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Oxidative stability, microbial and nutritional qualities and sensory characteristics of meat floss incorporated with *Mentha peperita* L. (peppermint leaves)

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***Target Audience:** Meat products consumer, Food safety industry*

Abstract

Oxidation and microbial degradation are the limiting factors in the quality and acceptability of meat products. The deleterious effect of synthetic additives has increased the demand for natural additive sources in order to ensure safety of meat products and consumers. Ingredients compositions and meatfloss production were carried out following a standard procedure. Mentha pepperita powder (MPP) was included in shredding recipe at 0, 1.25% and 2.50% in a completely randomized design. Protein and ash of freshly prepared meat floss Thiobarbituric Acid Reactive Substances (TBARS) (mgMA/kg) and Total Heterophilic Counts (THC) (cfu/gx10^3) at 0, 7, 14, 21, 28 days were assessed using standard procedures. Protein (40.90%; 40.87%) and ash (6.06%; 7.27%) contents of 1.25% and 2.50% MPP meatfloss were higher ($P<0.05$) than 39.19% (protein) and 4.07% (ash) of none MPP meatfloss. 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 respectively were lower ($P<0.05$) than 1.14-2.00 (TBARS) and 0.41-2.40 (THC) of meat floss with no MPP. The significant reduction in thiobarbituric acid reactive substances and low heterophilic counts of meat floss highlighted the potential of Mentha peperita as efficient inhibitors of oxidative and microbial processes in meat product.

***Keywords:** Shelf life, Mentha pepperita, lipid oxidation, antimicrobial activity, microbial counts, meatfloss*

Description of Problem

The rich nutritional composition of meat and meat products makes it highly susceptible to quality deterioration (1) such as oxidation and microbial spoilage. The oxidative deterioration of lipids is of great concern in the shelf life of foods. These manifest in meat and meat products in form of discoloration, nutrient, sensorial qualities, production and accumulations of potentially toxic compounds (2). Due to the nutrient content, meat product is also a good media for the proliferation of microorganisms (3) and these microorganisms are mostly spoilage organisms that are responsible for discoloration, off-odours, development of slime and production of toxic compounds and pathogens responsible for food-borne diseases (4). These occurring changes decreases the shelf life, acceptability and food safety of the meat (5) thus the need for preservation.

Preservation of meat and meat products is usually accomplished by various methods which greatly lengthen the keeping quality (6). However, some of these methods could be costly, energy consuming, may require the service of specially trained personnel or detrimental to consumer's health. Also, one of the aims of the meat processing industry is to develop a high quality product with low processing costs but with positive attributes related to appearance, practicality and safety (7). Therefore the need for alternative preservative methods that is less stressful, 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 (5). These additives can be found in naturally occurring spices which contain bioactive properties which have the ability of prolonging the shelf life of food.

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 (8). Meat floss is rich in protein and fat (8, 9) 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 (9). This is because storage conditions of meat products are essential factors in meat processing since problems related to storage stability are common (10).

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

Faced with this phenomenon, it is imminent to research into different plants/spices with large reserves of active substances that can confer high antioxidant and antibacterial properties to food in an attempt to promote the use of such plants for food preservation. These plant-derived antioxidant and antimicrobial properties have raised appreciable interest among consumers, food scientists and producers (11) due to the deleterious effect and safety surrounding the consumption of synthetic compounds conventionally used as food preservatives.

The African *Mentha pepperita* is a popular plant conventionally use in cosmeceuticals, personal hygiene products, foods and pharmaceutical products for both its flavouring and fragnance properties (12, 13). Its major constituents were menthol (44.32%), menthofuran (13.18%), menthl acetate (12.10%), menthone (7.42%) and 1.8-cineole (6.06%). Several researchers had described the *Mentha piperita* as a potential antioxidant (12) and antimicrobial element and most literatures available dwell more on the potential of the essential oil extracted from the plant in carrying out these activities.

This study therefore aimed at assessing the nutritional composition of meat floss incorporated with *Mentha piperita* leaves and its potential in extending the shelf life of the product.

Materials and Methods

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 (8). 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 (9). All the steps involved in the preparation of meat floss were carried out in the Animal Product and Processing Laboratory, Department of Animal Science, University of Ibadan, Oyo State, Nigeria.

