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To cite this article: Abimbola Arise , Amina Ahmed El-Imam & Fadilat Solola (2020): Effect of Different Pre-treatment Methods on the Quality, Sensory Properties and Storability of Bambara Groundnut Spread, Journal of Culinary Science & Technology, DOI: [10.1080/15428052.2020.1815627](https://doi.org/10.1080/15428052.2020.1815627)

To link to this article: <https://doi.org/10.1080/15428052.2020.1815627>



Published online: 02 Sep 2020.



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Effect of Different Pre-treatment Methods on the Quality, Sensory Properties and Storability of Bambara Groundnut Spread

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ABSTRACT

Spreads are made from plant oil and similar to margarine but with lower fat. In this study, Bambara spreads (BS) were made from pre-treated Bambara groundnuts using two different methods which are boiling (BBS) and fermentation (BFS). Spreads made from soaked Bambara and soyea were included as reference samples. Objective color determination, sensory evaluation, microbial profile and storability at refrigeration temperature were carried out using standard methods. The results obtained showed that spread made from boiled Bambara groundnut (BBS) is the most spreadable, organoleptically accepted by panelists and it has low fat and higher protein content. The coliform counts of the spread samples initially declined, then increased from day 6 of refrigerated storage; bacterial counts remained fairly static but also increased by day 6. Boiling may be the most suitable pre-treatment for Bambara groundnut spread in order to obtain a lower fat content spread that will result in great health benefits.

ARTICLE HISTORY

Received 23 April 2020
Revised 18 July 2020
Accepted 23 August 2020

KEYWORDS

Bambara groundnut;
fermentation; boiling;
storability; microbial count;
sensory

Introduction

Legumes are considered to be a cheap and affordable source of protein compared to animal proteins. They are the largest single source of vegetable protein in human diets and have historically been part of meals throughout the world (Adebowale, Schwarzenbolz, & Henle, 2011). Bambara groundnut (*Vigna subterranea*) is an underutilized grain legume grown in a number of countries in sub-Saharan Africa (Arise, Amonsou, & Ijabadeniyi, 2015). It is the third most important legume after cowpea (*Vigna unguiculata*) and groundnut (*Arachis hypogea*) in Africa (Arise, 2016; Arise et al., 2015). However, its economic importance has not been fully utilized. It is cultivated by farmers as a “famine culture” crop because of its several agronomic advantages including good resistance to pest and drought tolerance (Arise et al., 2015). It has been reported that the Bambara groundnut has been processed in different ways such as soaking,

boiling, frying and fermentation in Nigeria (Ijarotimi & Esho, 2009; Ndidi et al., 2014). The nutrient composition, especially the high protein content makes it an important source of food security for many households (Arise, Dauda, Awolola, & Akinlolu-ojo, 2017), thus it is considered a complete food (Arise, Akintayo, Dauda, & Adeleke, 2019; Arise, Oyeyinka, Dauda, Malomo, & Allen, 2018). The study of dietary fat consumption and its effects on human health is among the most investigated topics in the field of human nutrition (Akusu, 2019). As such, specific dietary recommendations on fat intake (in terms of quantity and quality) have been established by health organizations around the globe.

Spreads refer to series of products likened to margarine and butter but with lower fat content in the range of 25–75% (Young & Wassell, 2008). For many people who are obese or who have medical problems, a low calorie, low fat, diet is imperative. Therefore, the need to search for an alternative source of spread with lower fat content becomes important. Since pulses such as Bambara are generally low in fat (4.5–7.8%) with high amounts of protein (15–27%) (Arise et al., 2015, 2018), it is expected to be a good raw material for the production of spread. Hence, this study is aimed at producing a low fat spread from pre-treated Bambara groundnut.

Materials and methods

Materials

The seeds of Bambara groundnut were sourced from Oja-oba market in Ilorin, Kwara state, Nigeria along with other raw materials needed. The research project was carried out at the department of Home Economics and Food Science, University of Ilorin, Kwara state, Nigeria.

Sample preparation

The seeds were sorted and divided into three portions. The first portion was boiled for 10 min, second part was fermented for 48 hr at room temperature while the third part was soaked for 24 hr as a reference sample. Also, soybean was used as the positive control and it was soaked for 24 hr.

Spread production method

Each group is processed separately into milk by wet milling and sieving according to the method of Ahmad, Li, Yang, Ning, and Randhawa (2008), with slight modification. Briefly, the filtrates were collected in separate clean containers and the shaft was discarded. The milk was left to rest for an hour to allow the starch present in it settle, after which it was decanted.

