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Nutritional Quality, Sensory Characteristics, lipid Degradation and Microbial Quality of Meat Floss Incorporated with *Mentha Peperita* L. (Peppermint leaves)

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ABSTRACT

Oxidation and microbial degradation are the limiting factors in the quality and acceptability of meat product. Deleterious effect from synthetic additives usage has increase the demand for natural additive sources to ensure safety of meat products and consumers. Meatfloss was prepared from semitendinosus muscle following a standard procedure. *Mentha pepperita* powder (MPP) inclusion in shredding recipe was 0, 1.25% and 2.50%. The study was completely randomized and replicated threes. Protein, ash, saturated and unsaturated fatty acids of freshly prepared meatfloss, Thiobarbituric Acid Reactive Substances (TBARS) (mgMA/kg) and Total Heterophilic counts (THC) (cfu/gx10^3) at 0, 1, 2, 3, 4 weeks were assessed using standard procedures. Protein (40.90%; 40.87%) and ash (6.06%; 7.27%) of 1.25% and 2.50% MPP meatfloss were higher (P<0.05) than 39.19% (protein) and 4.07% (ash) meatfloss with no MPP. No significant differences (P>0.05) among saturated and unsaturated fatty acids. Irrespective of the storage period, TBARS levels (1.14-1.40); (1.13-1.20) and THC (0.30-0.23); (0.33-0.03) of 1.25% and 2.50% MPP meatfloss were higher (P<0.05) than 1.14-2.00 (TBARS) and 0.41-2.40 (THC) of meatfloss with no MPP. Reduced levels of thiobarbituric acid reactive substances and low total heterophilic counts highlighted the potential usage of *Mentha pepperita* as efficient inhibitors of oxidative and microbial processes.

1. Introduction

Preservation of meat and meat products is usually accomplished by various methods which greatly lengthen the keeping quality (Orji, *et al.,* 2015). However, some of these methods could be costly, energy consuming, may require the service of specially trained personnel or detrimental to consumers health

The rich nutritional composition of meat and meat products makes it highly susceptible to quality deterioration (Devatkal *et al.,* 2012) such as oxidation and microbial deterioration.

The oxidative deterioration of lipids is of great concern in the shelf life of foods. These manifest in meat/meat products in form of discoloration, nutrient, sensorial qualities and drip losses, production and accumulations of potentially toxic compounds (Contini *et al.,* 2014). These occurring changes decreases the shelf life, acceptability and food safety of the meat (Sharafi *et al*., 2010) thus the need for preservation.

Preservation of meat and meat products is usually accomplished by various methods which greatly lengthen the keeping quality (Orji, *et al*., 2015). However, some of the methods used in the preservation of meat and meat products could be costly, energy consuming, may require the service of specially trained personnel or detrimental to consumers health. Also, one of the aims of the meat processing industry is to develop a high quality product with lower processing costs but with positive attributes related to appearance, practicality and safety (de Almeida *et al*., 2015). Therefore the need for alternative preservative methods that is less involving affordable and also beneficial to human health.

Prevention or retardation of oxidation and microbial growth in meat products can be achieved through incorporation of additives with antioxidants and antimicrobial properties. (Sharafi *et al.,* 2010). These additives can be found in naturally occurring spices which contain bioactive properties and also have the ability of prolonging the shelf life of food through antimicrobial activities. The incorporation of natural spices into food not only promotes the sensory characteristics but also enhances the nutrition and keeping qualities hence, the need to incorporate some of these spices into production of meat products.

Meatfloss is a spicy shredded Ready-To-Eat (RTE) meat product common among the Hausas in Northern Nigeria. It is usually made from beef and consumed mainly as a snack or in combination with other food as part of daily diet (Omojola *et al*., 2014). Meat floss is rich in protein and fat which makes it more liable to oxidation and microbial activities.

Although some of the ingredients used in meatfloss production contain some spices (ginger and garlic) with antioxidant and anti-microbial properties. However, extension of storage period with retention of quality and safety is very important in the food industry (Kassim and Omojola, 2020). This is because storage conditions of meat products are essential factors in meat processing since

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Table 1. Composition of ingredients for cooking recipe used in meat floss production (g/100g)

Ingredients		Quantity g/100g
Common names	Scientific names/ Botanical names*	
Salt	Sodium Chloride	7.00
Maggi (Knorrs®)	Monosodium glutamate	13.00
Thyme	Thymus vulgaris L.	10.00
Curry	Murrayakoenigii (L.) Spreng.	10.00
Onion	Allium cepa L. var. cepa	60.00
Total		100.00

Source: Kassim and Omojola (2020)

*All botanical names according to Rehm and Espig (1991)

Table2. Composition of ingredients for shredding recipe used in meat floss production (g/100g)

Common names	Scientific names/ Botanical names*	Quantity g/100g		
		A	B	C
Red pepper	Piper nigrum L.	35.00	35.00	35.00
Maggi (Knorrs®)	Monosodium glutamate	30.00	30.00	30.00
African nutmeg	Monodora myristica (Gaertn.) Dunal	2.50	1.25	0
Mint leaves	Mentha suaveolens	0	1.25	2.50
Ginger	Zingiber officinale Rosc.	4.00	4.00	4.00
Garlic	Allium sativum L.	3.00	3.00	3.00
Cloves	Syzygium aromaticum (L.) Merr. et L.M. Perry	2.50	2.50	2.50
Thyme	Thymus vulgaris (L).	2.50	2.50	2.50
Curry	Murraya koenigii (L.) Spreng.	3.50	3.50	3.50
Salt	Sodium chloride	3.00	3.00	3.00
Onions	Allium cepa L. var. cepa	14.00	14.00	14.00
Total		100.00	100.00	100.00

Source: Kassim and Omojola (2020)

*All botanical names according to Rehm and Espig (1991)

problems related to storage stability are common (Kozačins *et al*., 2012).

