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MICROBIAL QUALITY EVALUATION OF MEAT FLOSS PRODUCED FROM BROILER CHICKENS FED DIETS CONTAINING VARYING ENERGY LEVELS

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ABSTRACTS

The research was conducted to evaluate the effects of storage period, energy levels and packaging materials on microbial quality of meat floss produced from broiler chickens fed varying energy levels. Two hundred and seventy Cobb-500 Strain day-old-chicks were raised intensively for 8 weeks in a Completely Randomized Design. The meat floss experiment was laid in a 3×4×6 factorial arrangement. The factors were 3 dietary energy levels (2400, 2600 and 2800 Kcal/kg); Four Packaging materials (High Density Polyethylene, Low Density Polyethylene, Polyvinyl Chloride and Aluminum Foil) and 6 Storage Period (0, 2, 4, 6, 8, 10 weeks). The bacteriological quality and safety of the meat floss were assessed. *Staphylococcus aureus* and *Escherichia coli* species were enumerated, isolated and identified which were evaluated to fall within the range of 4.53–8.30 x 10^4cfu/g. It can be concluded that the microbial load obtained in this study (4.53–8.30 x 10^4cfu/g) fall within the safe limits of 10^7cfu/g specified for meat products by the ICMSF, and aluminium foil should be recommended to package meat floss as it has the least bacterial and fungal load.

Keywords; Broiler chicken, Energy level, Meat floss, Microbial quality, Packaging material.

INTRODUCTION

Microbial food safety is a key issue of public health concern to both developing and advanced countries particularly under the present concept of one world one health (Bello *et al.,* 2011; Ko, 2015; Guerra *et al.,* 2016). Each year, as many as 600 million, or almost one in 10 people in the world, fall ill after consuming some sort of contaminated food (Guerra *et al.,* 2016). Out of that figure, 420,000 people die, including 125,000 children under 5 years of age as stated in the World Health Organization's estimates on the global burden of foodborne diseases (WHO, 2015). About 33% of the population in developing countries is affected by foodborne sicknesses every year (Isara *et al.,* 2010). Similarly, a review on the safety of animal food products safety situation in Nigeria highlighted the fact that the production, handling, sales, and consumption of poor quality animal food products are serious public health problems in the country (Okoli *et al.,* 2006).

There is an increasing demand for meat as well as concerns regarding its quality, freshness and wholesomeness (Selvan *et al.*, 2007). There have been many reports on outbreaks of food borne diseases associated with the consumption of meat (Bhandare *et al.,* 2007). The muscle tissue of healthy living animal is usually free from micro-organisms before slaughter, however, during the slaughtering and at different stages of meat processing after slaughtering, different microbes get introduced to the meat and these microbes tend to get the meat contaminated (Ebel *et al.,* 2004). The meat is potentially believed to be subjected to contamination from various sources during the slaughtering of animals, handling and during its sales (Awojimi *et al.,* 2022).

According to Elmossalami (2003), the increased consumer vulnerability to microbial infections through meat is as a result of poor knowledge of sanitary practices of the butchers, sales men, operators and patrons of abattoirs in developing countries. Dirty environment and unhygienic food handling influence wide spread of bacterial food poisoning (Burgess *et al.,* 2005). The contaminating organisms are derived mainly from the body of the animal, the faeces, the place of slaughter, the environment of the slaughter house, vehicle used for the transport of the meat from the slaughter house to the retail outlet, the floor of the retail outlet and the air in the outlet which all act as the external sources for the contamination of the meat (Sudhakar *et al.,* 2009; Awojimi *et al.,* 2022).

The microbiological quality of meat and meat products is very important due to its significance to public health (Bhandare *et al.,* 2007). It is therefore imperative that microbial contamination of meat and meat products do not exceed the threshold levels safe for human health (5 Log_{10} cfu/g or $1x10^6$ cfu/g). Furthermore, microbial loads exceeding this threshold levels could adversely affect the shelf life of meat and meat products and render it unwholesome and unfit for human consumption (Awojimi *et al.,* 2022). Several researches (Fasanmi *et al.*, 2010; Bakari *et al.*, 2015; Egbebi *et al.*, 2016; Awojimi *et al.,* 2022) have been carried out to assess the microbial quality of meat in Nigeria and other developing countries. However, information on the effect of energy levels and extrinsic factors such as processing methods, storage period and

packaging material on microbial quality of meat is not sufficient.