The milk filtrates obtained were then processed separately into cheese according to the method used by Zaki, Zayan, Nagi, and El-Salam (2018).

The milk was poured into different pots and boiled for about 20 minutes without covering them. After boiling, coagulant (lemon) is added to each group in a ratio of 1:20 and is left for an hour to allow coagulation to occur until the whey has separated from curd completely. The curd is separated from the whey using a muslin cloth. The cheese (200 g) along with salt (0.5), sugar (50 g) and vegetable oil (40 ml) was put into a blender and mixed thoroughly until completely homogenized. The spread was properly packaged in glass jars, pasteurized (70°C for 5 min) and used for further analyses.

Analysis

Color

olor measurements were taken in triplicate to determine L^* a^* b^* values. L^* represents the level of brightness with $L^* = 100$ as white and $L^* = 0$ as black; a^* represents red/green with $a^* =$ positive as red and $a^* =$ negative as green; and b^* represents yellow/blue with $b^* =$ positive as yellow and $b^* =$ negative as blue.

Sensory evaluation

A total of 50 panelists consisting of staff and students of the University of Ilorin, Nigeria, were used. Samples were randomly numbered in three digit codes and orders of serving were completely randomized. The samples were assessed using 9-point hedonic scale ranging between 9 (like extremely) to 1 (dislike extremely). Like Extremely 9; like very much 8; like moderately 7; like slightly 6; neither like nor dislike 5; dislike slightly 4; dislike moderately 3; dislike very much 2; dislike extremely 1.

Storability

Storage stability of the spreads was determined at refrigerated temperature through microbial analysis, proximate composition and spreadability of the samples.

Spreadability

Spreadability of the spread was measured at room temperature using laboratory Bostwick Consistometer (CSC Scientific company, Germany) as described by Akusu, Wordu, and Obiesie (2018). Briefly, the spread was placed in the instrument reservoir behind the gate of the consistometer. As the gate is released by pressing the lock release lever, the spring action ensures it opens

instantaneously. As the fluid flows down the instrument, the progress was accurately measured using the graduated Bostwick scale.

Spreadability (mm/sec) = d/s

d = distance covered;

s = time taken.

Proximate analysis

Moisture, fat and ash content were determined using AOAC methods (AOAC, 2012). The protein content was determined by the Kjeldahl method ($N \times 6.25$). Total carbohydrate was calculated by difference as expressed below:

Carbohydrate = $100 - (\text{Moisture} + \text{Ash} + \text{Fat} + \text{Fiber} + \text{Protein})$.

Microbial analysis

The spread samples were serially diluted in sterile distilled water and inoculated using the pour plate technique on nutrient agar (NA), potato dextrose agar (PDA) and MacConkey agar (MCA) for bacterial, fungal and coliform counts, respectively. All samples were plated in duplicates and the NA and MCA plates were incubated at 37°C for 24 hours while the PDA plates were incubated at 25°C for 7 days. Counts are presented as average log CFU/ml.

Statistical analysis

All experiments were conducted in triplicate. Data were analyzed using one-way analysis of variance (ANOVA) where necessary and the mean values were compared using Turkey's multiple comparison test with significant differences at $p < 0.05$.

Results and discussion

Color

The boiled Bambara spread (BBS) had the highest lightness value (72.04) but this value was not significantly different ($p < .05$) from other samples except the soy spread which had the least value of 68.11 (Table 1). The Bambara spread samples also had significantly different a^* values from the soy spread with 1.16. All samples appear to have significantly different b^* values except the BBS and soaked Bambara spread (BSS) which were similar.

Table 1. Color attributes of Bambara spread samples prepared using different methods.

Sample	L*	a*	b*
BBS	72.04 ^a ±1.40	-0.19 ^a ±0.18	9.98 ^b ±0.23
BFS	70.87 ^a ±1.27	-0.22 ^a ±0.05	9.21 ^c ± 0.40
BSS	71.26 ^a ±1.18	-0.11 ^a ±0.38	10.51 ^b ±0.36
SSS	68.11 ^b ±2.52	+1.16 ^b ±0.24	12.55 ^a ±0.39

Values are means of triplicate readings ± SD. Means with the same superscript within the same column are not significantly different ($p < 0.05$). BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

Sensory evaluation

The findings of the sensory panel revealed no significant difference in the samples' aroma. However, there appeared to be significant differences in appearance, taste, consistency and overall acceptability of the samples (Table 2). The BFS showed a significant difference in consistency from all other samples but appears to be similar to the control in appearance, taste and overall acceptability. The highest acceptability was observed in the soaked Bambara spread but it appears not to be significantly different from the boiled sample in appearance, taste, consistency and overall acceptability.