Therefore the need to further retard lipid oxidation and subsequent growth of microorganism in meat floss in order to make it more shelf stable.

2.Materials and Methods

2.1 Preparation of meat floss

Semitendinosus muscle was purchased from a commercial abattoir and transported to the laboratory within one hour of postmortem. The cooking (Table 1) and shredding ingredients recipe were compounded as described by Kassim and Omojola (2014). The percentage of African nutmeg in the ingredient composition (shredding recipe) was substituted with *Mentha Pepperita* (peppermint leaves) (Table 2). Meat floss was prepared following the procedure of Kassim and Omojola (2020). All the steps involved in the preparation of meat floss were carried out in the Meat Science Laboratory, Department of Animal Science, University of Ibadan, Oyo State, Nigeria.

2.2 Experimental design

The experiment was a completely randomized design where shredded meat samples were allotted to three experimental treatment represented by each frying ingredient recipe and each treatment replicated three times.

2.3 Parameters measured

2.3.1 Physicochemical properties of raw meat

Cooking loss

The cooking loss is calculated as

$$\text{Cooking loss \%} = \frac{\text{Initial weight of meat – weight of cooked meat X 100}}{\text{Initial weight of meat}}$$

Thermal shortening

Thermal shortening was calculated as

$$\text{Thermal shortening \%} = \frac{\text{Initial length of meat strip - final length of meat strip X100}}{\text{Initial length of meat}}$$

Water holding capacity (WHC)

The WHC of meat samples was determined by the press method as slightly modified by Suzuki *et al*. (1991) as described in Omojola *et al.* (2014). An approximately 1g of meat sample was placed between two (9 cm Whatman No1) filter papers (Model C, Caver Inc, Wabash, USA). The meat sample was then pressed between two 10.2 X 10.2 cm^2 Plexi glasses at about 35.2 kg/cm^3 absolute pressure for 1 minute using a vice. The meat samples were removed and oven dried at 80^{o}C for 24 hours to determine the moisture content. The amount of water released from the meat samples was measured indirectly by measuring the area of filter paper wetted relative to the area of pressed meat. Thus, the water holding capacity was calculated as follows:

$$\text{WHC} = \frac{100 - \{(Aw - Am \times 9.47)\}}{Wm - Mo}$$

Where: Aw = Area of water released from meat samples (cm^2)

Am = Area of meat samples (cm^2)

Wm = Weight of meat samples (g)

Mo = Moisture content of meat samples (%)

9.47 = a constant factor

2.3.2 Parameter measured on meat floss

Product yield

The product yield of meat floss was calculated using the method described by (Kembi and Okubanjo, 2002)

$$\text{Product Yield (\%)} = \frac{\text{Weight of meat floss X100}}{\text{Weight of raw meat sample}}$$

Proximate composition

The proximate composition of the raw meat sample used in the meat floss preparation and freshly prepared meat floss 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 has 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).

Sensory testing

The sensory tests were performed in the Meat Science Laboratory. The consumers were placed in individual tasting booths, where they received instructions on the use of nine-point hedonic scale, the nature and type of the products and the type of evaluation to be carried out. The samples were served on disposable white plastic plates coded with random three-digit numbers and evaluated under white light. The respondents were provided with water and unsalted crackers as palate cleanser between each sample. After the colour acceptance evaluation, the consumers were requested to taste the product and evaluate how much they liked or disliked each sample with respect to flavour, tenderness, roppiness, juiciness and overall acceptance. The scale is structured as (1=disliked extremely, 5=neither liked/nor disliked and 9=liked 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 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

Thiobarbituric acid reactive substances (TBARS)

The 2-thiobarbituric acid (TBARS) assay of meat floss at day zero and during storage were assessed by extraction method described by Vyncke. 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, Precisdg, 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.

Microbial assessment

The microbiological quality and safety of meat floss were assessed on the basis of Total Viable Bacterial Count (TVBC), Total Coliform Count (TCC), Total *Staphylococcus aureus* Count (TSAC) and Total *Salmonella* and *Shigella* Count (TSSC), and Total Fungal Count (TFC) using Plate count agar (PCA, Himedia, India), MacConkey agar (MCA, HiMedia, India), Mannitol Salt agar (MSA, Hi- Media, India), *Salmonella-Shigella* agar (SSA, HiMedia, India) and Potato Dextrose agar (PDA, HiMedia, India), respectively. Diluted meat samples in normal saline were spread onto these plates and incubated at 37°C for 24 hr. *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(1994) for further analysis.

3.Statistical analysis:

Data obtained were analysed by statistical analysis of variance (ANOVA) at Pα 0.05 probability level using SAS (2012). Bacterial counts were transformed from CFU/g to log10 CFU/g. The comparison of means was performed by the Duncan Multiple range Test (DMRT) procedure.

4. Results and Discussion

Physico-chemical properties

The physicochemical properties of the raw meat used in this study for the production of meat floss as displayed (Table 3) showed that the raw meat has a cooking loss of 27.82%, thermal shortening of 26.14% and water holding capacity of 77.31%.

Table 3. Physico-chemical properties of the raw meat used in meat floss production

Parameters (%)	Values (%)
Cooking Loss	27.82
Thermal Shortening	26.14
Water Holding Capacity	77.31

Product yield (%) and proximate compositions (%)

The yields and proximate compositions from meatfloss incorporated with *Mentha pepperita* powder (MPP) is displayed on Table (4).