MATERIALS AND METHODS

Study Area

The experimental research was conducted at the Poultry Demonstration Farm of the Department of Animal Health and Production, Binyaminu Usman Polytechnic, Hadejia, Jigawa State. The area is located on latitude 12^0 28' N and longitude 10^0 01' E. The study area has an annual rainfall ranging from 700-800mm accompanied by strong wind. The temperature of the area ranged from 31 to 40^0C. The area possesses palatable grasses (*Andropogan gayanus, Cyanodon dactylum*, *Pennisetum pedicelatum,* etc.) and legumes (*Centrosema pubescens*, *Stylosanthes hamata, etc.*) with crops residues such as sorghum stover, millet stalks, rice straws, cowpea haulms, ground nut hay and agro-byproducts which include wheat offal, cotton seed cake, ground nut cake and cereal bran. The area is conducive for livestock production, the common livestock species in the institution's farm includes; cattle, sheep, rabbit, goat and poultry. (BirdLife International, 2021; Muhammad *et al.,* 2023). Information from PPA (2019) showed that on daily basis, average of 400 chickens (improved and indigenous), 70 guinea fowls. 40 pigeons, 10 ducks and 1 turkey are slaughtered in Hadejia Local Government Area of Jigawa State.

Experimental Diets

Three experimental diets containing different energy levels of 2400, 2600 and 2800 Kcal/Kg designated as A, B and C, respectively were formulated and fed to the broiler chickens. The crude protein of the Starter and Finisher diets were fixed at 24 and 20%, respectively. Table 1 and 2 give the ingredients and nutrient composition of the experimental starter and finisher diets respectively.

Table 1: Ingredient and Nutrient Composition of Experimental Starter Diet

Ingredient	**Diets {Energy Levels (Kcal/Kg)}**		
	A	**B**	**C**
Maize	22.00	33.00	44.00
Soybean meal	24.00	26.00	29.00
Groundnut cake	15.00	16.00	16.00
Wheat offal	33.00	19.00	5.00
Bone meal	3.00	3.00	3.00
Limestone	2.00	2.00	2.00
Common salt	0.30	0.30	0.30
*Premix	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Lysine	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**
Calculated composition			
ME(Kcal/kg)	2417	2613	2810
Crude protein (%)	24.00	24.00	24.00
Lysine (%)	1.40	1.40	1.40
Methionine (%)	0.60	0.60	0.60
Calcium (%)	1.60	1.60	1.60
Phosphorus (%)	0.70	0.70	0.70
Crude fibre (%)	5.60	4.80	4.00
Ether extract (%)	3.80	3.90	3.90
Proximate (%)			
Moisture (%)	5.59	4.55	4.04
Ash (%)	11.94	10.45	12.67
Crude fat (%)	3.77	3.94	3.84
Crude protein (%)	24.97	25.66	24.60
Crude fibre (%)	5.93	5.68	5.01
Carbohydrate (%)	47.81	49.73	49.81

*Starter Premix provided per kg diet: Vitamin A 10,000mg, Vitamin D3, 20,000mg, Vitamin E 23,000mg, Vitamin K3 2,000mg, Vitamin B1 1,800mg, Vitamin B2 5,500mg, Niacin 27,500mg Pantothenic acid 7,500mg, Vitamin B6 3000mg, Vitamin B12 1500mg, Folic acid 750mg, Biotin H2 600mg, choline Chloride 500,000mg, Cobalt 200,000mg, Copper 3,000mg, Iodine 1000mg, Iron 20,000mg, Manganese 40,000mg, Selenium 200mg, Zinc 30,000mg, Antioxidant 1,250mg