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: (9)
*All botanical names according to (14)

Table 2: 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
peppermint leaves	*Mentha peperita*	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: (9)
*All botanical names according to (14)

Experimental design

The experiment was a completely randomized design where shredded meat samples were allotted to three experimental frying ingredient recipe represented by inclusion of *Mentha peperita* at graded levels of 0, 1.25%, 2.50% and each treatment replicated three times.

Parameters measured

Physicochemical properties of raw meat

a. Cooking loss : The cooking loss is calculated as

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

b. Thermal shortening: Thermal shortening was calculated as

$$\text{Thermal shortening \%} = \frac{\text{Initial length of meat strip} - \text{final length of meat strip} \times 100}{\text{Initial length of meat}}$$

c. Water holding capacity (WHC)

The WHC of meat samples was determined by the press method as slightly modified by (15) as described in. (8). 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^oC 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:

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

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

Parameter measured on meat floss

Product yield

The product yield of meat floss was calculated using the method described by (16)

Product Yield (%) =

$$\frac{\text{Weight of meat floss} \times 100}{\text{Weight of raw meat sample}}$$

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 (17). 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 550°C (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, hotness, juiciness and overall acceptance. The scale is structured as (1=disliked extremely, 5=neither liked/nor disliked and 9=liked extremely).

Fatty acid profile analysis

Lipid extraction was performed according to the method described by (18). The fatty acids were converted into fatty acid methyl esters using the method described by (19). 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 (20) for further analysis.

Statistical analysis:

Data obtained were analysed by statistical analysis of variance (ANOVA) at Pα 0.05 probability level using (21). 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 at P_{α}0.05.

Results

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 of meat floss incorporated with *Mentha pepperita* powder (MPP) is displayed on Table (4). The results revealed that no statistical variation (P>0.05) exists among the yields and ether extracts of the meat floss. The values range were 85.72-89.83% and 2.59-2.74 for yield and ether extracts contents respectively. 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.

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

	Inclusion levels of *Mentha pepperita* powder				
Parameters (%)	**0**	**1.25%**	**2.50%**	**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
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

Sensory evaluation of MPP meatfloss

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

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).

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

	Inclusion levels of *Mentha pepperita* powder				
Parameters	**0**	**1.25%**	**2.50%**	**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	6.00	6.94	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

Fatty acid profile

The fatty acid composition of MPP meatfloss (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.