Table 4. Yield and Proximate composition of meatfloss with graded levels of *Mentha pepperita* powder

	Meatfloss samples				
Parameters (%)	**A**	**B**	**C**	**SEM**	**P-value**
Moisture	9.95^{a}	6.05^{b}	6.65^{b}	0.997	0.0015
Protein	39.19^{b}	40.87^{a}	40.90^{a}	0.624	0.0003
Ether extract	2.63	2.59	2.72	0.071	0.3062
Ash	4.07^{b}	7.27^{a}	6.07^{ab}	1.185	0.0276
DM	96.05^{a}	95.95^{a}	93.35^{b}	0.997	0.0016
Product Yield	85.72	86.50	89.83	0.087	0.0006

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

Foot note: MPP= *Mentha Pepperita* powder

A= meatfloss with no MPP; B= meatfloss with 1.25% MPP; C= meatfloss with 2.50% MPP

The yields of the meat floss were not significantly different from each other and it ranged from 85.72-89.83%. The moisture contents (6.05% and 6.65%) of meatfloss with 1.25% and 2.50% MPP respectively were significantly lower (P<0.05) than 9.95% obtained in meatfloss with no MPP. The protein contents (40.87% and 40.90%) of meat floss with MPP were significantly higher (P<0.05) than 39.19% present in the control meat floss. The ash content 7.27% (2.50% MPP) and 6.07% (1.25% MPP) were not different (P>0.05) but higher (P<0.05) than 4.07% obtained in meatfloss with no MPP.

The proximate composition displayed further buttress that meatfloss is nutrient dense (Omojola *et al*., 2014). The high protein recorded in the present study could be as a result of the low fat content found in the meatfloss because a higher fat proportion in 100 g of sample indicates a lower protein proportion in the same 100g sample and *vice versa* (Wazir *et al*., 2019). The moisture, protein and ether extract contents of meat floss recorded in all the meat floss produced were lower than 17.69-19.59% (moisture), 39.75-46.73% (protein), 2.30-3.95% recorded for meat floss produced from different types of meat (Omojola *et al*. 2014). These results were also lower than 11.38-11.43% (moisture), 43.44-45.54% (protein) and 9.85-11.19% (ash) recorded for meat floss produced from different types of oil (Kassim and Omojola, 2020). However, the protein contents of meatfloss in this study were higher than 19.86-30.15% recommended for serunding samples (Huda *et al*., 2012). The differences in the nutrient contents could be attributed to the differences in the nutrient composition of the raw meat used in producing the different meatfloss. The reduced fat content is also indicates an improved and better quality of the product (meatfloss) which is also reflected in the low percentage of the sum total of the saturated fatty acids.

Displayed on Table (5) the average values of the effect of MPP inclusion on sensorial attributes such as aroma, flavour, taste, juiciness and overall acceptability of meatfloss.

Table 5. Sensory attributes of freshly prepared meatfloss with graded levels of *Mentha pepperita* powder

	Meatfloss samples				
Parameters	A	B	C	SEM	P-value
Aroma	5.13	4.69	5.69	0.567	0.44
Flavour	5.81	4.94	5.94	0.568	0.38
Taste	6.56	5.69	6.44	0.373	0.18
Juiciness	4.56	4.69	5.44	0.643	0.09
Overall acceptability	6.94	6.00	7.06	0.393	0.09

[abc] means in the same row with different superscripts are significantly different (P<0.05)

Foot note: MPP= *Mentha Pepperita* powder

A= meatfloss with no MPP; B= meatfloss with 1.25% MPP; C= meatfloss with 2.50% MPP

The results showed that all the attributes did not display any significant differences (p>0.05) among all the products. The panelists rating were 4.69-5.69 (aroma), 4.94-5.94 (flavor), 5.69-6.56 (taste), 356-5.44 (juiciness) and 6.00-7.06 (overall acceptability).

The sensory characteristics results highlighted that the attributes aroma, flavor, taste juiciness and general impression/acceptability of meatfloss with MPP (addition of 1.25% and 2.50%% of *Mentha pepperita*) received acceptance by the consumers. This is evident in the average scores received which are closer to seven. As reported by Dutcosky (2011), the acceptability index of 7.0 is the minimum that a product should reached in order to be considered of positive acceptability in the different sensorial parameters assessed. As observed by the panelists inclusion of MPP in meatfloss did not decrease or change the sensory characteristics of the product. The non-significance difference in the aroma and taste of MPP and control meat floss as rated by the panelist might be due to the low perception of *Mentha pepperita* in the meat floss due to its low percentage inclusion.

Fatty acid composition

The composition of meatfloss fatty acids (figure 1) ranged between 18.45- 25.77% saturated fatty acids (SFAs) and 71.14-81.15 % unsaturated fatty acids (USFAs). All the saturated fatty acids (Arachidic, Behenic, Heptadecanoic, Lauric, Lignoceric, Myristic, Palmitic and Stearic) (figure 2) analysed in this study were present in meatfloss with no MPP.

In meatfloss with 1.25% MPP, Heptadecanoic, Lauric and stearic acids were absent while in MPP with 2.50%, lauric acid is absent. In addition, the percentage of each of the saturated fatty acids present in meatfloss with MPP irrespective of the percentage inclusion were low. The unsaturated fatty acids analysed in this study (figure 3) were Cis -10-heptadecanoic, Cis-11-eicosenoic, Elaidic, Linoleic, Linolenic, Oleic and Palmitoleic. The amount of each of these unsaturated fatty acids in meatfloss with MPP were higher than the amount present in meatfloss containing no MPP. Although Cis-11-eicosenoic and Palmitoleic were absent in meat floss containing MPP.

