *Rhizopus stolonifer* was present in only sample B on day 10 and absent in all the other samples during the period of storage.

Table 3a Microbial counts (log cfu/g) of groundnut butter samples

Parameters	Day	A	B	C	D
	1	1.00±0.07^{d}	1.60±0.01^{a}	1.40±0.01^{b}	1.10±0.00^{c}
THBC	10	2.00±0.07^{a}	1.80±0.02^{b}	1.50±0.01^{c}	1.30±0.02^{d}
	20	2.60±0.07^{a}	1.00±0.01^{b}	0.60±0.01^{c}	0.40±0.02^{d}
	1	0.50±0.07^{a}	0.10±0.01^{b}	NIL	NIL
SC	10	0.90±0.02^{a}	0.30±0.01^{b}	NIL	NIL
	20	1.20±0.02^{a}	NIL	NIL	NIL
	1	1.00±0.00^{a}	1.00±0.02^{a}	1.00±0.02^{a}	NIL
FC	10	1.60±0.05^{a}	1.40±0.02^{b}	1.20±0.01^{c}	1.00±0.01^{d}
	20	2.10±0.02^{a}	1.20±0.02^{b}	0.50±0.02^{c}	0.30±0.01^{d}

Values are means ± S.D of triplicate determination, means in the same row with different superscripts are significantly different at ($p<0.05$). A= Groundnut butter + 0% *A. danielli* (Control), B= Groundnut butter + 0.2% *A. danielli*, C= Groundnut butter 0.4% *A. danielli*, D= Groundnut butter + 0.6% *A. danielli*. THBC= Total Heterotrophic Bacteria Count, FC= Fungal Count, SC= Staphylococcal Count, NIL=No growth

Table 3b Bacteria and fungi isolates from groundnut butter samples

Organisms	Day 1				Day 10				Day20			
	A	B	C	D	A	B	C	D	A	B	C	D
Bacteria												
Bacillus substilis	-	+	+	-	+	+	+	-	+	+	+	+
Staphylococcus aureus	+	+	-	-	+	+	-	-	+	-	-	-
Lactobacillus sp.	-	+	-	+	-	-	-	-	-	-	-	-
Staphylococcus albus	+	-	-	-	+	-	-	-	+	-	-	-
Fungi												
Pichia sp.	+	+	+	-	+	+	+	+	+	+	+	+
Rhizopus stolonifer	-	-	-	-	-	+	-	-	-	-	-	-

+ means the micro-organism was present, - means the micro-organism was absent

Sensory evaluation of groundnut butter samples

The sensory evaluation of the groundnut butter samples is shown in Table 4. There was no significant ($p>0.05$) difference in all the samples for all the sensory parameters on day 1 while significant ($p<0.05$) difference was observed on day 10 and 20 except for appearance. The appearance scores for the samples ranged from 7.50-7.70, 7.00-7.40 and 7.00-7.20 for day 1, 10 and 20, respectively. Aroma scores ranged from 6.90-7.50, 6.30-7.50 and 7.10-8.00 for day 1, 10 and 20, respectively. Taste scores ranged from 7.40-7.90, 6.20-7.10 and 7.10-7.90 on day 1, 10 and 20, respectively. After taste scores ranged from 6.70-7.50, 6.20-7.10 and 7.10-7.60 for day 1, 10 and 20, respectively. The overall acceptability of all the samples ranged from 7.20-8.00, 6.10-7.10 and 7.10-8.30 for day 1, 10 and 20, respectively.

Table 4 Sensory scores attributed to groundnut butter samples

Parameters	Day	A	B	C	D
	1	7.70±0.95^{a}	7.50±0.88^{a}	7.50±0.85^{a}	7.60±0.84^{a}
Appearance	10	7.00±1.16^{a}	7.00±1.16^{a}	7.40±0.84^{a}	7.10±0.24^{a}
	20	7.20±1.32^{a}	7.10±0.84^{a}	7.00±0.63^{a}	7.20±0.94^{a}
	1	7.50±0.85^{a}	7.40±1.08^{a}	6.90±1.20^{a}	7.20±0.92^{a}
Aroma	10	6.30±1.06^{c}	7.00±0.94^{b}	6.30±1.34^{c}	7.50±1.27^{a}
	20	7.10±0.99^{c}	7.20±0.92^{c}	7.50±0.57^{b}	8.00±0.79^{a}

Table Continued...