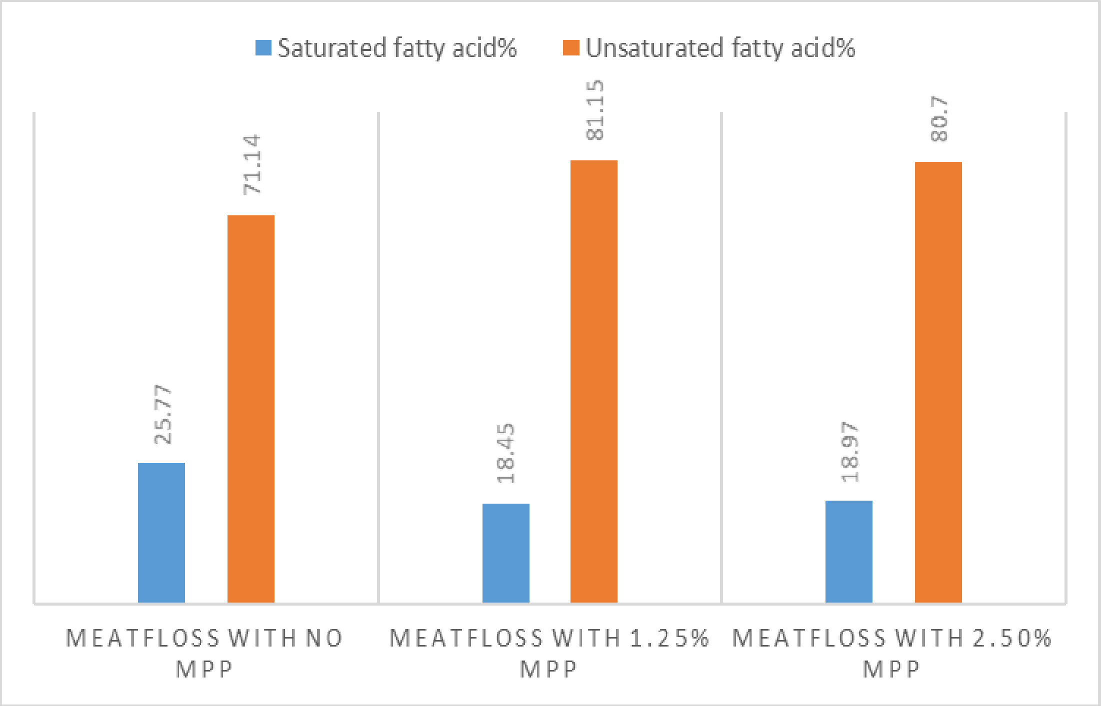

Figure 1: Saturated and unsaturated fatty acids composition of meat floss incorporated with *Mentha pepperita* powder
Footnote: MPP= *Mentha pepperita* powder

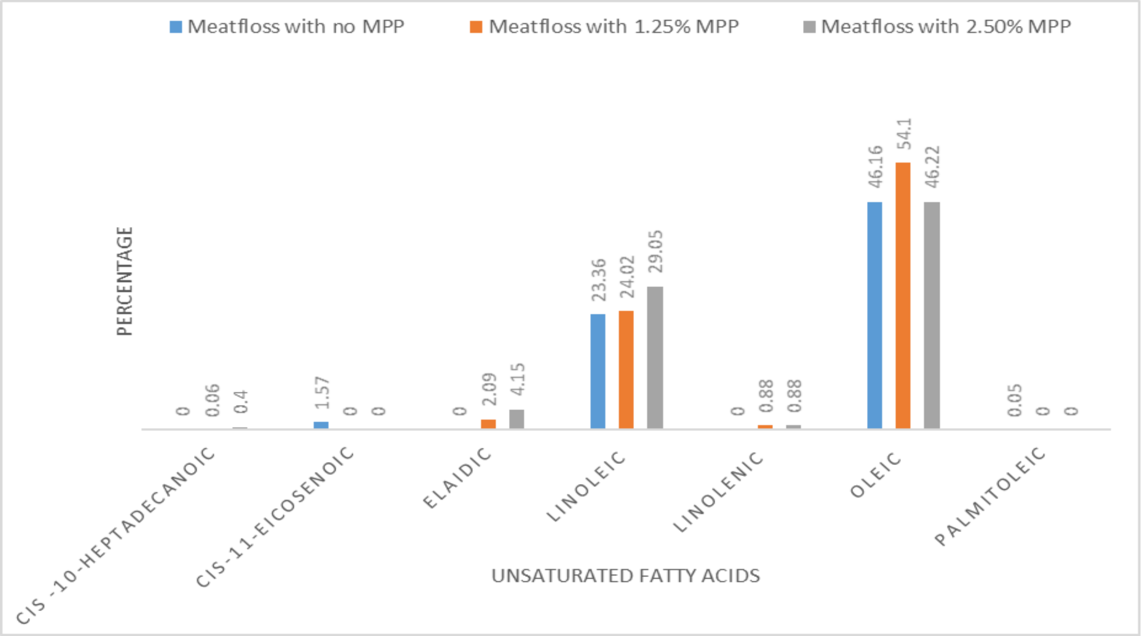

Figure 2: Saturated fatty acid profile of meatfloss with graded levels of *Mentha pepperita* powder
MPP= *Mentha Pepperita* powder