In shredded meat products, fatty acid composition is of great importance because the susceptibility to lipid oxidation depends largely on the unsaturation degree of the fatty acids (Wazir, *et al*., 2019).

The results in the present study were similar to 69.40 % for PUFAs, 30.60 % for SFAs indicated by the United States Department of Agriculture. The results also showed that the fatty acids compositions were acceptable as the food industry aims to develop products with low levels of SFAs and higher contents of PUFAs to increase the nutritional value of food. This also confirms that inclusion of MPP did not negatively affect the fatty acid profile of meat floss. The sum total of unsaturated fatty acids in all the products were higher than the total saturated fatty acids which contradicts the report of Wazir *et al*. (2019) who reported a higher proportion of saturated and lower unsaturated fatty acids in shredded meat. The differences in fatty acids proportions recorded by these researchers 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 effect of graded levels of MPP on the saturated and unsaturated fatty acid composition showed that the fatty acids content varied and that meatfloss is rich in essential fatty acids. Meatfloss with MPP inclusion contain one of the most important fatty acid such as linolenic acid required in the diet (Kaur, *et al*., 2014). Also, the percentage of linoleic (24.02%; 29.05%) and oleic acids (54.10%; 46.22%) found in MPP meatfloss were higher than 23.36% (linoleic) and 46.16% (oleic) obtained in meatfloss with no MPP. This also affirms that the presence of *Mentha pepperita* in food will have a positive effect on the nutritional composition of the food.

Thiobarbituric acid reactive substances (TBARS)

The TBARS levels (MAmg/Kg) (Table 4) in the freshly prepared meat floss did not display any significant differences (P>0.05) among the treatments at week zero, the values ranged between 1.13-1.14MAmg/kg.

Table 6. Thiobarbituric acid reactive substances (mgMA/kg) of meat floss incorporated with *Mentha Pepperita* during storage

Storage period	**Meatfloss samples**				
	A	**B**	**C**	**SEM**	**P-value**
Week 0	1.14	1.14	1.13	0.01	0.88
Week 1	1.24^{a}	1.16^{b}	1.14^{b}	0.03	0.002
Week 2	1.27^{a}	1.20^{b}	1.14^{c}	0.04	0.0005
Week 3	1.93^{a}	1.35^{b}	1.26^{c}	0.22	0.00007
Week 4	2.00^{a}	1.40^{b}	1.20^{c}	0.10	0.0004

[abc] means in the same column with different superscripts are significantly different (P<0.05)

Foot note: MPP= *Mentha Pepperita* powder

A= meatfloss with no MPP; B= meatfloss with 1.25% MPP; C= meatfloss with 2.50% MPP

At the 1st week, no significant difference (P>0.05) was observed in the TBARS of MPP meatfloss. The values 1.16 (1.25%) and 1.14 (2.50%) were significantly lower than 1.24 obtained in for meatfloss with no MPP. This trend was also noticed at 2nd, 3rd and 4th week where TBARS levels (1.20, 1.14), (1.35, 1.26) and (1.40, 1.20) of meat floss incorporated with 1.25% and 2.50% MPP respectively were significantly lower (P<0.05) than 1.27, 1.93 and 2.00 recorded in meat floss with no MPP at 2nd, 3rd and 4th week respectively.

Oxidation is one of the most important factors that limits the quality and acceptability of meat product (Das *et al.*, 2020) and one of the leading products of fatty acids decomposition during lipid oxidation process is malonaldehyde (MDA) which is quantified through TBARS assay. As expected, during the storage periods, TBARS levels of meatfloss varied. It was observed that all meat floss incorporated with MPP have reduced TBARS indicating slow rate of oxidation in these products. This trend is more evident in meat floss with 2.50% MPP. These observations highlighted the lipid oxidation inhibition effect and the satisfying antioxidant action of MPP. This also confirmed that MPP contains some bioactive compounds that are capable of retarding/inhibiting lipid oxidation (Nascimento *et al*., 2020**;** Biswas *et al*., 2021). This indicates that MPP could be a good preservative alternative in meat floss production thus eliminating the possible toxicology effect from the use of synthetic preservatives. The results of this study corroborate the reports of Abu Salem and Ibrahim (2010), Bussata (2010) and Jayawardana *et al*. (2011) that addition of natural antioxidants in meat products keeps the TBARS levels relatively constant during storage period. At the end of the experimental storage period, the TBARS levels recorded for all meatfloss are higher than 0.5 and 1.0 mg MDA/kg at which no rancidity is detectable in meat products (Ahmad and Srivastava, 2007). However, the TBARS values obtained in this study were lower than 1.59 mg MDA/kg reported by Torres and Okani (1997) as the level where sensorial analysis did not perceived rancidity. This implies that meatfloss prepared with MPP and stored for four weeks as carried out in this study is still within the values, quality and invariably will not cause any harm to consumer's health.

Microbiological growth (cfu/gx10^3)

The microbes (cfu/gx103) analysed in this study (Table 7) were Total heterophilic counts (THC), Total *Coliform* counts (TCC), Total *Enterococcus* spp (TEnC), Total *Escherichia coli*, (TEcC), Total *Pseudomonas* spp, Total *Staphylococcus aureus* and Total *Lactobacillus* counts (TLC). The results showed that irrespective of the storage days, meat floss containing MPP had lower (P<0.05) microbial loads.

Furthermore, the displayed result also indicate that *TEcC*, TPsC, TSC and TLC; TEnC, TEcC, TPsC and TSC; TEcC and TPsC ; TEnC, TEcC, and TSC; TEcC, TPsC, TSC and TLC were absent at 0, 1, 2, 3 and 4 week respectively in meatfloss containing 2.50% MPP. Also, at 1st week TPsC and TSC were not recorded so aslo TEcC at 3rd and 4th week in meatfloss containing 1.25% of MPP.