Parameters	Day	A	B	C	D
	1	7.50±1.27^{a}	7.40±0.84^{a}	7.60±1.08^{a}	7.90±1.17^{a}
Taste	10	6.30±0.82^{c}	6.20±1.23^{d}	7.10±1.10^{a}	6.60±1.43^{b}
	20	7.10±0.99^{d}	7.30±0.68^{b}	7.20±0.63^{c}	7.90±0.94^{a}
	1	7.50±0.71^{a}	6.70±1.16^{a}	6.70±1.34^{a}	7.20±0.92^{a}
After taste	10	6.70±0.68^{ab}	6.30±0.68^{b}	6.20±0.74^{b}	7.10±1.03^{a}
	20	7.20±1.03^{a}	7.10±0.88^{a}	7.60±0.70^{a}	7.10±0.99^{a}
	1	8.00±0.94^{a}	7.20±1.32^{a}	7.40±0.84^{a}	8.00±0.82^{a}
Overall acceptability	10	7.10±1.37^{a}	6.10±0.99^{d}	6.40±1.34^{c}	6.70±0.85^{b}
	20	7.10±1.37^{c}	7.10±1.20^{c}	8.00±0.67^{b}	8.30±1.25^{a}

Values are means ± S.D of triplicate determination, means in the same row with different superscripts are significantly different at ($p<0.05$).A= Groundnut butter + 0.1% *A. danielle* (Control), B= Groundnut butter + 0.2% *A. danielli*, C= Groundnut butter + 0.4% *A. danielle*, D= Groundnut butter + 0.6% *A. danielli*

Discussion

Addition of *A. danielli* increased the moisture content of the fresh groundnut butter samples as compared to the control on day 1. The loses observed in day 10 and 20 confirm the result of Adedeji and Ade-Omowaye[23] where higher moisture loss was recorded in samples treated with *A. danielli* and ginger extracts compared to the control. The greater moisture loss in groundnut butter samples B, C and D may be attributed to the presence of *A. danielli.* The values obtained in this study were lower compared to the findings (10-13.5%) of Matsiko *et al*.[12] for Rwanda peanut butter during storage. The lower the moisture content of a sample, the longer its storage ability.[24] This implies that the samples with *A. danielli* would have a longer shelf life. Increase in crude protein on day 1 agrees with the work of Ashaye *et al.*[25] where an increase in protein content of warakanshi samples incorporated with *A. danielli* was observed for the first 3 days of storage for all the different concentrations. Ashaye *et al*.[25] stated that the increase in protein content may be due to the presence of some micro-organisms and/or their enzymes which aid in the synthesis of nitrogenous substances. Therefore, it can be deduced that the reduction in the crude protein content observed on day 10 and 20 may be due to the anti-microbial property of *A. danielli*. Crude fat content increased with increase in the concentration of *A. danielli* as the storage period progressed. The control sample had the highest rate of decrease on day 20.

This observation is similar to the result of Adegoke and Falade[14] where they reported an increase in fat content of peanut milk with 1.5 and 2.0% *A. danielli*, and highest rate of decrease in the control sample on storage. This decrease may be due to the higher rate of fat oxidation as a result of the absence of *A. danielli* which have been reported to have anti-oxidant properties. The control sample had the least fibre content on day 20, and this may be attributed to the absence of *A. danielli*. Fibre helps in controlling blood sugar, lowering the serum cholesterol and increase bulk stool. Therefore, the increase in crude fibre content indicates that groundnut butter is a healthy food commodity. The ash content is an indication of the level of mineral contents present in the sample.[26] A slight increase was observed in the ash content for all the samples as the concentration of *A. danielli* increased. This is similar to the result of Ashaye *et al.*[25] where an increase in the ash content of Warakanshi incorporated with *A. danielli* was reported. The increase in the ash content of the samples may be due to the minerals present in the spice and also those produced by microbial activities. Furthermore, the spice has been reported to contain a number of essential minerals.[27] Its contribution to the increase in the ash content may not be overruled. The highest carbohydrate content was observed in control on day 1, 10 and 20. This is similar to the result obtained by Adedeji and Ade-Omowaye[23] where the control sample had a higher carbohydrate content compared to the samples treated with *A. danielli* and ginger extracts. This may also be attributed to the absence of *A. danielli.*

PV is the widely used parameter for expressing the extent of lipid oxidation. When peroxide value of edible oil approaches 10 meq/kg, it develops a rancid taste.[28] Sample A (control) having the highest PV as this justified the absence of *A. danielli*. This finding explains the reports of Matsiko *et al.*[12] and Gong *et al.*[29] whose PV of their peanut butter (without preservative) significantly increase during storage. Therefore, reduction in PV in this study during storage as a result of *A. danielli* powder addition means that lipid oxidation was considerably retarded in treated samples but rapid in the control sample. This is similar to the results of Beltran *et al*.;[30] Ashaye *et al*.;[25] Adegoke *et al*.[31] where it was stated that *A. danielli* is effective in slowing down lipid oxidation in mayonnaise, cooked chicken slurries and warakanshi, respectively. The values obtained in this study were lower compared to the findings of Shibli *et al*.[8] on peanut butters from different peanuts cultivars on storage without preservatives. Sample D had the least PV for fresh and stored samples and it signifies that it would be the least sample to undergo lipid oxidation. This means that 0.6% *A. danielli* powder reduced the level of lipid oxidation. This is due to the concentration and effectiveness of *A. danielli* which was responsible for the work of anti-oxidation in the groundnut butter. These observations further confirm the antioxidant effectiveness of the spice at low concentrations as reported by Adegoke *et al.*[31]