Table 2: Ingredient and Nutrient Composition of Experimental Finisher Diet

Ingredient	Diets {Energy Levels (Kcal/Kg)}		
	A	**B**	**C**
Maize	33.00	40.00	50.50
Soybean meal	18.00	17.00	20.00
Groundnut cake	7.00	10.00	11.80
Wheat offal	39.00	27.00	11.70
Bone meal	3.00	3.00	3.00
Limestone	2.00	2.00	2.00
Common salt	0.30	0.30	0.30
*Premix	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Lysine	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**
Calculated composition			
ME(Kcal/kg)	2430	2602	2816
Crude protein (%)	19.80	19.70	20.20
Lysine (%)	1.20	1.10	1.20
Methionine (%)	0.50	0.50	0.50
Calcium (%)	1.60	1.60	1.60
Phosphorus (%)	0.70	0.60	0.60
Crude fibre (%)	5.40	4.70	3.90
Ether extract (%)	3.60	3.70	3.70
Proximate (%)			
Moisture (%)	5.58	5.27	4.35
Ash (%)	11.06	10.38	11.92
Crude fat (%)	4.05	4.30	4.55
Crude protein (%)	22.87	22.09	20.46
Crude fibre (%)	5.82	5.63	5.38
Carbohydrate (%)	50.62	52.32	53.34

*Finisher Premix provided per Kg diet: Vitamin A 8,500iu, Vitamin D3 1,500iu, Vitamin E 10,000mg, Vitamin K3 1,500mg, Vitamin B1 1,600mg, Vitamin B2 4,000mg, Niocin 20,000mg, Pantothenic Acid 5000mg, Vitamin B6 1,500mg, Vitamin B12 1000mg, Folic Acid 500mg, Biotin H2 750mg, Choline Cloride 175,000mg, Cobalt 200mg, Copper 3000mg, Iodine 1000mg, Iron 20,000mg, Manganese 40,000mg, Selenium 200mg, Zinc 30,000mg, Antioxidant 1,250mg.

Experimental Animals and Their Management

Two hundred and seventy (270) day old broiler chicks of Cobb 500 strain were purchased from a reputable distributor. The chicks on arrival were weighed and randomly allotted to the treatments containing ninety birds per treatment; each treatment had three replications of thirty birds. The birds were managed under deep litter system with wood shavings as litter materials. The chickens were vaccinated against Newcastle Disease and Gumboro. The pen was cleaned and disinfected using recommended disinfectant (7% Tar Acid Phenol and 2% Cresylic Creosote) to avoid microbial contamination. Routine management was carried out as described by Oluyemi and Roberts (2000). Experimental feed and fresh clean water were provided *ad-libitum*. At the end of the production, 27 birds (three birds per replication) were slaughtered for the preparation of meat floss.

Preparation of Spice Mixtures for Meat Floss Production

Two spice mixtures were formulated as shown in Tables 3 and 4. The ingredients used for the formulations were purchased from a local spice market within the study area. Each spice was dried and ground separately using a table top grinder (Model BLSTMG. PN133093-002) and the coarse particles removed using a sieve of 1.0 mm mesh diameter. The cooking and shredding recipes were separately stored in airtight polyvinyl chloride containers for subsequent use.

Table 3: Composition of Cooking Spice Mixture used for Broiler Chicken Meat Floss Production (g/100g)

Ingredient	Quantity (%)
Common Salt (Sodium Chloride)	10.00
Thyme (*Thymus vulgaris* L.)	12.50
Curry Powder®	12.50
Onions (Allium cepa L. var. cepa)	50.00
Stalk Cube	15.00
Total	100.00

Source: Omojola *et al*., 2014
® Trade name

Table 4: Composition of Shredding Recipe before Frying used for Broiler Chicken Meat Floss Production (g/100g)

Ingredient	Quantity (%)
Pepper (*Piper nigrum* L.)	35.00
African Nut Meg (*Monodora myristica* (Gaertn.) Dunal)	2.50
Ginger (*Zingiber officinale* Rosc.)	4.00
Garlic (*Allium sativum* L.)	3.00
Cloves (*Syzygium aromaticum* (L.) Merr. et L.M. Perry)	2.50
Curry Powder®	3.50
Thyme Leaves (*Thymus vulgaris* L.)	2.50
Common Salt (Sodium Chloride)	5.00
Onions (*Allium cepa* L. var. cepa)	12.00
Stalk Cube	30.00
Total	100.00

