MICROBIAL QUALITY AND SENSORY ACCEPTABILITY OF PEANUT BUTTER PRODUCED FROM THREE LOCAL GROUNDNUT MARKET TYPES

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Abstract

Peanut butter is a nutrient-dense product whose safety and acceptability can be influenced by the source of groundnuts and by processing hygiene. This study evaluated the microbial quality and sensory acceptability of peanut butter produced from three local groundnut market types: Solar, Kampala, and White. The samples were sorted, roasted, blanched, milled, packaged separately, and evaluated by standard culture-based methods. Total bacterial count (TBC), total coliform count (TCC), and total fungal count (TFC) were determined, while representative isolates were characterized using cultural, microscopic, Gram-stain, and biochemical tests. Sensory evaluation was conducted with 10 panelists using a nine-point hedonic scale. TBC values were 7.3×10^3, 8.2×10^3, and 6.5×10^3 CFU/g for Solar, Kampala, and White samples, respectively. TFC values were 6.3×10^3, 5.8×10^3, and 2.9×10^3 CFU/g, respectively. Coliforms were not detected in Solar or Kampala samples but were enumerated at 1.9×10^3 CFU/g in the White sample. Presumptive isolates included Staphylococcus spp. and Bacillus cereus in Solar, Bacillus cereus in Kampala, and Salmonella-like and Bacillus cereus isolates in White; Aspergillus-like fungi were observed in all samples. Kampala had the highest overall mean sensory score (7.20 ± 1.43), closely followed by Solar (7.22 ± 1.35), whereas White was least preferred (4.00 ± 2.13). The occurrence of coliforms and presumptive food-safety-relevant organisms indicates the need for improved sanitation, confirmatory identification, and mycotoxin testing before commercial distribution.

Keywords: peanut butter, groundnut, sensory evaluation, microbial quality, food safety, Aspergillus

1. Introduction

Groundnut (*Arachis hypogaea L.*) is an economically important oilseed legume and a widely consumed source of protein, unsaturated lipids, dietary fibre, vitamins, minerals, and bioactive compounds. Peanuts are processed into several foods, including peanut butter, which is produced by grinding roasted kernels into a paste. Peanut butter is valued for its energy density, palatability, and use in household foods and nutrition interventions (Arya *et al.,* 2016; Munyaka *et al.,* 2021).

The quality of peanut butter depends on raw-material quality, cultivar or market type, roasting conditions, particle size, formulation, packaging, and storage. Sensory properties such as appearance, texture, taste, aroma, and colour are important determinants of consumer acceptance. Roasting is particularly important because it affects flavour development and product colour (Wang & Adhikari, 2017; Lykomitros *et al.,* 2018).

Peanuts and peanut products may be contaminated with bacteria and fungi at pre-harvest, harvest, storage, processing, or post-processing stages. Inadequate drying, poor hygienic practices, contaminated equipment, and inappropriate storage may increase the risk of contamination. Fungal contamination is especially important because some Aspergillus species can produce aflatoxins under favourable conditions (Mupunga *et al.,* 2017).

This study assessed the microbial quality and sensory acceptability of peanut butter prepared from three locally traded groundnut market types, designated Solar, Kampala, and White. These labels are retained as local market-type identifiers and should not be interpreted as officially registered botanical cultivar names.

2. Materials and Methods

2.1 Study materials and sample collection

Three locally traded groundnut market types, designated Solar, Kampala, and White, were purchased from Sayedero Market in ilaro, Ogun State and transported in clean, labelled polythene bags to the Science Laboratory Technology laboratory, The Federal Polytechnic, Ilaro, Nigeria. The samples were maintained in dry, cool conditions before processing. Each market type was processed separately to minimize cross-contamination.

2.2 Peanut butter production

Groundnut kernels were sorted manually according to standard food processing guidelines (AOAC, 2016) to remove visibly defective kernels and foreign materials. The kernels were cleaned, dried, roasted, cooled, blanched to remove skins, and milled to obtain peanut butter. The products were packed separately in sterilized containers.

2.3 Microbiological analysis

Media preparation and aseptic techniques followed standard microbiology protocols outlined by Cheesbrough (2006). For each sample, 10 g of peanut butter was aseptically homogenized in 90 mL of sterile 0.1% peptone water to obtain a 10^{-1} dilution. Tenfold serial dilutions were prepared to 10^{-6}. Appropriate dilutions were plated in duplicate using nutrient agar for aerobic bacterial enumeration, MacConkey agar for coliform screening, and potato dextrose agar for fungal enumeration. Bacterial plates were incubated at 37 °C for 24–48 h. Fungal plates were incubated at approximately 25 °C for 5–7 days. Plates with countable colonies were used to calculate microbial loads, expressed as CFU/g.

Nutrient agar, MacConkey agar, and fungal culture medium were prepared according to the manufacturers' instructions and sterilized by autoclaving at 121 °C for 15 min.

2.4 Identification of isolates

Representative bacterial colonies were characterized by colony morphology, Gram staining, catalase, citrate, urease, motility, hydrogen sulfide, and indole tests. Fungal isolates were examined for colony characteristics on potato dextrose agar and microscopic features after lactophenol cotton blue staining (Kumar *et al.,* 2016; Samson *et al.,* 2010). Identifications are reported as presumptive because confirmatory biochemical panels, selective confirmation, molecular identification, and toxigenicity testing were not performed.

2.5 Sensory evaluation

Ten panelists (five male and five female) evaluated coded peanut butter samples for appearance, texture, taste, aroma, and colour using a nine-point hedonic scale, where 1 = dislike extremely and 9 = like extremely. Scores are reported as mean ± standard deviation (SD). The overall sensory score was calculated as the mean of the five attribute scores for each sample.

