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# Nutritional qualities, sensory characteristics, lipid oxidation and microbial assessment of meat floss marketed locally in Sabo-Mokola in Ibadan, Oyo State

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**Abstract**

Meat floss (MF) is one of the popular, traditional read-to-eat meat product produced and sold by local Northerner women in Nigeria. Due to the informal nature and procedures involved in its production, hygiene procedures are given little or no attention. Producers (P) were painstakingly sought in Sabo-Mokola. Freshly prepared MF (500g each) were purchased from three producers (PMF1, PMF2 and PMF3) and on the same day of purchase, Laboratory MF (LMF) was prepared following standard procedures. The experiment was completely randomized and replicated three times. Sensory characteristics using 9-point hedonic scale, protein (%), ash (%) saturated and unsaturated (%) contents using standard procedures were determined immediately. Thiobarbituric Acid Reactive Substances (TBARS) (MAmg/kg) and Total Heterophilic Counts (THC) (cfu/gx103) were assessed at 0, 7, 14 and 21 days. The LMF protein (47.66) was higher (P<0.05) than 37.57 (PMF1), 39.62 (PMF2), 40.19 (PMF3) while ash 5.50 (LMF), 4.97 (PMF2) and 4.73 (PMF3) were higher (P<0.05) than 3.40 (PMF1). Saturated fatty acid found in PMF ranged from 70.38-75.67 while unsaturated fatty acids ranged from 24.33-29.62. The LMF TBARS (1.12 -1.92) were lower (P<0.05) than 2.90-4.51, 3.51-4.90, 4.13-6.15 and 5.24-7.03 obtained in all PMF during storage. The PMF aroma (3.00-4.13), flavour (4.19-5.81) juiciness (3.56-3.75) were lower (P<0.05) while THC (0.30-5.67) was higher (P<0.05) than LMF aroma (5.13), flavour (5.81), juiciness (6.56) and THC (0.13-0.23). The low sensorial attributes, high saturated fatty acid, thiobarbituric acid reactive substances and microbial load revealed that meatfloss sold in Sabo-Mokola were low in quality. Effective steps should be taken to educate these producers on food safety including personnel hygiene and good manufacturing practices in order to improve and ensure safety of products.

## Introduction

In most developing countries, meat is widely processed into different meat products to avoid any form of spoilage (Thippareddi and Sanchez, 2006, Heinz and Hautzinger, 2007; Yusuf *et al.*, 2019) and also to meet the continuous increase demand for meat products that is highly nutritive, affordable and safe for consumption (Tijani and Jumare, 2014; Shaltout *et al.,* 2014).

These meat products ranges from the industrially processed ham, bacon, sausages to indigenous or traditionally processed ready-to-eat (RTE) meat products such as *balangu*, *tsire*, *banda*, *suya*, *kilishi*, *danbunama* (meatfloss) (Omojola *et al.,* 2014; Abdullahi *et al*., 2020).
These RTE meat products are easy, accessible and convenience food options for consumers (Pérez-Rodríguez *et al.,* 2010) because they are usually consumed without further processing or cooking. Their consumption have drastically increased due to the increasing volumes of works and extension of possible business hours of people (Bielemann *et al.,* 2015). However, due to the informal nature of most of these RTE meat products, it is often neglected by regulatory authorities, resulting in unwholesome practices.

Meat floss is one of the traditionally processed ready-to-eat (RTE) meat products usually produced and sold by the local Northerner women in Nigeria. Although, it is not a popular meat products as other street vended meat products like Suya and Kilishi, but it is fast becoming a household name because of its ability to keep for several days at room temperature (Omojola *et al.,* 2014). The growing importance of meatfloss as an indigenous fast food (Umar and

Mohammed, 2019) and the high demand by consumers for fresh, durable and safe foods makes it pertinent for the food producers (including producers of meatfloss) to present their products at its best (Jaeger *et al.*, 2014).

Due to the informal nature and local procedures involved in meatfloss production, hygiene procedures are given little or no attention. This exposes the products to various forms of contamination at every stage of handling and processing. Also, most producers of meatfloss (as with other street food vendors) are often poor, usually not educated and therefore lack knowledge and appreciation on basic food safety (Abdulmajid *et al.*, 2014) and consumers are little aware of the high health risk in the consumption of contaminated products (Ologhobo *et al.*, 2010).

Furthermore, most of safety studies on foods usually focused on microbiological contamination while few studies are available on other aspects such sensory characteristics and lipid oxidation that could affect the quality and safety of food as well.

This study is therefore designed to investigate the nutrient composition, sensory characteristics, fatty acid profile and the keeping quality in terms of thiobarbituric acid reactive substances (TBARS) and microbial loads of meat floss sold in Sabo-Mokola Ibadan Oyo State, Nigeria.

## Materials and methods

### Study area

Sabo axis of Mokola falls within Ibadan North Local Government area of Oyo State where highest population of the Northerners is located. This area is also assumed to be the highest producing area of meat floss within Ibadan metropolis.