Storability

The spread samples were stored at a refrigerated temperature (4°C) for 8 days. Spreadability, proximate composition and microbial analysis were carried out on the spread samples.

Spreadability

The spreadability of the spread samples improved after 8 days of storage at refrigeration temperature (Figure 1). This could be as a result of the increase in the moisture content of all spread samples after storage. The spreadability (mm/sec) of samples BBS, BFS, BSS and SSS ranged from 0.18 to 0.22, 0.09 to 0.17, 0.12 to 0.15 and 0.2 to 0.25, respectively. This result is in line with the findings of Akusu et al. (2018) who studied changes in physicochemical properties of table spread produced from African pear pulp during storage. The Bambara spreads

Table 2. Organoleptic assessment of Bambara spread samples prepared using different methods.

Sample	Appearance	Aroma	Taste	Consistency	Overall acceptability
BBS	6.44 ^{ab} ±1.25	6.10 ^a ±1.58	6.50 ^{ab} ±1.25	6.44 ^a ±1.11	6.50 ^{ab} ±1.33
BFS	5.58 ^c ± 1.63	5.58 ^a ±1.66	5.94 ^b ±1.85	5.72 ^b ±1.62	5.62 ^c ± 1.89
BSS	6.72 ^a ±1.25	5.80 ^a ±1.95	6.74 ^a ±1.38	6.66 ^a ±1.19	6.90 ^a ±1.25
SSS	5.90 ^{bc} ±1.64	5.74 ^a ±1.68	5.88 ^b ±1.52	6.54 ^a ±1.28	6.16 ^{bc} ±1.45

Values are mean ± SD. Means with the same superscript within the same column are not significantly ($p < 0.05$) different. BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

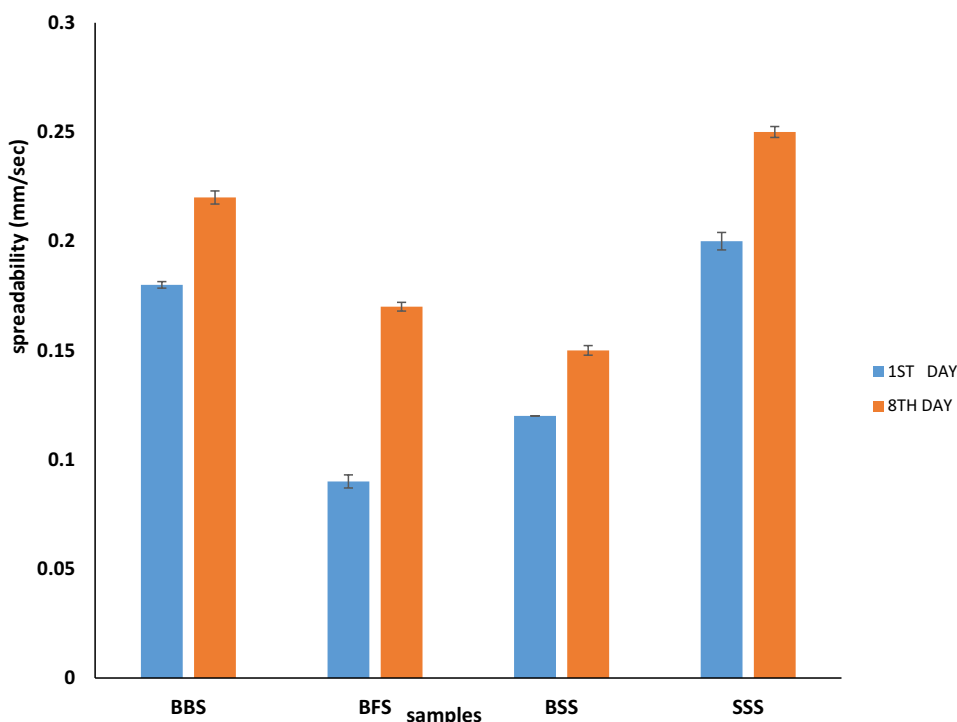


Figure 1. Spreadability of various Bambara spread samples on 1st and 8th day of storage (4°C). BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

all showed lower spreadability than the soy spread. Sample BFS showed the greatest increase in spreadability after storage although; BBS had the highest spreadability value before storage and after storage.