2.6 Data analysis

Descriptive statistics were calculated from the recorded sensory scores. Means and sample SDs were calculated for each attribute.

3. Results

3.1 Microbial counts

The microbial loads of peanut butter samples are presented in Table 1. Kampala had the highest TBC (8.2×10^3 CFU/g), followed by Solar (7.3×10^3 CFU/g) and White (6.5×10^3 CFU/g). Solar had the highest TFC (6.3×10^3 CFU/g), while White had the lowest TFC (2.9×10^3 CFU/g). Coliforms were not detected in Solar and Kampala samples but were recorded in the White sample at 1.9×10^3 CFU/g.

Sample	TBC (CFU/g)	TCC (CFU/g)	TFC (CFU/g)
Solar	7.3×10^3	Not detected	6.3×10^3
Kampala	8.2×10^3	Not detected	5.8×10^3
White	6.5×10^3	1.9×10^3	2.9×10^3

Table 1. Total bacterial count (TBC), total coliform count (TCC), and total fungal count (TFC) in peanut butter samples.

3.2 Presumptive microbial identification

The original laboratory results indicated presumptive Staphylococcus spp. and Bacillus cereus isolates in Solar, Bacillus cereus in Kampala, and Salmonella-like and Bacillus cereus isolates in White (Table 2).

Sample	Presumptive bacterial isolates	Presumptive fungal isolate
Solar	*Staphylococcus spp.; Bacillus cereus*	*Aspergillus*-like isolate

Kampala	*Bacillus cereus*	*Aspergillus*-like isolate
White	*Salmonella*-like isolate; *Bacillus cereus*	*Aspergillus*-like isolate

Table 2. Presumptive microbial isolates recovered from peanut butter samples.

Fungal colonies were described as dark green, rapidly growing colonies with radiate conidial heads and globose vesicles, consistent with *Aspergillus*-like morphology. The report described the hyphae as non-septate; this characteristic is inconsistent with typical *Aspergillus* morphology. Therefore, the isolates are described here as *Aspergillus*-like pending confirmatory identification.

3.3 Sensory acceptability

Kampala and Solar peanut butter samples received higher sensory ratings than the White sample (Table 3). Solar recorded the highest mean appearance score (7.40 ± 1.51), while Kampala recorded the highest scores for texture (6.90 ± 2.08), taste (7.60 ± 1.71), and aroma (7.20 ± 1.14). Solar and Kampala had equal colour scores (7.80). The overall sensory scores were 7.22 ± 1.35 for Solar, 7.20 ± 1.43 for Kampala, and 4.00 ± 2.13 for White.

Attribute	Solar	Kampala	White
Appearance	7.40 ± 1.51	6.50 ± 2.17	4.20 ± 2.57
Texture	6.80 ± 1.75	6.90 ± 2.08	3.90 ± 2.18
Taste	7.40 ± 1.51	7.60 ± 1.71	3.70 ± 2.00
Aroma	6.70 ± 2.11	7.20 ± 1.14	4.50 ± 1.78
Colour	7.80 ± 1.32	7.80 ± 1.03	3.70 ± 2.54
Overall sensory score	7.22 ± 1.35	7.20 ± 1.43	4.00 ± 2.13

Table 3. Sensory scores (mean ± SD) for peanut butter samples on a nine-point hedonic scale (n = 10).

4. Discussion

Variation in microbial loads among the samples may reflect differences in the quality of raw kernels, roasting effectiveness, moisture conditions, equipment hygiene, packaging, and post-processing handling. Although peanut butter has low water activity, contamination can occur from raw materials and during processing, particularly when hygienic controls are inadequate.

The detection of coliforms in the White sample suggests possible contamination from water, equipment, handlers, or the processing environment. It should not be concluded that any sample meets microbiological safety criteria solely from total counts. In particular, the presence of coliforms or presumptive food-safety-relevant organisms warrants investigation and corrective action.

The report of a Salmonella-like isolate in White and *Staphylococcus spp*. in Solar is a food-safety concern, but the available tests do not confirm species identity. Salmonella confirmation normally requires validated selective enrichment, biochemical identification, and serological or molecular confirmation. Likewise, identification of *Staphylococcus* and *Bacillus* species should be confirmed using appropriate standardized methods. Consequently, this study does not claim definitive detection of these pathogens.

The recovery of *Aspergillus*-like fungi from all samples is relevant because peanuts can support the growth of *Aspergillus* species under poor drying and storage conditions. However, morphology alone cannot determine whether the isolates are toxigenic, and fungal isolation alone cannot demonstrate the presence of aflatoxins. Future work should include validated aflatoxin testing, such as ELISA, HPLC, or LC–MS/MS, alongside molecular identification of fungal isolates.

Solar and Kampala samples were substantially more acceptable than the White sample, particularly for taste, colour, and overall acceptance. The differences may be associated with market-type variation in oil content, kernel composition, roasting behaviour, particle size, and flavour development. Because sensory evaluation was performed using only 10 trained panelists, a larger blinded consumer study is needed before making broad market-preference claims.

5. Conclusion

Peanut butter prepared from Solar, Kampala, and White local groundnut market types showed differences in microbial quality and sensory acceptability. Kampala had the highest total bacterial count, Solar had the highest fungal count, and coliforms were detected only in White. Solar and Kampala had similar and substantially higher overall sensory ratings than White. The microbiological results indicate that stronger hygiene controls are needed during raw-material handling, roasting, milling, packaging, and storage.

The recovery of presumptive bacterial and fungal isolates should not be interpreted as definitive pathogen identification. Confirmatory microbiological testing and aflatoxin analysis are essential before any commercial, public-health, or regulatory conclusion is made about product safety.

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