### Sample collection

A total of 9 samples of meat floss (five hundred grams (500g) each) were purchased from three different producers (P1, P2, and P3) in Sabo -Mokola area. These producers were painstakingly sought for because only few people are engaged in the business. These producers were approached ahead (one week) of the day of purchase to inform them of the day the freshly prepared product will be needed. This is done to ascertain that the products will be freshly prepared on the proposed purchasing day and also to eliminate the effect of differences in the day of production. After purchase, each sample was wrapped in a foil paper and transported immediately to the laboratory. The sample were later stored in acrylic bottles at room temperature (Kassim and Omojola 2020) for further analysis.

### Meatfloss preparation

On the same day of purchase of meatfloss from Sabo-Mokola, another set of meat floss was prepared in the laboratory. Semitendinosus muscle was purchased from a commercial abattoir and transported to the laboratory within one hour of postmortem. The cooking and shredding ingredients recipe were compounded as described by Kassim and Omojola (2014) and meat floss was prepared following the procedures of Kassim and Omojola (2020).

### Experimental design

The meat floss samples were prepared in triplicates and the experiment was repeated three times in a completely randomized design.

### Parameters measured

**Proximate composition**

The proximate composition on all the freshly prepared meat floss (laboratory meat floss and the meat floss from the three producers) were determined according to AOAC (2000) methods. A drying method (ISO 1442, 1997) at 100 ± 2 °C for a period of 24 h (at this time a constant weight would have been achieved) was used for the determination of the content of dry matter. The samples were weighed after cooling and the content of dry matter calculated. The crude fat content was determined by extraction method using a SOXTEC instrument (Foss, Hilleroed, Denmark). Petroleum ether was used as the extraction agent. Crude proteins were determined by subsequent conversion of organic nitrogen to inorganic nitrogen in a KJELTEC instrument (Foss, Hilleroed, Denmark) by the Kjeldahl method. A factor of 6.25 was used for the conversion of the nitrogen content to the protein content . Ash content was determined by ashing samples overnight at 550C (Thermolyne Sybranm model: 6000, USA).

Thiobarbituric acid reactive substances (TBARS)

The 2-thiobarbituric acid (TBARS) assay was assessed by extraction. Two grams (2.0 g) sample was homogenized (Ultra Turrax T-25, Janke & Kunkel IKA-Labortechnik, Staufen, Germany) with 10 mL of 5% trichloroacetic acid (TCA) for 2 min (Allegra X-22R, Beckman, Fullerton, CA, USA). The homogenate was centrifuged for 10 min at 3500 rpm (Allegra X-22R, Beckman, Fullerton, CA, USA) and then filtered through 0.45 μm (Filter Lab, Spain).The extract (5.00 mL) was mixed with 0.2 M TBA (5.00 mL) and heated in a 97°C water bath (JP Selecta, Precise, Barcelona, Spain) for 40 min and cooling immediately in ice-water for 5 min. The absorbance was measured on a spectrophotometer (Agilent 8453, Waldbronn, Germany) at 532nm against a blank consisting of 5mL of the same homogenizing solution plus 5mL of TBA solution. The TBARS values were calculated from a standard curve performed with 1,1,3,3 tetraethoxypropane and expressed as milligrams malonaldehyde (MDA)/kg sample.

Sensory testing

Sensory parameters, including aroma, flavor, taste, juiciness and overall acceptability were evaluated using 30 untrained sensory panelists randomly selected (Sęczyk, *et al.,* 2016) among students and staff of the Department of Animal Science University of Ibadan. The panelists were presented with the meat floss samples in identical but labeled serving plate with a three-digit code for their evaluation. A 9-point hedonic scale test was used to obtain the acceptability score of the meat floss products. The likeness scale was arranged in accordance with the below sensory parameters as follows: 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely.

Fatty acid profile

Lipid extraction was performed according to the method described by Folch *et al*. (1957). The fatty acids were converted into fatty acid methyl esters using the method described by Hartman and Lago (1973). The fatty acid profile was determined by high-resolution gas chromatography (GC) using a gas chromatograph (HP 5890) equipped with a SUPELCO SP-2560 capillary column (100 mm×0.25 mm) coupled to a flame ionisation detector. The temperature program was set as follows: 130 °C (1.0 min) to 170 °C (6.5°/ min), 170 °C to 215 °C (2.75 °C/min), 215 °C (12 min), 215 °C to 230 °C (40°/min) and 230 °C (6 min). The injector and detector temperatures were 270 °C and 280 °C, respectively. The samples (0.3 μl) were injected by the direct injection technique. Saturated and unsaturated fatty acids containing 6, 8, 10, 12, 14, 15, 16 (cis and trans), 17, 18 (cis and trans), 20, 22 and 24 carbon atoms were identified by comparison with the data obtained for the GC of authentic methylated standards eluted under the same conditions

Microbial assessment

The microbiological quality and safety of meat floss were assessed on the basis of Total Heterophilic Count (THC), Total Coliform Count (TCC), Total *Staphylococcus aureus* Count (TSC), Total *Enterococcal* Count (TEcC) Total *Echerichia coli* Count (TEcC), Total *Pseudomonas* (TPsC) and Total *Lactobacillus* Count (TLC) using Plate count agar (PCA, Himedia, India), MacConkey agar (MCA, HiMedia, India), Mannitol Salt agar (MSA, Hi-Media, India), respectively. Diluted meat samples in normal saline were spread onto these plates and incubated at 37°C for 24 hr except detection of fungi, which were incubated at 25°C for 5 days. *Staphylococcus* isolates were confirmed by microscopic, cultural and standard biochemical tests (motility, catalase, coagulase, oxidase, urease, citrate utilization, indole, gelatin hydrolysis, MR-VP, TSI test) according to Bergey's Manual of Determinative Bacteriology, ($9^{th}$ Edition, 1994) for further analysis.