The increase in the microbial growth on day 10 for all the samples may be attributed to the availability of nutrients in the samples being utilized for growth by the micro-organism. This corroborates with the findings of Adegoke and Skukra,[32] Adegoke *et al*.;[16] Adegoke and Falade,[14] that *A. danielli* is known to possess preservative properties having both antibacterial and antifungal effects. The absence of salmonella, shigella and coliform shows that there was no faecal contamination in the samples. It also confirms the report of Adegoke and Skukra[32] and Fasoyiro *et al*.[33] who stated that *A. danielli* inhibits

these organisms. It can be deduced that *A. danielli* is an anti-microbial agent and the higher the concentration, the lesser the micro-organisms present.

All the samples were judged as acceptable but sample D with 0.6% *A. danielli* concentration had greater preference. This disagrees with the work of Adedeji and Ade-Omowaye[23] where they observed that bean cakes treated with 0.2 and 0.4% *A. danielli* and ginger extract were more acceptable than 0.6% and 0.8% treated samples. Groundnut butter is a spicy groundnut paste and this was enhanced by the presence of *A. danielli*, hence the greater preference. This supports the fact that spices are believed to have medicinal values and have desirable determinative influence on the overall organoleptic analysis when used.[34]

Conclusion

The result of this study has shown that incorporating *A. danielli* into groundnut butter at 0.6% is more effective as a natural preservative by reducing its lipid oxidation as evident in low peroxide value and microbial growth rate, while still retaining a reasonable amount of nutrients. It may also be used as a natural spice in groundnut butter at this level of concentration without objectionable attributes in the sensory quality. Taking into consideration, the need for food preservation, and the effectiveness and accessibility of *A. danielli* from this study, as a natural preservative, it may be recommended for use in place of synthetic preservatives, for groundnut butter and some other food products.

Funding

None.

Acknowledgments

None.

Conflicts of interest

The authors declare that there was no conflict of interest.