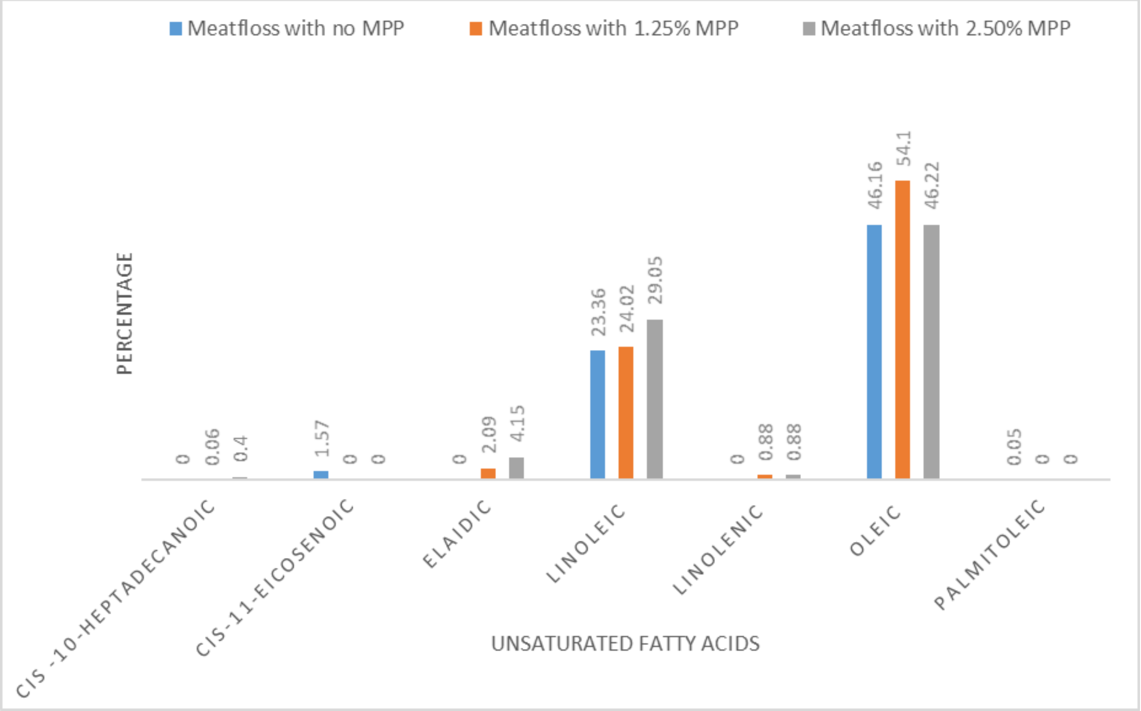

Figure 3: Unsaturated fatty acid profile of meatfloss with graded levels of *Mentha pepperita* powder (MPP)
MPP= *Mentha Pepperita* powder

Thiobarbituric acid reactive substances (TBARS)

The TBARS levels (MAmg/Kg) (Table 6) in the freshly prepared meat floss did not display any significant differences (P>0.05) in all the meatdloss day zero, the values ranged between 1.13-1.14. At day 7, no significant difference (P>0.05) was observed in the TBARS levels of 1.25% (1.16) and 2.50% (1.14) MPP meatfloss but were significantly lower than 1.24 found in meatfloss with no MPP. On the 14th day, the rate (1.27) of lipid oxidation in meat floss with no MPP was significantly lower (P<0.05) than 1.14 recorded in meat floss with 2.50% MPP but similar with 1.20 found in 1.25% MPP meatfloss. The level of TBARS in meatfloss with no MPP on the 21st (1.93) and 28th (2.00) days of storage were significantly higher (P<0.05) than 1.35, 1.40 and 1.20, 1.26 recorded in 1.25% and 2.50% MPP at 21st and 28th day of storage respectively.

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

	Inclusion levels of *Mentha pepperita* powder				
Storage days	0	1.25%	2.50%	SEM	P-value
0	1.14	1.14	1.13	0.01	0.88
7	1.24^{a}	1.16^{b}	1.14^{b}	0.03	0.002
14	1.27^{a}	1.20^{ab}	1.14^{b}	0.04	0.0005
21	1.93^{a}	1.35^{bc}	1.20^{c}	0.22	0.00007
28	2.00^{a}	1.40^{bc}	1.26^{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

Microbiological growth (cfu/gx10^3)

The results displayed (Table 7) showed that irrespective of the MPP inclusion level and storage days, meat floss containing MPP had lower (P<0.05) microbial loads. The results further revealed at some days of storage some of the microbes analysed were absent in MPP meat floss with 2.50% inclusion. These were TECC, TPSc, TSC and TLC at zero and 28th, TEnC, TECC, TPSc and TSc at 7th and 21st and TECC and TPSc at 14th days of storage respectively. Also, 1.25% MPP suppressed the growth of TPSc and TSC, TEcC and TECc in the meatfloss at 7, 21 and 28 days of storage respectively. Furthermore, irrespective of the storage days and inclusion level of MPP, the presence of TEnC, TECC, TPSc, TSC and TLC were not significant (P>0.05) in all the meatfloss.