Proximate composition

The moisture content of the samples ranges from 37.20% to 37.33% on the first day of storage (Figure 2). These values are lower than 55.54–60.68% recorded by Zaki et al. (2018) who studies spread from tofu prepared from soybean. An increase in the moisture content of all samples was observed after 8 days of storage and this is similar to reports of Akusu et al. (2018). The authors reported an increase in moisture content (62.2% to 75.9%) of spread made from African pear after 4 weeks of storage. The ash contents indicate the presence of minerals in the spread, and the amounts (3.03–3.19%) were similar across the samples. However, the ash content of the boiled Bambara spread was lower than the soaked and fermented spread and is similar to the trend observed by Yagoub and Abdalla (2007) who reported a decrease in ash content of cooked Bambara compared to that of soaked Bambara. The mineral content of the fermented product is also higher than the soaked product and

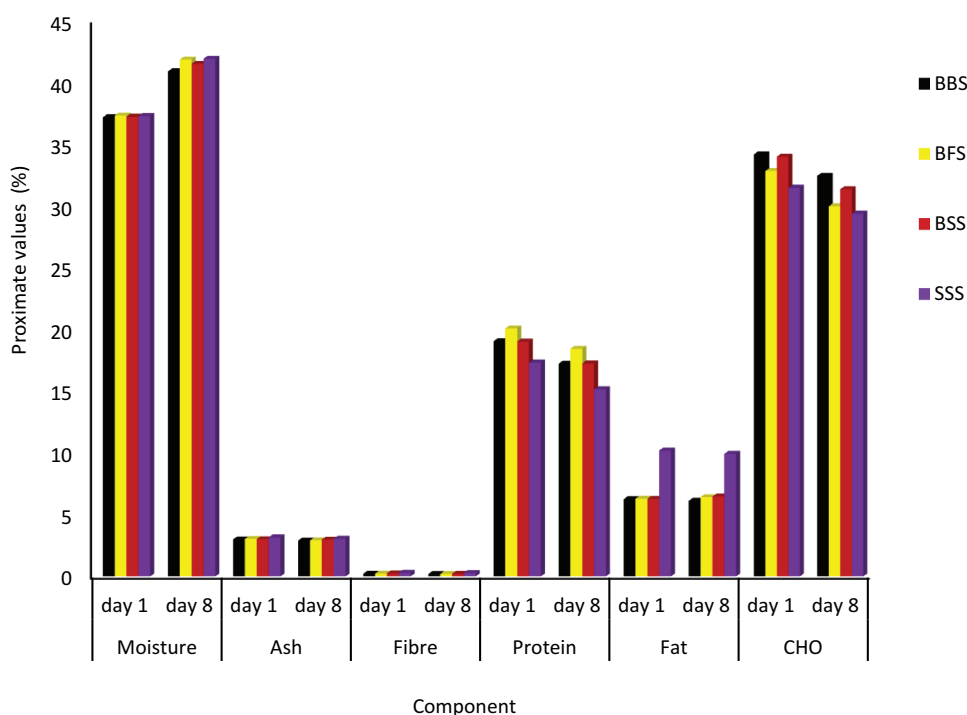


Figure 2. Proximate composition of various spreads on 1st and 8th days of storage. BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

agrees with the conclusion of Amonsou, Taylor, Beukes, and Minnaar (2012) that ash content of soybean could increase with increased soaking time. This could be termed true since the fermented product needed more soaking time for the Bambara groundnut to ferment. The lower value of ash was recorded on the 8th day of storage. This shows that there was a decrease in mineral content of the sample with time.

The fermented sample had a significantly higher protein than the boiled and soaked samples. A similar finding was made by Adeparusi (2001) when boiling Lima beans. Ijarotimi and Esho (2009), also discovered that fermentation increases the protein content of Bambara groundnut. It was also noticed that the protein content of all samples was lower on the 8th day of storage.

There was no significant ($p < .05$) difference in the fiber content of all samples except with the soybean spread that had higher fiber content. This may be due to the fact that soybean has higher fiber content than Bambara groundnut. Reduction in the fiber content also happened over the period of storage.