Statistical analysis

Data obtained were subjected to the statistical analysis of variance (ANOVA) at Pα 0.05 probability level using SAS. Bacterial counts were transformed from log10 CFU/g to CFU/g. Significant differences among treatments were separated using Duncan Multiple range Test (DMRT) procedure.

## Results

### Proximate composition of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola

The proximate compositions (%) of freshly prepared meat floss from laboratory and sampled producers in Sabo-Mokola as displayed on Table 1. The moisture (4.05) content of laboratory meatfloss (LMF) were significantly lower (P<0.05) than 9.08 (PMF1), 7.39 (PMF2) and 7.28 (PMF3). The LMF protein (47.66) was significantly higher (P<0.05) than 37.57, 39.62 and 40.19 recorded in PMF1, PMF2 and PMF3 respectively. The ash contents of LMF (5.50), PMF2 (4.97) and PMF3 (4.73) obtained in meatfloss from the different producers were significantly higher (P<0.05) than 3.40 recorded in PMF1. There was no significant differences (P>0.05) in the ether extract 2.31 (PMF1), 2.14 (PMF2), 2.45 (PMF3) and 2.63 (LMF) obtained in all the products under study.

Table 1: Proximate composition of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola

| Parameters (%) | PMF1 | PMF2 | PMF3 | LMF | SEM | P-value |
|---|---|---|---|---|---|---|
| Moisture content | $9.08^{a}$ | $7.39^{b}$ | $7.28^{b}$ | $4.05^{c}$ | 1.159 | 0.0003 |
| Protein | $37.57^{c}$ | $39.62^{b}$ | $40.19^{b}$ | $47.66^{a}$ | 2.317 | 0.0037 |
| Ether | 2.31 | 2.14 | 2.45 | 2.63 | 0.172 | 0.2152 |
| Ash | $3.40^{b}$ | $4.97^{a}$ | $4.73^{a}$ | $5.50^{a}$ | 0.510 | 0.0016 |

$^{abc}$ means in the same row column with different superscripts are significantly different (P<0.05)

Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

Mean scores from the sensory evaluation for each sensory characteristic (aroma, flavour, taste, juiciness, roppiness and overall acceptability) of the sample were depicted in Table 2. The aroma (3.63, 3.63, 3.00, 4.13), flavour (4.31, 4.69, 4.19, 5.81) and juiciness (3.75, 3.75, 3.56, 3.56) of all the sampled meatfloss from the Sabo producers were not significantly different (P>0.05) from each other but were significantly lower (P<0.05) than 5.31, 5.81 and 6.56 recorded for aroma, flavour and juiciness of the laboratory prepared meatfloss (LMF). The taste of meat floss from

PMF1 (6.56) and PMF2 (6.19) were not significantly different (P>0.05) from LMF (7.13) but these are significantly higher (P<0.05) than 4.69 recorded for PMF3.

Table 2: Sensory characteristics of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola

| | Meatfloss | | | | | |
|---|---|---|---|---|---|---|
| Parameters | PMF1 | PMF2 | PMF3 | LMF | SEM | P-value |
| Aroma | 3.63 | 3.63 | 3.00 | $5.13^{a}$ | 0.470 | 0.0090 |
| Flavour | $4.31^{b}$ | $4.69^{b}$ | $4.19^{b}$ | $5.81^{a}$ | 0.459 | 0.0023 |
| Taste | $6.56^{a}$ | $6.19^{ab}$ | $4.69^{b}$ | $7.13^{a}$ | 0.296 | 0.0076 |
| Juiciness | $3.75^{b}$ | $3.75^{b}$ | $3.56^{b}$ | $6.56^{a}$ | 0.607 | 0.0014 |
| Overall_acceptability | $6.94^{a}$ | $5.75^{ab}$ | $4.13^{b}$ | $7.19^{a}$ | 0.402 | 0.0120 |

$^{abc}$ means in the same row with different superscripts are significantly different (P<0.05)
Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

**Thiobarbituric acid reactive substances levels of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola**

The TBARS (MAmg/kg) levels of laboratory meatfloss and sampled producers in Sabo-Mokola is displayed on Table 3. The TBARS of LMF at 0 (1.12), 7 (1.14), 14 (1.17) and 21 (1.92) days were significantly lower (P<0.05) than (4.51, 2.90, 3.09), (4.90, 3.51, 3.54), (6.15, 4.13, 4.16), (7.03; 5.24; 5.89) obtained in PMF1, PMF2 and PMF3 at 0, 7, 14 and 21 days of storage respectively.