Microbiological stability is very crucial to products quality (Cabral *et al*., 2021) because microbial degradation of a product contributes to its spoilage. The high THC (cfu/g x 10^3) found in meatfloss with no MPP might be attributed to the high moisture content recorded in the meat floss (Table 3). This is because moisture is one of the major intrinsic factor that plays important role in bacteria distribution in foods (Hammed *et al*., 2019). However, the enumeration of THC during storage were lower than $5x10^4$-10^5 cfu/g recommended by FDA guideline (2013) as the acceptable limit in processed meat. Also, at day zero and during storage, the mean values of THC obtained in the meatfloss is lower than 7.5×10^3 cfu/g obtained by Uddin (2018) for fried chicken sold in Dhaka city and $3.3x10^5$ found in locally processed meat products (Hassanien *et al*., 2018), while *Staphylococcus aureus* count and *Enterobacteriaceae spp* were lower than $4.27x10^3$ and $0.2x10^2$ recorded by Uddin (2018). The displayed results showed that the storage period is directly associated with the development and survivability of the assessed microorganisms. It was observed that some of the microorganism assessed were absent in meatfloss with MPP and where there is growth, it was minimal/slight. Another observation worthy of mention is that irrespective of the storage time there was no growth of *Echerichia coli* and *Pseudomonas* spp in the meat floss containing 2.50% MPP while their growth in meatfloss with 1.25% MPP were almost negligible. This indicates that *Mentha pepperita* (peppermint leaves) possess antimicrobial properties (Brown *et al*., 2019) that can inhibitor/ retard the growth of microorganisms. This also corroborate the report of Bupesh *et al*. (2007) and Mancuso (2020) that *Mentha* species are bacteriostatic especially against gram positive bacteria such as *Staphylococcus aureus, Enterococcus* spp and gram negative bacteria such as *Pseudomonas* spp and *Escherichia coli*. This is evident in the slow proliferation of these microorganisms during storage in meatfloss incorporated with MPP. Furthermore, the slow growth of these microorganisms in MPP meatfloss also agrees with the report of Cabral *et al*. (2021) that natural additives in food prevent/retard the growth of some species of microorganisms.Although, the isolation of *Pseudomonas* species from the meatfloss is an indication of possible post production contamination because these organisms are expected to have been destroyed during the high temperature treatment of frying (Raji, 2006). However, aerobic bacteria especially gram negative rod shaped such as *Pseudomonas spp* have been reported to be dominant meat spoilage organisms (Dainty and Mackey, 1992; Borch *et al*., 1996). In addition the presence of *Staphylococcus aureus* could be due to the fact that humans are the primary reservoirs of *Staphylococcus aureus* (Abdullahi *et al*., 2020). The low frequency of occurrence of *Staphylococcus aureus* and *Escherichia coli* in these products ascertained the healthiness of the meatfloss produced in this study, this is because these microorganisms cannot be tolerated in large numbers particularly in ready-to-eat meat products (Abdullahi *et al*. 2020). This observation contradicts the report of Tijani *et al.* (2015) and Ananias and Roland (2017) that these microorganisms are the most isolated microorganism in meat products. The less frequency occurrence of Staphylococcus aureus and Escherichia coli in this study is in conformity with the report of Nwakanma *et al.* (2015), Lawrence *et al.* (2016), Falegan *et al.* (2017) and Abdullahi *et al.* (2020) on stored meat products. However, the presence of *Staphylococcus aureus* could be due to the fact that humans are the primary reservoirs of *Staphylococcus aureus* (Abdullahi *et al*., 2020).

Conclusions

Increasing the shelf-life of foods is an the important aspect and one of the major purposes of food processing and this can be achieved by delaying lipid oxidation and inhibiting/retarding microbial activities of the food. The outcome of this study showed that inclusion of *Mentha pepperita* in meatfloss do not change the taste, flavor and other functional properties of meatfloss. It also highlighted the potentials of *Mentha pepperita* as efficient inhibitors of

Table 7. Microbial load (cfu/gx10^3) of meat floss incorporated` with *Mentha pepperita* powder during storage

	Meatfloss samples	THC	TCC	TEnC	TEcC	TPsC	TSC	TLC
0	A	$2.40^{a(a)}$	$0.80^{a(a)}$	0.23	0.13	0.13	0.17	0.17
	B	$0.23^{b(a)}$	$0.23^{b(a)}$	0.13	0.13	0.20	0.10	0.13
	C	$0.33^{b(a)}$	$0.23^{b(a)}$	0.07	0.00	0.00	0.00	0.00
	P value	$6.8x10^{-6}$	$1.27 x10^{-2}$	0.563	0.379	0.618	0.394	0.258
1	A	$2.63^{a(a)}$	$0.13^{a(b)}$	0.20	0.13	0.10	0.10	0.20
	B	$0.20^{b(a)}$	$0.10^{a(a)}$	0.13	0.13	0.00	0.00	0.10
	C	$0.03^{b(b)}$	$0.07^{a(b)}$	0.00	0.00	0.00	0.00	0.10
	P value	0.003	0.813	0.562	0.562	0.492	0.492	1.000
2	A	$0.33^{a(b)}$	$0.23^{a(b)}$	0.10	0.13	0.10	0.17	0.10
	B	$0.13^{b(b)}$	$0.20^{b(a)}$	0.13	0.10	0.20	0.13	0.10
	C	$0.03^{b(b)}$	$0.17^{b(b)}$	0.03	0.00	0.00	0.10	0.10
	P value	$5.88x10^{-8}$	$3.83x10^{-5}$	0.739	0.562	0.368	0.842	0.422
3	A	$0.40^{a(b)}$	$0.47^{a(b)}$	0.10	0.03	0.10	0.10	0.10
	B	$0.30^{b(a)}$	$0.20^{b(a)}$	0.10	0.00	0.03	0.03	0.01
	C	$0.03^{c(b)}$	$0.17^{b(b)}$	0.00	0.00	0.01	0.00	0.01
	P value	$5.01x10^{-3}$	$1.46x10^{-3}$	0.593	0.492	0.492	0.492	0.927
4	A	$0.41^{a(b)}$	$0.40^{a(b)}$	0.20	0.10	0.10	0.10	0.01
	B	$0.30^{b(a)}$	$0.27^{b(a)}$	0.10	0.00	0.03	0.03	0.01
	C	$0.03^{c(b)}$	$0.10^{c(b)}$	0.10	0.00	0.00	0.00	0.00
	P value	$3.22x10^{-2}$	$1.21x10^{-3}$	0.873	0.672	0.761	0.547	0.874