References

1. Nwabunnia E, Ezeimo NE. Bacteriological quality of processed, packaged and stored conophor (*Tetracarpidium conophorum*) nuts. *Nigerian J Microbiol.* 2015;29:3022–3028.
2. Fadleseed MA, Hussein AA, Hassan SA et al. Proximate composition, chemical and microbiological evaluation of peanut butter in supermarkets in Khartoum State. *Int J Recent Adv Multidiscipl Res.*2017;4(7):2694–2697.
3. Bello FA, Etim UE, Nwabueze TU. Performance evaluation of selected packaging materials on the chemical compositions and consumer acceptability of roasted groundnut seeds stored at ambient temperature. *Adv Food Sci Engr.* 2019;3(4):70–76.
4. Eshun G, Amankwah EA, Barimah J. Nutrients content and lipid characterization of seed pastes of four selected peanut (*Arachis hypogaea*) varieties from Ghana. *African J Food Sci*. 2013;7(10):375–381.
5. Ocheme OB, Igyor MA, Hassan H. Isolation and characterization of microorganisms in dakuwa (a Nigerian cereal/ groundnut snack). *International Journal of Research in Pure and Applied Microbiology*. 2014;4(1):15–19.
6. Akinnibosun FI, Osawaru EE. Quality assessment of peeled and unpeeled roasted groundnut (*Arachis hypogaea L.*) sold in Benin City, Nigeria. *International Research Journal of Natural and Applied Sciences*. 2015;2(3):18–32.
7. Olawuni IA, Uzoukwu AE, Agunwah IM, et al. Incorporation of peanut butter as substitute for shortening in biscuit production. *IOSR–JESTFT*. 2019;13(10):62–69.
8. Shibli S, Siddique F, Raza S, et al. Chemical composition and sensory analysis of peanut butter from indigenous peanut cultivars of Pakistan. *Pak J of Agric Res.* 2019;32(1):159–169.
9. Sanders TH. Non detectable level of transfatty acids in peanut butter. *J Agric Food Chem.* 2001;49(5):2349–2351.
10. Kane N, Ahmedna M, Yu J. Development of a fortified peanut–based infant formula for recovery of severely malnourished children. *Intl J Food Sc. Technol*. 45(1):1965–1972.
11. Nepote V, Mestrallet MG, Grosso NR. Oxidative stability in fried–salted peanuts elaborated with high–oleic and regular peanuts from Argentina. *Int J Food Sci Technol.* 2006;41:900–909.
12. Matsiko F, Murindwa E, Niyigena C, et al. Comparison and Evaluation of the Quality and Storage Stability of Soy and Peanut butter. *Pakistan Journal of Food Sciences*. 2014;24(1):50–56.
13. Fasoyiro SB, Adegoke GO. Phytochemical characterization and the antimicrobial property of Aframomum danielli extract. *Afr J Agric Res.* 2007;2:76–79.
14. Adegoke GO, Falade AT. Effect of Aframomum danielli on Peanut Milk Characteristics and Flavor. *Nutr Food Technol*. 2016;3(1):1–5.
15. Oluwabamiwo BF, Adegoke GO, Akinoso R, et al. Control of aflatoxigenic mould and aflatoxins in melon seeds using *Aframomum danielli* indigenous plant. *Acta Hortic.* 2018;507–512.
16. Adegoke GO, Fasoyiro SB, Skura B. Control of microbial growth, browning and lipid oxidation by the spice *Aframomum danielli. Eur. Food Res. Technol*. 2000;211(5):342–345.
17. Aroyeun SO, Adegoke GO, Varga J, et al. Potential of *Aframomum danielli* spice powder in reducing ochratoxin A in cocoa powder. *American J Food Nutr.* 2011;1(4):155–165.
18. Fasoyiro SB. Preservative property of *Aframomum danielli* fractions in stored grains. *Afr J Biotech.* 2007;6(3):235–237.
19. AOAC, Official Methods of Analysis, 18th edition. Association of official analytical chemists. Washington DC: USA, 2005.
20. Ihekoronye AI, Ngoddy PO. Integrated food science and technology. New York*:* Macmilian Publishers; 1985. 296–301.
21. Pearson D. The chemical analysis of foods. New York: Churchill Livingstone. 1976.
22. APHA. Compendium of methods for the microbiological examination of foods, 4th edition. *American Public Health Association*, Washington DC: USA; 2001.
23. Adedeji TO, Ade–Omowaye BIO. The preservative effects of two local Nigerian spices on the shelf life of fried bean cake snacks. *J Nutr Food Sci.* 2013;3:188.
24. Bello FA, Akpan ME, Sodipo MA. Physicochemical and sensory properties of cookies produced from wheat, unripe plantain and germinated fluted pumpkin seed composite flour. *Food Science and Quality Management*. 2020;96:36–43.
25. Ashaye OA, Taiwo OO, Adegoke GO. Effect of local preservative (*Aframomum danielli*) on the chemical and sensory properties of stored warakanshi. *Afr J Agric Res.* 2006;1:10–16.
26. Bello FA, Udo JA. Effect of processing methods on the nutritional composition and functional properties of flours from white and yellow local maize varieties. *Journal Adv Food Sc Technol*. 2018;5(1):1–7.
27. Adegoke GO, Gopalakrishna AG. Extraction and identification of antioxidants from the spice *Aframomum danielli*. *J Am Oil Chem Soc.* 1998;75:1047–1052.

28. Anaysor GN, Ogunwenmo KO, Oyelana OA, et al. Chemical analyses of groundnut (*Arachis hypogea*) oil. *Pak J Nutr.* 2009;8(3):269–272.

29. Gong A, Shi A, Liu H, et al. Relationship of chemical properties of different peanut varieties to peanut butter storage stability. *J Integr Agric.* 2018;17(5):1003–1010.

30. Beltran E, Pla R, Yutse J, et al. Use of antioxidants to minimize rancidity in pressurized and cooked chicken slurries. *Meat Science.* 2004;66:719–725.

31. Adegoke GO, Etti CJ, Etti IC. Lipid Oxidation: the role of *Aframomum danielli* antioxidant extracts in preservation. *IOSR Journal of Engineering*. 2012;2:46–50.

32. Adegoke GO, Skura BJ. Nutritional profile and antimicrobial spectrum of the spice *Aframomum danielli* K. Schum. *Plants Food Human Nutr.* 1994;45:175–182.

33. Fasoyiro SB, Adegoke GO, Ashaye OA, et al. Antimicrobial characterisation of spice on, *Escherichia coli* and *Staphylococcus aureus*. *Moor J Agric Res*. 2001;2:159–161.

34. Wood CD, Manno JE, Wood M. Comparison of efficacy of ginger with various anti–motion sickness drugs. *Clin Res Pr Drug Regul Aff.* 2000;6:29–136.

Citation: Bello FA, Ndah LS, Irem Oka JA, et al. The preservative effect of *Aframomum danielli* spice powder on the chemical, microbial and sensory properties of groundnut butter. *MOJ Food Process Technol.* 2020;8(2):71–78. DOI: 10.15406/mojfpt.2020.08.00245