Table 3: Thiobarbituric acid reactive substances (MAmg/kg) levels of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola

| | Meatfloss | | | | | |
|---|---|---|---|---|---|---|
| storage days | PMF1 | PMF2 | PMF3 | LMF | SEM | P-value |
| 0 | $4.51^{a}$ | $2.90^{b}$ | $3.09^{b}$ | $1.12^{c}$ | 0.7305 | 0.00112 |
| 7 | $4.90^{a}$ | $3.51^{b}$ | $3.54^{b}$ | $1.14^{c}$ | 0.8264 | 0.00396 |
| 14 | $6.15^{a}$ | $4.13^{b}$ | $4.16^{b}$ | $1.17^{c}$ | 1.0727 | 0.00215 |
| 21 | $7.03^{a}$ | $5.24^{c}$ | $5.89^{b}$ | $1.92^{d}$ | 1.1467 | 0.00137 |

$^{abc}$ means in the same row with different superscripts are significantly different (P<0.05)
Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

**Proportion amounts of saturated and unsaturated fatty acids of freshly prepared meatfloss from the laboratory and different producers in Sabo-Mokola**

The proportion (%) of saturated and unsaturated fatty acids (figure 1), different saturated fatty acids (figure 2) and unsaturated fatty acids (Figure 3) in laboratory and producers sampled meat loss is shown below. The amount of saturated fatty acids in the sampled producers meatfloss were 75.36 (PMF1), 75.67 (PMF2) and 70.38 (PMF3) while the laboratory meat floss contain 16.38. The unsaturated fatty acids recorded in LMF was 83.62 while 24.64, 24.33 and 29.62 were obtained in PMF1, PMF2 and PMF3respectively. The ratio of poly unsaturated fatty acid and saturated fatty acid were 0.32 (PMF1), 0.32 (PMF2), 0.42 (PMF3) and 5.11 (LMF). Arachidic, behenic, heptadecanoic, Lignoceric were all absent in PMF1 and PMF2 while stearic acid was absent in all the meatfloss sampled from producers. Capric and caprylic were absent in both PMF3 and LMF while lauric acid is absent in LMF while myristic and palmitic fatty acids were present in all the meatfloss. The unsaturated fatty acids such as cis -10-heptadecanoic, cis-11-eicosenoic and palmitoleic were all absent in PMF1 and PMF2. Arachidonic is not detected in

both PMF3 and LMF while linolenic is absent in all the PMF while elaidic, linoleic and oleic were present in all the meatfloss.

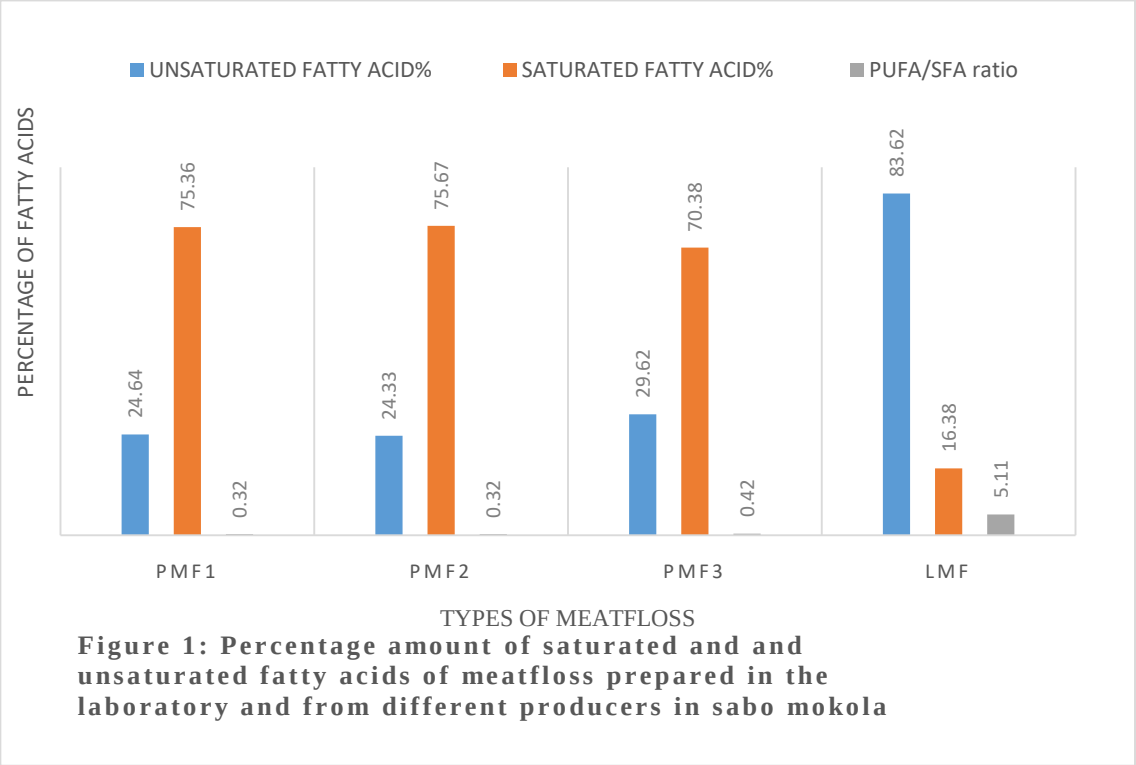


**Figure 1: Percentage amount of saturated and and unsaturated fatty acids of meatfloss prepared in the laboratory and from different producers in sabo mokola**

Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

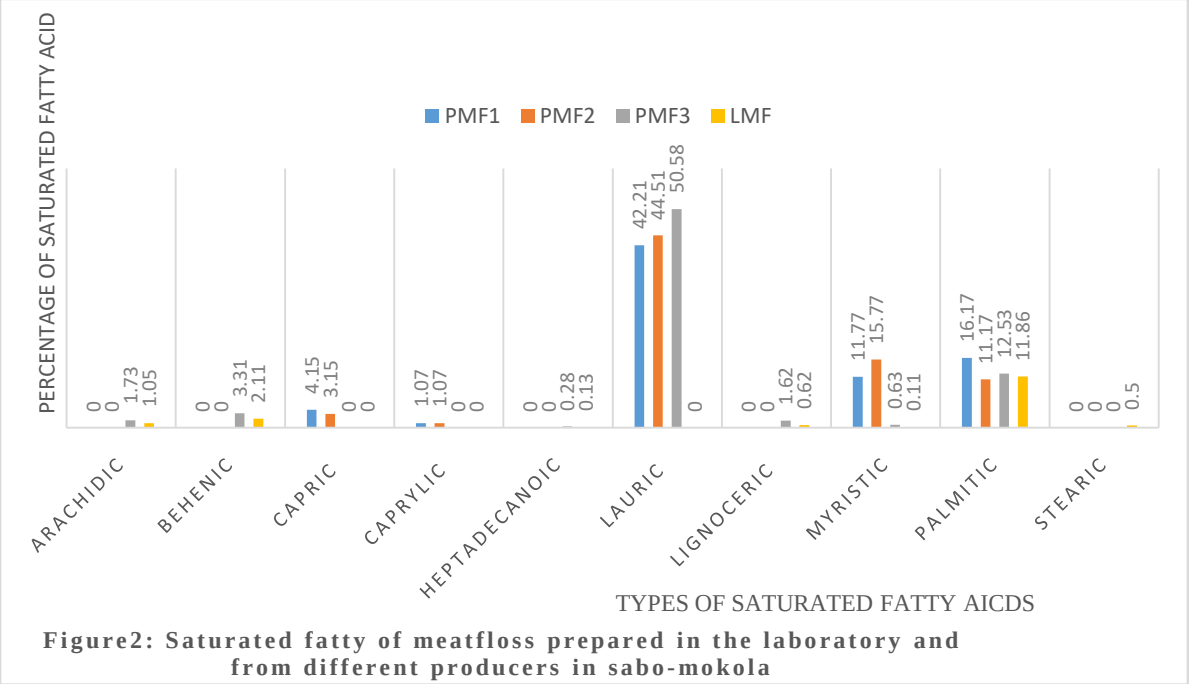


**Figure2: Saturated fatty of meatfloss prepared in the laboratory and from different producers in sabo-mokola**

Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

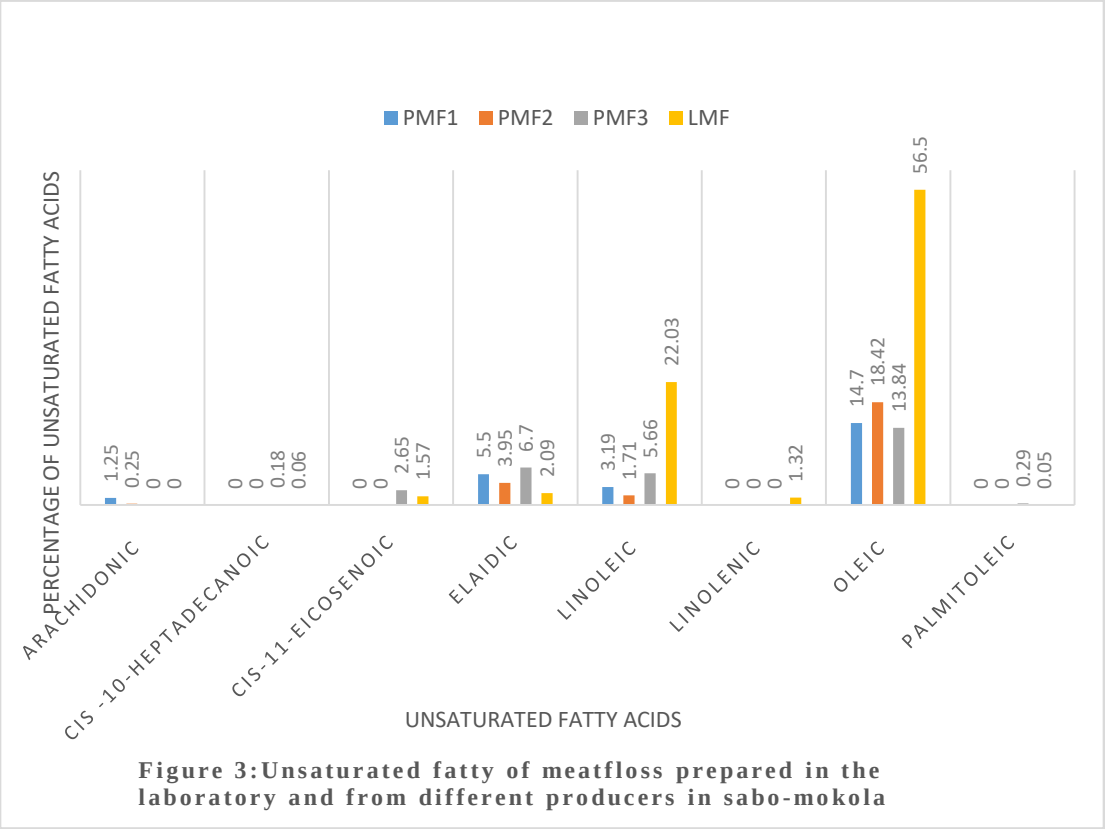


**Figure 3:Unsaturated fatty of meatfloss prepared in the laboratory and from different producers in sabo-mokola**

Footnote: PMF= Producer meatfoss; LMF= Laboratory meatfloss

**Microbial loads in meatfloss sampled from different producers in Sabo-Mokola and laboratory prepared meatfloss**

In this study Total heterophilic counts (THC) of the samples were determined and six different bacteria species: (Total *Coliform* counts (TCC), Total *Enterococcus* spp (TEnC), Total *Escherichia coli*, (TEcC), Total *Pseudomonas* spp, Total *Staphylococcus aureus* and Total *Lactobacillus* counts (TLC) were isolated from the sampled meatfloss. There is a highly significant differences (P<0.05) in THC, *Enterococcus*, *Escherichia coli*, *Coliform* counts among the examined products while the counts of *Pseudomonas*, *Staphylococcal* and Total *Lactobacillus* counts were not significant (P>0.05).

Table 6: Microbiological quality (cfu/gx$10^3$) of meatfloss prepared in the laboratory and from different producers in Sabo-Mokola during storage

| Days | samples | THC | TCC | TEnC | TEcC | TPsC | TSC | TLC |
|---|---|---|---|---|---|---|---|---|
| 0 | A | $5.67^{a(a)}$ | $1.47^{a(b)}$ | $0.57^{a(a)}$ | $0.23^{a(a)}$ | 0.10 | $0.13^{a}$ | $0.13^{b(a)}$ |
| | B | $4.77^{b(a)}$ | $0.13^{c(c)}$ | $0.20^{b(b)}$ | $0.03^{b(b)}$ | 0.13 | $0.17^{a}$ | $0.10^{b(a)}$ |
| | C | $4.87^{b(a)}$ | $0.47^{b(b)}$ | $0.43^{a(a)}$) | $0.17^{ab(a)}$ | 0.13 | $0.17^{a}$ | $0.10^{b(b)}$ |