^{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)
Foot note: MPP= *Mentha Pepperita* powder
A= meatfloss with no MPP; B= meatfloss with 1.25% MPP; C= meatfloss with 2.50% MPP

oxidative processes and also retards of growth and activities of spoilage microorganisms thus act as a preservative in extending the shelf life of meatfloss.

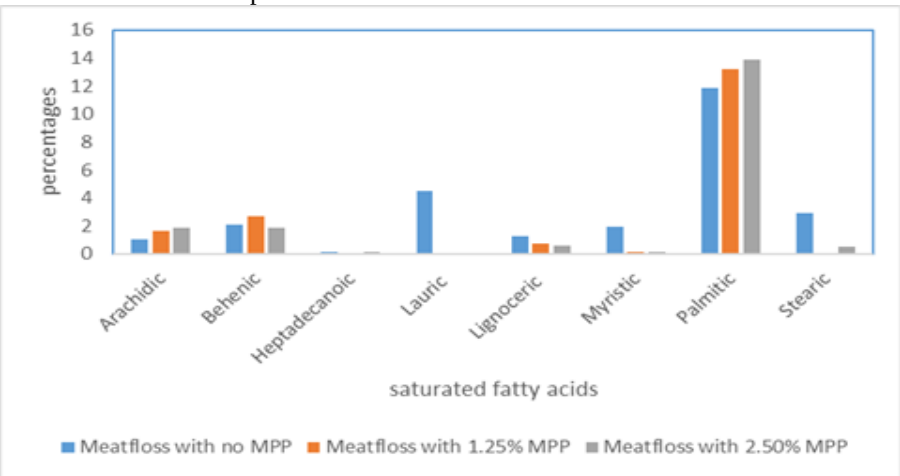

Figure 1. Saturated and unsaturated fatty acids composition of meat floss incorporated with *Mentha pepperita* powder Footnote: MPP= *Mentha pepperita* powder Footnote: MPP= *Mentha pepperita* powder

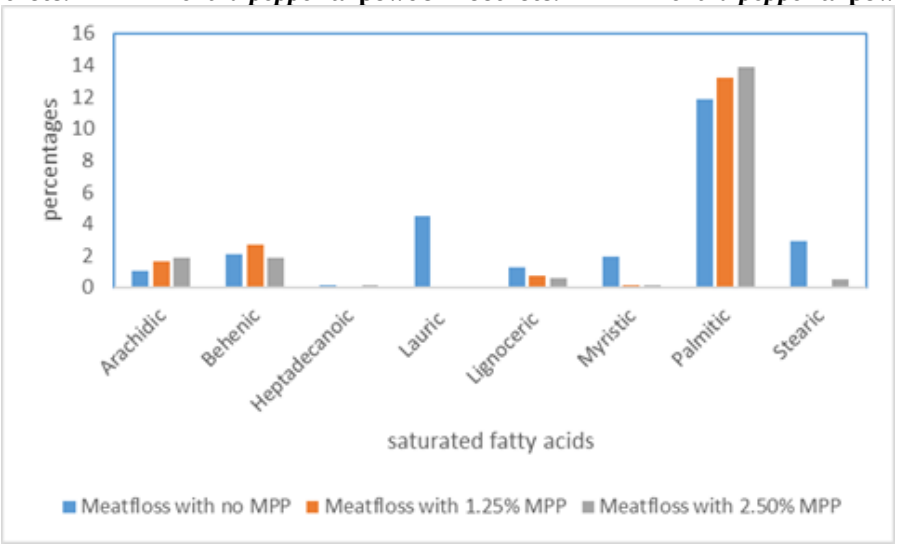

Figure 2. Saturated fatty acid profile of meatfloss with graded levels of *Mentha pepperita* powder (MPP) MPP= *Mentha Pepperita* powder