The fat content of the Bambara spread samples ranged from 6.33% to 6.37% while the soybean spread (control) recorded higher fat value (10.30%). This might be because soybean is an oilseed and has high-fat content, 22.80% compared to Bambara groundnut which is a pulse and has low-fat content (4–6%) (Amonsou et al., 2012; Arise et al., 2015, 2018). Zaki et al. (2018), reported the fat content

gotten from spreadable tofu blends to range from 18.12% to 18.80%. These values are higher than the fat contents recorded in this research which makes the products in this research a healthier choice in terms of fat content.

Microbial storage

Bacterial count

The bacterial count of all spreads increased during refrigerated storage (Figure 3). This may be due to the increase in the moisture content of the samples during storage. An increase in the moisture content of spread made from African pear was also reported by Akusu et al. (2018).

Sample BFS had the highest microbial count at both the first and last days of storage and this can be attributed to the presence of fermentation microorganisms in this sample. While not significantly lower, the boiled Bambara spread (BBS) had the lowest bacterial counts which shows that the boiling process killed some of the native microorganisms present in the Bambara groundnuts.

Coliform counts

Coliform populations declined in all samples (Figure 4) indicating that they were unable to compete favorably with other bacteria whose populations increased with time. By Day 8 the population rose which suggests the resurgence and thus dominance of a psychrophilic coliform species. The BFS

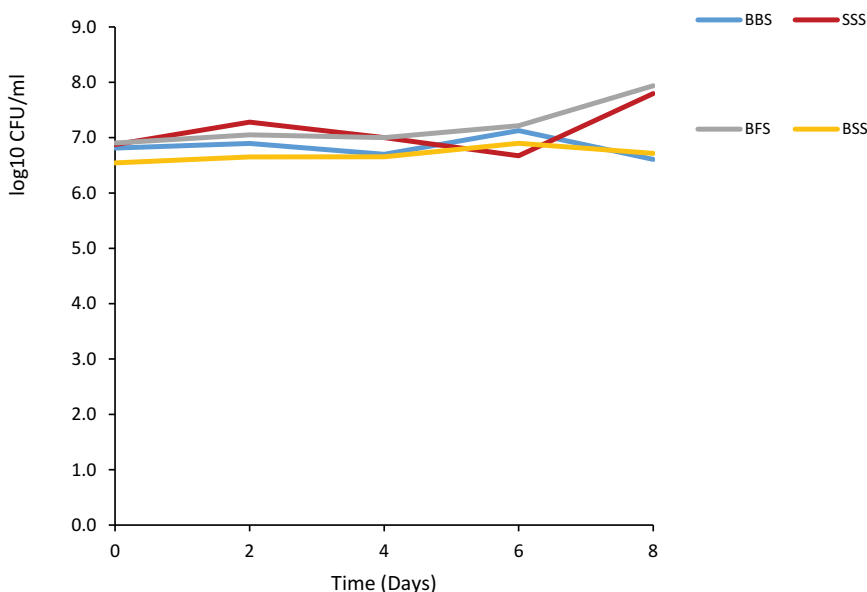


Figure 3. Bacterial count of various Bambara groundnut spread samples over eight days of refrigerated storage. BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

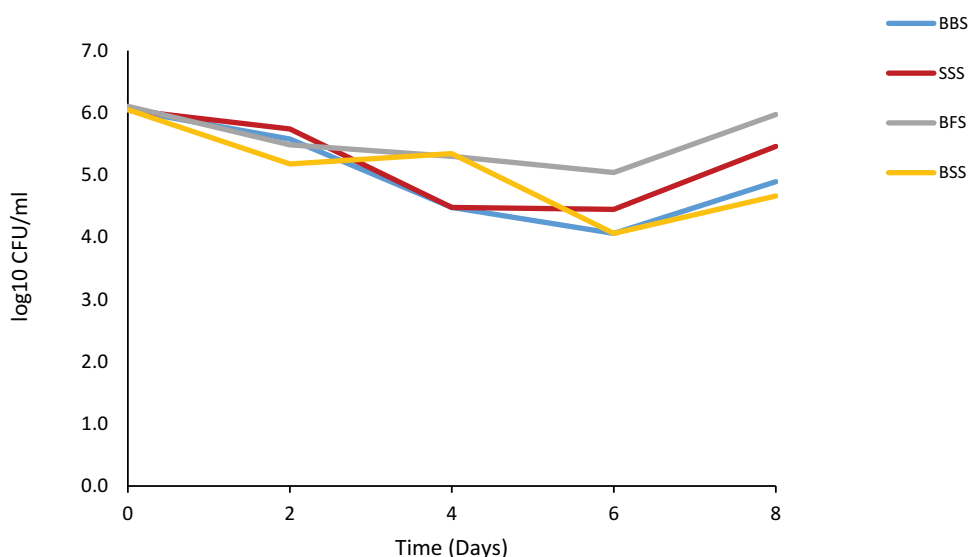


Figure 4. Coliform count of various Bambara groundnut spread samples over eight days of refrigerated storage. BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