| | D | $0.23^{c(b)}$ | $0.23^{bc(a)}$ | $0.07^{c(b)}$ | $0.13^{ab(a)}$ | 0.03 | $0.03^{b}$ | $0.03^{a(b)}$ |
| | P-value | $2.61x10^{-10}$ | $1.86x10^{-5}$ | 0.014 | 0.039 | 0.596 | 0.028 | 0.042 |
| 7 | A | $4.63^{a(a)}$ | $3.97^{a(a)}$ | $0.13^{a(}$b) | $0.13^{a(b)}$ | 0.13 | $0.10^{b}$ | $0.10^{ab(a)}$ |
| | B | $4.43^{a(a)}$ | $1.67^{b(a)}$ | $0.20^{a(b)}$ | $0.10^{a(a)}$ | 0.17 | $0.13^{b}$ | $0.10^{ab(a)}$ |
| | C | $3.03^{b(b)}$ | $1.47^{b(a)}$ | $0.20^{a(b)}$ | $0.17^{a(a)}$ | 0.17 | $0.27^{a}$ | $0.30^{a(a)}$ |
| | D | $0.33^{c(a)}$ | $0.17^{c(b)}$ | $0.13^{a(a)}$ | $0.03^{b(b)}$ | 0.03 | $0.03^{c}$ | $0.03^{b(b)}$ |
| | P-value | $2.33x10^{-8}$ | $1.3x10^{-7}$ | 0.109 | 0.0086 | 0.484 | 0.0129 | 0.034 |
| 14 | A | $4.37^{a(a)}$ | $1.73^{a(b)}$ | $0.13^{a(b)}$ | $0.10^{a(b)}$ | 0.10 | $0.13^{a}$ | $0.10^{a(a)}$) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B | $4.27^{ab(a)}$ | $0.47^{ab(b)}$ | $0.20^{a(b)}$ | $0.10^{a(a)}$ | 0.13 | $0.17^{a}$ | $0.10^{a(a)}$ |
| | C | $3.93^{b(b)}$ | $0.30^{b(b)}$ | $0.30^{a(ab)}$ | $0.17^{a(a)}$ | 0.20 | $0.17^{a}$ | $0.20^{a(ab)}$ |
| | D | $0.33^{c(a)}$ | $0.27^{b(a)}$ | $0.10^{a(a)}$ | $0.03^{a(b)}$ | 0.10 | $0.03^{b}$ | $0.17^{a(a)}$ |
| | P-value | $2.08x10^{-7}$ | 0.014 | 0.397 | 0.546 | 0.693 | 0.019 | 0.370 |
| 21 | A | $0.10^{b(b)}$ | $0.17^{a(c)}$ | $0.13^{ab(b)}$ | $0.10^{a(b)}$ | 0.10 | $0.10^{a}$ | $0.10^{a(a)}$ |
| | B | $0.17^{b(b)}$ | $0.10^{a(c)}$ | $0.33^{a(a)}$ | $0.13^{a(b)}$ | 0.17 | $0.13^{a}$ | $0.20^{a(a)}$ |
| | C | $0.30^{a(c)}$ | $0.27^{a(b)}$ | $0.23^{ab(b)}$ | $0.10^{a(b)}$ | 0.23 | $0.20^{a}$ | $0.30^{a(a)}$ |
| | D | $0.13^{b(c)}$ | $0.07^{b(c)}$ | $0.10^{b(a)}$ | $0.00^{b(c)}$ | 0.10 | $0.03^{b}$ | $0.10^{a(ab)}$ |
| | P-value | 0.016 | 0.021 | 0.016 | 0.0139 | 0.561 | 0.027 | 0.270 |
| | P value | 0.00001 | 0.00001 | 0.0106 | 0.479 | 0.890 | 0.900 | 0.7861 |