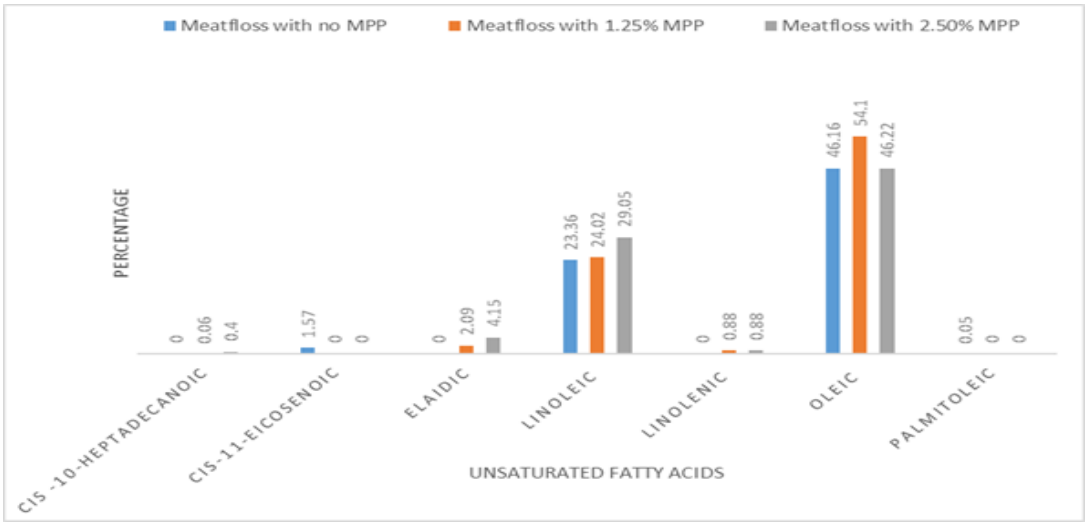

Figure 3. Unsaturated fatty acid profile of meatfloss with graded levels of *Mentha pepperita* powder (MPP)
MPP= *Mentha Pepperita* powder

References

Abdullah, F. S., Igwegbe, A. O., Bello, B. A., Igwegbe, I. U., Badau, M. H., Abashe S. and Ali, Z. (2020). A comparative study of bacteriological load of freshly fried and stored sallah meat from Danbatta Local Government Area of Kano State, Nigeria. International Research Journal of Public and Environmental Health.7 (4), 117-126.

Ananias B and Roland K. (2017). Bacterial contamination of ready-to-eat meat vended in highway markets in Uganda. African Journal Food Science 11(6), 160-170.

AOAC (2000). Official methods of analysis of the association of the official analysis chemists 17th (ed.) Arlington, Virginia. AOAC International.

Bergey, D. H., Holt, J. G. and Krieg. N. R (1994). Bergey's Manual of Determinative Bacteriology, 9th Edition. Lippincott Williams & Wilkins. MI, USA.

Borch, E., Kant-Muermans, M. L. and Blixt, Y. (1996). Bacterial spoilage of meat and cured meat products. International Journal. Food Microbiology. 33: 103–120.

Brown, N., John, J. A. & Shahidi F. (2019). Polyphenol composition and antioxidant potential of mint leaves. Food production, processing and nutrition 1:1 https://doi.org/10.1186/s43014-019-0001-8.

Bupesh, G., Amutha, C. Nandagopal, S., Ganeshkumar, A. Sureshkumar, P. and Saravana Murali, K. (2007). Antibacterial activity of Mentha piperita L. (peppermint) from leaf extracts – a medicinal plant. Acta agriculturae Slovenica, 89, 73-79.

Cabral, N., de Oliveira, R. F., Henry, F. de Oliveira, D.B., Santos Junior, A. C., Maia Junior, J. and Martins, M. L. (2021). Effect of the fruit aqueous extract of balloon pepper (Capsicum baccatum var. Pendulum) on lipid oxidation, microbiological quality and consumer acceptance of fresh pork sausage and smoked. Food Science and Technology ISSN 1678-457X (Online) DOI: https://doi.org/10.1590/fst.09221.

Contini, C., Alvarez, R., O'Sullivana, M., Dowling, D. P., Gargan, S. O. & Monahan, F. J. (2014). Effect of an active packaging with citrus extract on lipid oxidation and sensory quality of cooked turkey meat. Meat Science 96:1171-1176.

Dainty, R. H. and Mackey. B. M. (1992). The relationship between phenotypic properties of bacteria from chill stored meat and spoilage processes. Journal Applied Bacteriology Symposium. Suppl. 73, 103S–114S.

Das, A. K., Nanda, P. K., Bandyopadhyay, S, Banerjee, R., Biswas, S. and McClement, D. J. 2020. Application of nanoemulsionbased approaches for improving the quality and safety of muscle foods: A comprehensive review. Comprehensive Review Food Science and Food Safety, 19(5), 2677-2700, doi: 10.1111/1541-4337.1260

de Almeida, M. A., Villanueva, N. D. M., Gonçalves, J. R. and Contreras-Castillo, C. J. (2015). Quality attributes and consumer acceptance of new ready-to-eat frozen restructured chicken. Journal Food Science and Technology 52(5), 2869–2877.

Devatkal, S. K., Thorat, P. and Manjunatha, M. (2012). Effect of vacuum packaging and pomegranate peel extract on quality aspects of ground goat meat and nuggets. Journal of Food Science and Technology, http://dx.doi.org/10.1007/s13197-012-0753-5.

Dutcosky, S. D. (2011). Análise sensorial de alimentos (3rd edtition) Curitiba: Editora Universitária Champagnat.

Falegan C.R., Akoja, S. O. and Oyarekua M. A. (2017). Microbiological assessment of suya in Ado Ekiti metropolis, Ekiti State, Nigeria. MOJ Biol. Med. 2(3), 266-269.

Folch, J., Lees, M. and Stanley, G. H. S. (1957). A Simple Method for the Isolation and Purification of Total Lipides from Animal Tissues. Journal Biology Chemistry 226(1):497–509

Food and Drug Administration (FDA). (2013). Revised guidelines for the assessment of microbiological quality of processed food.

Hammuel, C., Abdullahi, I. O., Whong, C.M.Z., Kadima, K.B. and Enenya, R. (2019). Assessment of proximate composition and bacteriological quality of some fresh meat sold in parts of Kaduna State, Nigeria. FUDMA Journal of Microbiology 2(1): 26-31.