Source: Omojola *et al.,* 2014
®Trade name

Cooking of Meat

After slaughtering and dressing of the birds, the bones and the muscles were separated; lean meat was cut into pieces of approximately 4 cm by 2.5 cm dimension, washed with clean water and mixed with spices. Each meat type was cooked on an adjustable Pifco Japan Electric Hot Plate (Model Number ECP 2002). The cooking recipe was added in the ratio of 1 g of spice to 100 g of meat. Four (4) medium-sized (500 g) onions (approximately 50 g of onions on Dry Matter basis) were thinly sliced and added. Water was added at the ratio of 1.5 liters to 1.0 kg of meat. The meat samples were cooked to an internal temperature of 72 ºC and the broth was allowed to dry with the meat. The meat samples were removed and allowed to equilibrate to room temperature and weighed.

Meat Shredding

The cooked meat samples were pounded into shreds using a mortar and pestle. The shredding recipe was added in the ratio of 1:20 (50 g of spice to 1000 g of meat), while 120 g onion on dry matter basis was added to every 100 g of spice used. These were weighed and added a little at a time as pounding progressed for uniform mixing of the recipe.

Frying of Meat to Floss

The shredded meat from each meat type was separately shallow fried using stainless steel pot in Soy bean oil (Grand®) which was pre-heated to 70 ºC. The ratio of oil to meat was 1 liter to 500 g of meat. The meat samples were fried at 70 strokes per minute (Farouk *et al.,* 2015) until a golden brown colour was obtained (20 minutes). Figure 1 demonstrates chicken meat floss production.

Draining of Oil

The products were poured into a colander after frying and pressure applied to remove excess oil and prevent the final product from sticking. The dry spongy product from each meat type was poured into separately marked flat containers, allowed to cool and separated into strands.

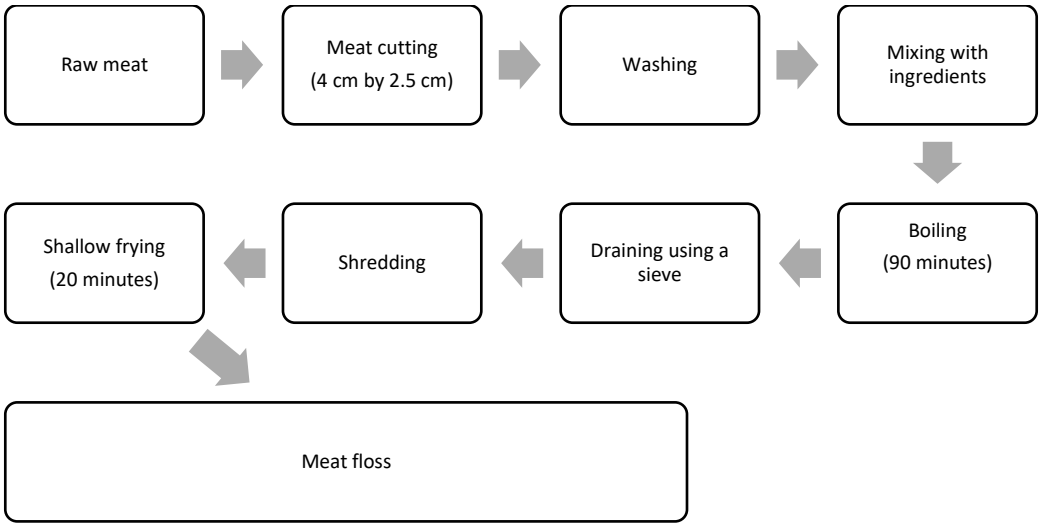

Figure 1: Procedure for broiler chicken meat floss preparation (Farouk, 1985; Umar *et al*., 2023).

Packaging of Broiler Chicken Meat Floss

Four (4) different packaging materials: Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Aluminium Foil (AF) and Polyvinyl Chloride (PVC) were used to store broiler chicken meat floss at 30^{o}C±10^{o}C (Eke *et al.,* 2012) for ten weeks. The effect of packaging materials on bacterial load of broiler chicken meat floss were determined as described by Ogunsola and Omojola (2007).