$^{abc}$ means in the same column with different superscripts are significantly different (P<0.05)
$^{abc}$ means in parenthesis in the same column with different superscripts are significantly different (P<0.05)

Footnote:
PMF= Producer meatfoss; LMF= Laboratory meatfloss
The superscripts in parenthesis describes the microbial growth in individual product on each of the storage days
THC: Total Heterotrophic Count; TCC: Total *Coliform* Count; TEnC: Total *Enterococcal* Count; TEcC: Total *Echerichia coli* Count; TPsC: Total *Pseudomonas* Count; TSC: Total *Staphylococcal* Count; TLC: Total *Lactobacillus* Count

## Discussion

Consumers' attitudes towards taste, healthiness and safety are the most important factors influencing consumption intentions (Latvala *et al*., 2012; Demartini *et al*., 2018). Consumer demands and the need for the food industry to manage product quality necessitate the need for food analysis (Nworu *et al*., 2021). Proximate analysis is of utmost importance to food manufacturer because of the need to ensure products meet the appropriate requirements in terms of laws and legal declaration as well as the safety aspects of the end products when released to the consumer (Nworu *et al*., 2021). The moisture contents of the PMF were higher than LMF but were still <10 thus making them to be classified as low-moisture food. The nutritional composition of the meatfloss varied although in a very narrow range but confirming the possibility of variation among the samples. This is reflected in the different moisture and fat contents recorded in all the PMF. This variation might be attributed to the different raw materials being used as they are from different sources. For instance, the fat content found in meat products is highly variable because its amount in meat products depends on the raw material the meat products are made from, the share of fatty tissue, recipe and production process (Jimenez-Colmenero, 2001). The low nutritional composition (which is reflected in the protein contents) of PMFs could be due to the use of repeated frying oil (a common practice with producers of fried food) because repeated frying oil decreases the nutritional value of the fried food (Abriana, *et al.*, 2019).

Thermal oxidation is one of the greatest threats to lipid in food and unsaturated lipids are especially susceptible (Stewart *et al*., 2003; Webera *et al*., 2008) and the extent of this lipid degradation in products is assessed by measuring the product TBARS levels (Naveena *et al*., 2005). As expected the level of TBARS in each of the product increased as the number of storage days increases. However, the rate of lipid oxidation in the LMF is slow compared with the meatfloss from the sampled producers. At the end of the experimental storage days, the level of TBARS recorded in all PMF and LMF were higher than 0.38-0.81 reported by Ogunsola and Omojola (2008) as the level of peroxidation found in meat floss during 6-9 weeks of storage.

However the values of TBARS found in all PMF products were as high as thrice as that found in the LMF. The observed differences in the result could be attributed to the type of oil used in the frying process. Although, groundnut oil is the standard/recommended oil used in the frying process but producers might have used adulterated oil which will eventually be reflected in the product. This is because the oil used in the cooking of food becomes part of the food (Miheala *et al*., 2010). Also, it might be that the oil used in the deep frying process of these products have been used repeatedly for frying (which is a normal practice with producers of fried food) which consequently will have tendency of high oxidation (Abriana, *et al.*, 2019).

Sensory analysis are used to evaluate sensory properties that are directly related to consumer understanding of quality (Ghonaim *et al*., 2020). Sensory characteristics such as appearance, flavor and texture are considered to be the most important determinant factor of consumer acceptability of meat and meat products Ghonaim *et al*., 2020). The high rating of the LMF by the panelists in most of the sensory parameters assessed might be attributed to the deep frying method used in meatfloss production. This is because deep fat frying of food contributes to the texture and flavour of fried foods (Abriana, *et al.*, 2019). Although it is expected that the PMFs should also be rated high as it is expected/assumed that these products are also deep fried but the reverse was observed. The marked decrease in some of the investigated sensory attributes (especially aroma, flavor and juiciness) in these PMFs might probably be due to the type of oil used by these sampled producers because most of the producers of fried food are culprit in repeated oil usage (using same oil repeatedly in frying). This is because the use of oil many times makes the structure and appearance of fried food less attractive thereby creating an unpleasant taste and smell and consequently the flavour of such fried food will not be preferred (Abriana, *et al.*, 2019). The low rating is also reflected in the overall acceptability of the PMF which might be attributed to the low acceptance of the flavour of these products. This is because the acceptability of meat products depends on their flavor (Ramarathnam and Rubin 1994) because flavour is an important factors that determine consumer's meat buying habits and preferences of meat and meat products (Ghonaim *et al*., 2020). The low sensory characteristics qualities recorded in PMFs might also be as a result of the high lipid oxidation (even as at the first day of production) recorded in these products. This is because sensorial quality of foods is one of the most important quality parameters affected by lipid oxidation (Morrissey *et al*., 1998).