Hartman, L. and Lago, R. (1973). Rapid preparation of fatty acid methyl esters from lipids. Laboratory practice 22(6), 475-479.

Hassanien, Fatin S., Shaltout, A. Fahi., Hashim F. Mohammed., Lamiaa M. Lotfy and El-Nagar, M.Hatem. (2018). Quality assurance of some locally processed meat products. Benha Veterinary Medical Journal, 34(1), 41-47.

Huda N, Fatma Y, Fazillah, A. and Adzitey F. (2012). Chemical composition, colour and sensory characteristics of commercial serunding (Shredded Meat) in Malaysia. Pakistan Journal of Nutrition. 11(1), 1-4.

Jayawardana, B. C., Hirano, T., Han, K. H., Ishii, H., Okada, T., Shibayama, S., Fukushima, M., Sekikawa, M. and Shimada, K. (2011). Utilization of adzuki bean extract as a natural antioxidant in cured and uncured cooked pork

sausages. Meat Science, 89(2), 150-153. http://dx.doi. org/10.1016/j.meatsci.2011.04.005. PMid: 21663804.

Kassim O. R. and Omojola, A. B. (2014). Yield, nutritional and sensory qualities of meat floss prepared from three frying oils. Ibadan Journal of Agricultural Research 10(2):157-167.

Kassim, O. R. and Omojola, A. B. (2020). Effects of cooking oils and packaging media on quality of meat floss. Nigerian Journal Animal Production 47(3), 323 – 335.

Kaur, N., Chugh V. and Gupta A. K. (2014). Essential fatty acids as functional components of foods- a review. Journal Food Science Technology. 51(10), 2289–2303.

Kembi S.O. and Okubanjo A.O. (2002). Physicochemical and sensory properties of dehydrated beef patties containing soybean products. Tropical Animal Production Investigation. 5,137-148.

Kozačins, L., Fleck, C., Filipović, I., Mitak, M., Bratulić, M., and Mikuš, T. (2012). Evaluation of shelf life of pre-packed cut poultry meat. Veterinarski Arhiv, 82(1), 47-58.

Lawrence O. A., Faith, O. S., Ruth, E. and Nathaniel, N. N. (2016). Bacterial status and anti-bacterial susceptibility profiles of selected pathogens associated with Suya samples purchased in Bori, Metropolis, Rivers State, Nigeria. Internationsl. Research Journal Public and Environmental Health 3(2), 14 - 19.

Mancuso Monique (2020). The antibacterial activity of Mentha. In Herbs and Spices. Muhammad Akram and Rabia Shabir Ahmad edition.

Mihaela, G., Mira, T., George, B., Petru, N. and Vasilica, S. (2010). Nutritional and health aspects related to frying (1). Romanian Biotechnology Letters 15 (6), 5675-5682.

Nwakanma C., Unachukwu, M. N. and Momoh O. R. (2015). Bacteriological examination of suya meat sold in Enugu metropolis. World Journal Pharmaceutical Research 4(12): 61-70.

Omojola, A. B, Kassim, O. R., Olusola, O. O., Adeniji, P. O. and Aremo, J. O. (2014). Development and quality evaluation of danbunama (meat floss) - a Nigerian shredded meat product. British Journal of Applied Science & Technology 4(26), 3862-3873.

Orji J., Ugbo E., Ejikeugwu C., Okonkwo E., Nwuzo A., Moses I., Nwakaeze E., Agumah N. and Ogene L. (2015). Microbial Contamination of Ready-to-Eat Fried Chicken Meat Sold in two Selected Motor Park Points in Abakaliki, Ebonyi State, Nigeria. International Journal of Pure and Applied Bioscience. 3(4), 271-275.

Raji, A. I. (2006). Bacteriological Quality of Dried Sliced Beef (Kilishi) Sold In Ilorin Metropolis. Journal Applied Science, Environment and Management. 10 (1), 93- 96.

Sampaio, G. R., Saldanha, T., Soares, R.A. M. and Torres, E. A. F. S. (2012). Effect of natural antioxidant combinations on lipid oxidation in cooked chicken meat during refrigerated storage.

SAS 2012. Statistical Analysis System, Cary, North Carolina.

Shah, M. A., Bosco, S. J. D. and Mir, S. A. (2014). Plant extracts as natural antioxidants in meat and meat products. Meat Science, 98(1), 21–33.

Sharafi, S. M., Rasooli, I., Owlia, P., Taghizadeh, M. and Astaneh, S. T. A. (2010). Protective effects of bioactive phytochemicals from Mentha piperita with multiple health potentials. Pharmacognosy Magazine Jul-Sep 2010 Vol 6 Issue 23.

Suzuki, A., Kaima N. and Ikeuchi Y. 1(991). Carcass composition and meat quality of Chinese purebred and European X Chinese crossbred pigs. Meat Science.29, 31-41.

Tijani, A.O. and Jumare, S. (2014). Microbiological quality assessment of meat Samples sold in Kaura, Namoda. International Conference on Earth, Environment and Life Sciences December 23-24. Dubai, UAE.

Uddin, M. A. (2018). Microbiological analysis of ready to eat foods collected from different places of Dhaka city, Bangladesh. Stamford Journal of Microbiology. 8(1): 30-33.

Wazir, H., Chay, S. Y., Zarei, M., Hussin, F. S., Mustapha, N. A., Wan Ibadullah Wan Z. and Saari, N. (2019). Effects of Storage Time and Temperature on Lipid Oxidation and Protein Co-Oxidation of Low-Moisture Shredded Meat Products. Antioxidants, 8, 486, 1-17. doi:10.3390/antiox8100486.