Discussion

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* (22). The proximate composition displayed further buttress the fact that meatfloss is nutrient dense (8). 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% reported by (8) for meat floss produced from different types of meat. These results were also lower than

11.38-11.43% (moisture), 43.44-45.54% (protein) and 9.85-11.19% (ash) reported for meat floss produced from different types of oil (9). However, the proximate composition of MPP meatfloss obtained in this study were higher than 19.86-30.15% (protein) recommended for serunding samples (23) and 28.13-30.27% (protein), 4.45-5.68% (ash) but lower than 14.79-18.02% (fat) and 16.45-17.39% (moisture) reported by (24) The differences in the nutrient contents reported by these researchers could be attributed to the differences in the nutrient composition of the raw meat used in producing each meatfloss. The reduced moisture, increased crude protein and ash contents indicated an improved and better quality of the product (meatfloss) confirming that the presence of *Mentha pepperita* in food will have a positive effect on the nutritional composition of the food. The sensorial reports of the panellist showed that inclusion of MPP in meatfloss did not decrease the sensory characteristics of the product. Although there were no differences but numerically, the sensory scores of MPP meatfloss were high in most of the sensory attributes assessed. 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 (25). Perusing the sensory scores it was observed that the MPP products had a positive acceptability because the average scores was 7.06 in meatfloss with 2.50% MPP and close to 7 (6.94) in meatfloss with 1.25% MPP. The high acceptability rating of the MPP meatfloss could be that the panelists had a low perception of *Mentha pepperita* in aroma and taste of the meat floss probably due to its low percentage inclusion.

In shredded meat products, fatty acid composition is of great importance because it will indicate its susceptibility to lipid oxidation which largely depends on the degree of unsaturation of the fatty acids (22). The total amount of unsaturated fatty acids in all the products in this study were higher than the total saturated fatty acids which contradicts the report of (22) 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 (26). The results in the present study were similar to 69.40 % for PUFAs and 30.60 % for SFAs recommended by the United States Department of Agriculture for food. Again, the unsaturated fatty acid recorded in MPP meatfloss were higher than what was obtained in meatfloss with no MPP affirming that inclusion of MPP in meatfloss did not negatively affect the fatty acid profile of meat floss but rather improved it. The study also depicts that meatfloss with MPP inclusion contain one of the most important fatty acid such as linolenic acid required in the diet (27) Furthermore, the amount of each of the assessed unsaturated fatty acids in meatfloss containing MPP were higher than the amount found in meatfloss with no MPP. For instance, 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 showed that MPP meat floss is nutritious and acceptable to the food industry which aim developing products with low levels of SFAs and higher contents of PUFAs in order to increase the nutritional value of food. This further affirms that the presence of *Mentha pepperita* in food will have a positive effect on the nutritional composition of the food.