Bacterial Analysis of Broiler Chicken Meat Floss

Meat Sample Preparation

Samples of meat floss produced from broiler chickens fed diets containing 2400, 2600 and 2800 Kcal/Kg were examined for bacterial load. One gram (1.0 g) of each meat floss sample was weighed and aseptically taken into a sterile jar containing 9 mL sterile peptone water, which was homogenized with sterile blender (Retsch, GM 200, Australia) at 3000 rpm for 10 minutes. A 1 mL aliquot of homogenate was transferred to a test tube containing 9 mL sterile distilled water to make 10^{-2} dilution and centrifuged with v0ortex mixer (Digosystem, VM-1000, Taiwan) at 2000 rpm for 5 minutes. Serial dilutions up to 10^{-5} were prepared for the bacteriological analysis. Test tubes were labeled with respect to their dilution.

Culturing of Meat Floss Samples

The bacteriological quality and safety of meat floss were assessed on the basis of Total Viable Count (TVC), Total *Staphylococcus aureus* Count (TSAC), Total *Escherichia coli* Count (TECC) and Total Fungal Count (TFC) using Nutrient Agar, Mannitol Salt Agar, Mac Conkey Agar and Potato Dextrose Agar, respectively. All culture media were prepared in accordance with the manufacturer's specification. Aliquots (0.1 mL) of each dilution were transferred in replicate into corresponding differential and selective media (in duplicates), and were spread uniformly using a hockey stick. Diluted meat floss samples were spread on to those plates and incubated at 37^{0}C for 24 hours except detection of fungi, which were incubated at 25^{0}C for 5 days. Discrete colonies were sub-cultured into fresh agar plates aseptically to obtain pure cultures of the isolates. Pure isolates of resulting growth were then stored for further identification.

Enumeration and Isolation

From the 10-fold dilutions of the homogenates; 0.1ml of 10^{-2}, 10^{-3} and 10^{-4} dilutions of the homogenates were plated on different media, using pour plate method. The plates were then incubated at 37^{0}C for 24 hours. Mac Conkey Agar was used for *E. coli* enumeration while Mannitol Salt Agar was used for *S. aureus*, TVC was performed on Nutrient Agar. At the end of the incubation period, colonies (30-300) that appeared on each plate for the different dilution were counted and recorded using the illuminated colony counter (Gallenkamp, England). The counts for each plate were expressed as colony forming unit (cfu/g) of the suspension. i.e.

$$\text{Colony forming unit/g} = \frac{\text{Number of colony counted x Reciprocal of dilution factor}}{\text{Volume of sample inoculated}}$$

Identification and Characterization of the Isolates

Colonies identifiable as discrete on the nutrient agar were carefully examined microscopically for cultural characterization such as shape, colour, size and consistency. Bacterial isolates were characterized based on microscopic appearance, colonial morphology and gram staining reaction as well as appropriate biochemical test, for examples, Fructose, Citrate Test, Urease Test, Catalase and Coagulate Test were carried out as described by Cheesbrough (2003). The isolates were identified by comparing their characteristics with those of known texa as described by Bergey's Manual for Determinative Bacteriology (Buchanan and

Gribbson, 1974), as well as based on their biochemical reaction according to Buchanan and Gribbson, (1974).

Experimental Design and Statistical Analysis

The meat floss experiment was laid in a Completely Randomized Design. Data were generated on bacterial load of raw meat and meat floss and analysed using ANOVA in SPSS version 17.0 and significantly different means were separated using LSD.

RESULTS AND DISCUSSION

Microbial Quality of Raw Broiler Chicken Meat and Meat Floss

The Bacteriological quality of raw broiler chicken meat fed diets with varying energy levels is presented in Table 5. The results indicated that all the samples were contaminated by indicator microbes that can pose threat to public health. *Staphylococcus aureus* and *Escherichia coli* species were detected. The total viable count ranged from 1.20 to 3.00 $x10^{-4}$cfu/g.