The result of the fatty acid profile showed that the percentage of SFA in all the PMF were higher than what is obtained in LMF. The ratio of PUFA/SFA is an indicator of fatty acid quality of meat and meat products. The PUFA/SFA ratio in most of the PMF were lower than 0.4 recommended as the minimum ratio of PUFA/SFA (Simopoulos, 2002) to be found in food with good fatty acid quality. These differences in proportions of saturated and unsaturated fatty acids recorded in these sampled meatfloss from the producers might be due to the differences in the degree of unsaturation of the oil used. This is because frying oils are absorbed by cooked food and so become part of the food (Mihaela *et al*., 2010). The wide range differences in values of PUFA/SFA ratio in LMF and PMF is not expected because it is assumed that groundnut oil which is mostly used in deep frying of meatfloss is highly unsaturated and it is expected that this will be reflected in the meatfloss produced. However, the reverse is observed in all PMF and this difference might probably be that the oil used in production might have been adulterated through repeated usage (which is a common practice among producers of fried food because repeated use of cooking oil will change the physicochemical properties of the oil (Abriana, *et al.*, 2019).

The rate of development as well as continued existence of bacteria need to be monitored not only to determine the microbiological quality but also to evaluate the consumer welfare of such food products (Tavoschi, *et al*., 2015). The bacterial quality of the meatfloss under studied varied with the producers. It was also observed that based on the microbiological guidelines of ready-to-eat

food (CFS, 2014), the sampled meatfloss from the producers were of unsatisfactory quality due to their high THC. Furthermore, the heterogenous flora with respect to microbial numbers and composition of the sampled PMF generally had a high counts. The high THC recorded in all the PMF meat floss could be adduced to the high moisture content recorded in these products compared to LMF. This is because moisture content has great influence in the growth and replication of bacteria in foods as it contributes significantly to their microbial flora (Prescott, *et al*., 2002) However, these counts were lower than the values proposed by ICMSF (1986) who stated that values greater than or equal to $10^6$ cfu/g is dangerous and could result to some health problems such as food poisoning and intoxication. The THC obtained in this study was also within the acceptable limit of $5x10^4$-$10^5$cfu/g in case of total viable bacteria as proposed by FDA guideline (2013).

Contamination by pathogenic microorganisms is one of the most important challenges faced by producers of processed meat products. Ready-to-eat (RTE) meats products are especially of great concern because they are most times usually consumed without further cooking and are known to be good growth substrates for microorganisms. The identification of foodborne pathogenic bacteria in food is important both for quality assurance and to detect pathogens within the food supply (Hyun- Joong *et al*., 2008). These microbial groups are safety indicators, the presence of high counts may indicate possible presence of pathogens (Jay, 2005).

The general hygiene status of food is usually accessed through Enterobacteriaceae counts. The high Enterococcal counts observed in all the PMF as compared to LMF could be as a result of post-processing contamination. This is because most times their presence especially in heat treated food indicates inadequate cooking or post- processing contamination (CFS, 2014). Their presence could also be as a result of inadequate storage and displaying conditions during sale. This corroborates reports by Abdulmajid *et al*. (2014) that there is usually an unsanitary practices during handling, preparation and sale among the vendors of street foods.

Total *Escherichia coli* and Total *Coliform* counts enumeration are usually used as a food-quality structure (Nworu *et al*., 2021). For instance, elevated counts of *Escherichia coli* and total *Coliform* in foods usually implies lack of hygiene in handling and production operations, insufficient storage and post-process contamination (Akusu *et al*. 2019); while presence of Staphylococcus aureus in RTE food is an indication of poor hygiene which is associated with cross contamination occurring during processing and storage or through the contamination of raw ingredients (Akindele and Ibrahim, 2016). The presence and high incidence of *Escherichia coli, Staphylococcus aureus* and *Coliform* spp in all PMF indicate that there is relatively lack of some fundamental hygienic process among these producers. This is because the safety of food products on a consumer's plate depends largely on the way they have been produced of which personal hygiene is of utmost importance. These producers are also usually not adequately educated and without formal training in food preparation as common with producers involved in the processing and sale of street vended fried meat products. They thereby lacks knowledge and appreciation of basic food safety (Abdulmajid *et al*. 2014) which is necessary in the hygienic handling of foods (FAO, 1999). Incidentally, all mentioned organisms were also isolated in the LMF however, their presence is slight or almost not present.

## Conclusion

The findings from this study revealed that ready-to eat meatfloss sold in Sabo-Mokola axis of Ibadan is low in quality and might be unfit for human consumption because of its low sensorial qualities and high saturated fatty acids. This study has also shown that the microbial quality of meatfloss sold in this region although did not exceed the safety levels in terms of total heterophilic counts but still constitute a significant risk as it contains some foodborne pathogens. This implies that safe food handling practices and processing can improve the food quality, safety as well as the health of both food producers/vendors and consumers in developing

countries. Therefore, the food- regulatory agencies in this region should step up their surveillance and enlightment programmes on the importance of food hygiene and safety with a view to ensuring that the meat products sold in this area are safe for consumption.

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