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

Storage Days	MPP meat floss samples	THC	TCC	TEnC	TEcC	TPsC	TSC	TLC
0	0	$2.40^{a(a)}$	$0.80^{a(a)}$	0.23	0.13	0.13	0.17	0.17
	1.25%	$0.23^{b(a)}$	$0.23^{b(a)}$	0.13	0.13	0.20	0.10	0.13
	2.50%	$0.33^{b(a)}$	$0.23^{b(a)}$	0.07	0.00	0.00	0.00	0.00
	SEM	0.11	0.15	0.12	0.18	0.20	0.07	0.09
	P value	$6.8x10^{-6}$	$1.27\ x10^{-2}$	0.563	0.379	0.618	0.394	0.258
7	0	$2.63^{a\ (a)}$	$0.13^{a(b)}$	0.20	0.13	0.10	0.10	0.20
	1.25%	$0.20^{b(a)}$	$0.10^{a(a)}$	0.13	0.13	0.00	0.00	0.10
	2.50%	$0.03^{b(b)}$	$0.07^{a(b)}$	0.00	0.00	0.00	0.00	0.10
	SEM	1.38	0.05	0.20	0.21	0.11	0.12	0.13
	P value	0.003	0.813	0.562	0.562	0.492	0.492	1.000
14	0	$0.33^{a(b)}$	$0.23^{a(b)}$	0.10	0.13	0.10	0.17	0.10
	1.25%	$0.13^{b(b)}$	$0.20^{b(a)}$	0.13	0.10	0.20	0.13	0.10
	2.50%	$0.03^{b(b)}$	$0.17^{b(b)}$	0.03	0.00	0.00	0.10	0.10
	SEM	0.40	0.08	0.07	0.09	0.25	0.10	0.02
	P value	$5.88x10^{-8}$	$3.83x10^{-5}$	0.739	0.562	0.368	0.842	0.422
21	0	$0.40^{a(b)}$	$0.47^{a(b)}$	0.10	0.03	0.10	0.10	0.10
	1.25%	$0.30^{b(a)}$	$0.20^{b(a)}$	0.10	0.00	0.03	0.03	0.01
	2.50%	$0.03^{c(b)}$	$0.17^{b(b)}$	0.00	0.00	0.00	0.00	0.01
	SEM	0.12	0.14	0.30	0.04	0.35	0.32	0.10
	P value	$5.01x10^{-3}$	$1.46x10^{-3}$	0.593	0.492	0.492	0.492	0.927
28	0	$0.41^{a(b)}$	$0.40^{a(b)}$	0.20	0.10	0.10	0.10	0.01
	1.25%	$0.30^{b(a)}$	$0.27^{b(a)}$	0.10	0.00	0.03	0.03	0.01
	2.50%	$0.03^{c(b)}$	$0.10^{c(b)}$	0.10	0.00	0.00	0.00	0.00
	SEM	0.18	0.05	0.03	0.20	0.07	0.09	0.05
	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

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

Oxidation is one of the most important factors that limits the quality and acceptability of meat product (28) 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, the TBARS levels of all the meatfloss increased during the storage periods. However, it was observed that meat floss incorporated with MPP irrespective of the inclusion level have reduced TBARS. This indicate slow rate of oxidation in these products which 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 (29). This also implies 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 (30), and (31) that addition of natural antioxidants in meat products keeps the TBARS levels relatively low and constant during storage period. At the end of the experimental storage period of this study, 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 (32). However, the TBARS values obtained in this study were lower than 1.59 mg MDA/kg reported by (33) as the level where sensorial analysis did not perceived rancidity. This implies that meatfloss prepared with MPP and stored for 28 days (as done in this study) is still within the values, quality and invariably will not cause any harm to consumer's health.

Microbiological stability is very crucial to products quality (34) because microbial degradation of a product contributes to its spoilage. The enumeration of THC (cfu/g x 10^3) of meatfloss in this study during storage were lower than $5x10^4$-10^5 cfu/g recommended by (35) 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 (36) for fried chicken sold in Dhaka city and $3.3x10^5$ found in locally processed meat products (37), while *Staphylococcus aureus* count and *Enterobacteriaceae spp* were lower than $4.27x10^3$ and $0.2x10^2$ recorded by (36). However, a high THC was found in meatfloss with no MPP which might be attributed to its high moisture content (Table 3). This is because moisture is one of the major intrinsic factor that plays important role in bacteria distribution in foods (38). The displayed results further showed that 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/low. 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 (39) that can inhibitor/ retard the growth of microorganisms. This also corroborate the report of (40, 41) 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. The slow growth of these microorganisms in MPP meatfloss also agrees with the report of (34) that natural additives in food prevent/retard the growth of some species of microorganisms. 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 (42). However, aerobic bacteria especially gram negative rod shaped such as *Pseudomonas spp* have been reported to be dominant meat spoilage organisms (43, 44). In addition the presence of *Staphylococcus aureus* could also be due to the fact that humans are the primary reservoirs of *Staphylococcus aureus* (45). 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 (45). The results of this study contradicts the report of (46, 47) that *Staphylococcus aureus* and *Escherichia coli* 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 (45,48 49,50) on stored meat products.

Conclusion and Application

1. Increasing the shelf-life of meat floss can be achieved by delaying lipid oxidation and retarding microbial activities by incorporating preservatives with antioxidant properties in the production process.
2. The incorporation of *Mentha pepperita* L. in meatfloss production highlighted its potentials as efficient inhibitors of oxidative processes and proliferation and activities of spoilage microorganisms thus act as a preservative in extending the shelf life of meatfloss.
3. The addition of *Mentha pepperita* in meatfloss production do not change the sensorial characteristics but enhanced the nutritional composition of the product.

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