Table 5: Bacteriological Quality of Raw Broiler Chicken Meat fed Diets Containing Varying Energy Levels (Kcal/Kg)

Energy Level (Kcal/kg)	TVC (cfu/g) × 10^4	Isolate
2400	1.20	*Staphylococcus aureus*
	1.70	*Escherichia coli*
2600	1.40	*Staphylococcus aureus*
	3.00	*Escherichia coli*
2800	2.00	*Staphylococcus aureus*
	1.30	*Escherichia coli*

TVC = Total Viable Count; cfu/g = Colony Forming Unit Per Gram

Effect of packaging and storage duration (2 Weeks) on bacterial mesophilic count (cfu/g) of broiler chicken meat floss

The experimental broiler chicken meat floss was examined to ascertain the bacterial mesophilic count (cfu/g) after two weeks storage in different packaging materials and the result presented (in Table 6) showed that chicken meat floss packaged in LDPE recorded high contamination of TVC while AF recorded the least. Similarly higher concentration of *S. aureus* and *E. coli* were recorded in LDPE.

Table 6: Effect of Packaging and Storage Duration (2 weeks) on Bacterial Mesophilic Count (cfu/g) of Chicken Meat Floss

Packaging Materials	TVC (cfu/g) × 10^4	*S. aureus* (cfu/g) × 10^4	*E. coli* (cfu/g) × 10^4
HDPE	6.70	3.40	3.60
LDPE	7.00	3.70	4.20
AF	5.50	2.80	3.10
PVC	6.10	3.00	3.30

HDPE = High Density Polyethylene, LDPE = Low Density Polyethylene, AF = Aluminium Foil, PVC = Polyvinyl chloride, TVC = Total Viable Count, cfu/g = Colony Forming Unit Per Gram

Characterization and identification of isolates

The characterization and identification results were presented on Tables 7 and 8. The isolates identified were *Staphylococcus aureus* and *Escherichia coli*.

Table 7: Microscopic, Culture Media Identification and Characterization of the Isolates

Microscopic Morphology	Mac Conkey	Mannitol Salt	Isolate
Rod	Red colouration on the surface	-	*E. coli*
Cocci	-	Yellow zone surrounding growth	*S. aureus*

Table 8: Biochemical Identification and Characterization of the Isolates

Gram Reaction	Fructose	Citrate	Urease	Catalase	Coagulase	Isolate
-	+	-	-	-	-	*E. coli*
+	-	+	-	+	+	*S. aureus*

Impact of packaging materials (10 weeks) on bacterial mesophilic count (cfu/g) of broiler chicken meat floss

Table 9 presents the impact of packaging materials (10 weeks) on bacterial mesophilic count (cfu/g) of broiler chicken meat floss. The results showed no growth of *S. aureus* was recorded on chicken meat floss packaged in HDPE and LDPE while no growth of *E. coli* was recorded on chicken meat floss Packaged in Polyvinyl chloride.

Table 9: Impact of Packaging Materials (10 weeks) on Bacterial Mesophilic Count (cfu/g) of chicken Meat Floss

Packaging Materials	TVC (cfu/g) × 10^4	*S.aureus* (cfu/g) × 10^4	*E.coli* (cfu/g) × 10^4
HDPE	2.40	0.00	1.30
LDPE	2.90	0.00	1.20
AF	1.70	1.00	1.00
PVC	2.20	1.10	0.00

HDPE = High Density Polyethylene; LDPE = Low Density Polyethylene; AF = Aluminium Foil PVC = Polyvinyl chloride; TVC = Total Viable Count; cfu/g= Colony Forming Unit Per Gram

Effect of fungal count on meat floss prepared from broiler chicken fed diets containing varying energy levels

The effect of fungal count on meat floss prepared from broiler chickens fed varying energy levels is presented on Table 10. The results showed that the Fungal Count from treatments A and B were statistically ($P>0.05$) similar, so also Treatments B and C, but there was significant difference ($P<0.05$) of fungal load between treatments A and C. The result also showed that Treatment A has the highest Fungal Count while treatment B has the least.