sample had the highest coliform population for most of the storage period thus suggesting that they were able to tolerate the high acid production usually associated with fermentation and persist during storage. The increase in the population of coliforms in the samples suggests a need for the use of better quality water and hygienic practices in the production process.

Fungal counts

Only yeasts were observed with no molds recorded in all samples. All the spreads recorded lower fungal counts on Day 8 of refrigerated storage except sample BFS (Figure 5) which also had the highest counts ($\log_{10}$ 8.2 cfu/ml). BBS had the least fungal count both on the first and last day of storage which shows that the boiling process killed off most fungal propagules. The soaking process also seems to have removed considerable amounts of fungal spores.

The high microbial counts are observed because soybean is a good medium for microbial growth, and Figure 3–5 indicate that the counts are likely to continue to increase. However, the absence of molds means that there is no risk of mycotoxin contamination of the spreads.

Conclusion

This study showed that acceptable spreads of low-fat content can be produced from Bambara groundnut. The study also revealed that processing methods had effect on spread produced from Bambara groundnut. Boiled Bambara

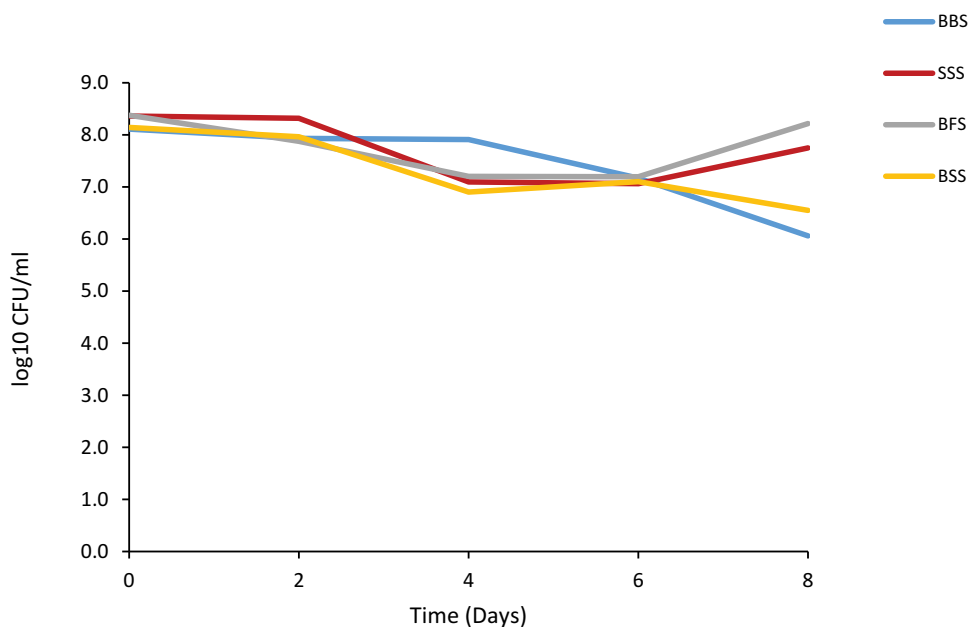


Figure 5. Fungal count of various Bambara groundnut spread samples over eight days of refrigerated storage. BBS = Boiled Bambara spread; BFS = Fermented Bambara spread; BSS = Soaked Bambara spread; SSS = Soaked soybean spread.

groundnut was the most acceptable in terms of sensory evaluation, color and nutritionally. It is also interesting to note that boiling also reduces the microbial loads compared to other pre-treatment methods as boiled samples had the lowest coliform and lowest mesophilic bacterial counts. Boiled Bambara groundnut can be used in the production of spread that can be taken by both children, adult and people suffering from diseases such as obesity and cholesterol-related problems.

Declaration of interest

The author declares no conflict of interest.

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