Table 10: Effect of Energy Level on Fungal Count of Meat Floss Prepared from Broiler Chicken

Energy Levels (Kcal/kg)	Fungal Count (cfu) × 10^4	S.E.
A (2400)	6.96^{a}	0.05
B (2600)	5.54^{ab}	0.05
C (2800)	5.55^{b}	0.05

Means along the same row having different superscripts ($P<0.05$) differ

Effect of fungal count of broiler chicken meat floss stored in different packaging materials

Table 11 presents the effect of fungal count of broiler chicken meat floss stored in different Packaging Materials. Results showed that the fungal load of chicken meat floss stored in HDPE and LDPE were statistically ($P>0.05$) similar. Chicken meat floss stored in HDPE has the highest Fungal Count while that stored in AF has the lowest fungal count.

Table 11: Effect of Packaging Materials on Fungal Count of Broiler Chicken Meat Floss

Packaging Materials	Fungal Count (cfu) × 10^4	S.E.
HDPE	6.36^{a}	0.06
LDPE	6.32^{a}	0.06
AF	5.13^{c}	0.06
PVC	6.26^{b}	0.06

HDPE = High Density Polyethylene, LDPE = Low Density Polyethylene, AF = Aluminium Foil, PVC = polyvinyl chloride.

Means along the same row having different superscripts ($P<0.05$) differ.

DISCUSSION

Microbial Quality of Raw Broiler Chicken Meat and Meat Floss

Microorganisms grow on meat causing visual, textural and organoleptic changes when they release metabolite (Walter and Kundin, 2002). A lot of factors affect the growth of microorganisms on meat. These factors include temperature, pH, water availability, presence of nutrients, gaseous requirement and atmosphere of storage (Nester *et al.,* 2001).The possible sources of contamination are through slaughtering of sick animals, washing the meat with contaminated water, handling by butchers, contamination by flies, processing close to sewage or refuse dumps environment, addition of contaminated spices, transportation and use of contaminated equipment such as knives and other utensils (Enem and Onyekwodiri, 2015; Igyor and Uma, 2005*)*. Processing operations such as heating, boiling, filtration, freezing, irradiation of finished products, addition of condiment and condition of storage affect both bacterial and fungal loads (Igene *et al.,* 1990). The slaughtering process affords extensive contamination of sterile tissue with gram-negative enteric bacteria from animal intestine including *Salmonella spp* and *Escherichia coli* as well as contaminant such as gram-positive *cocci* associated with humans, animals and the environment (Nwakanma *et al.*, 2015).

Gilbert and Harrison (2001) reported that the presence of *Staphylococcus spp* on meat samples is as the result of cross contamination from meat handlers during processing, since it is a normal flora

of the skin. *Staphylococcus spp* and *Bacillus spp* are abundant in the nose and throat as well as the skin of humans. They can be found in the air and even in the spices and the spores are heat resistant (Samuel *et al.,* 2015), in a related work Dineen *et al.* (1999) showed that coliforms are introduced from the water used for washing the meat, this is also in agreement with the report of Umoh (2004) that the presence of *Escherichia coli* arises from the use of non-portable water during washing of raw meat.

The microbial load obtained in the current study (1.10 - 7.00 x 10^4cfu/g) could be compared to what had been reported locally: 2.88 x 10^2 – 9.49 x 10^3 (cfu/g) by Abubakar *et al*. (2014) for *Dambun-Nama*, 7.00 x 10^2 – 1.71 x 10^4cfu /g by Uzeh *et al.,* (2006) for *tsire suya*, 3.30 x 10^4cfu/g for processed ready to eat beef by Ologhobo *et al*. (2010), 7.00 x 10^3- 2.22 x10^5cfu/g for ready to eat *suya* by Edema *et al*. (2008), 3.70 x 10^5 – 2.40 x 10^6cfu/g by Inyang *et al*. (2005), 7.40 x 10^4cfu/g by Chukwu and Imodiboh, (2009) and 8.00 x 10^5 cfu/g by Shamsuddeen and Oyeyi, (2008), all these fall within the safe limits of 10^7 cfu/g specified for meat products by the ICMSF (1978). On the contrary Salihu *et al*. (2010) obtained total mesophilic aerobic bacteria count of 4.50 x 10^9cfu/ g on traditionally prepared *Dambun -Nama* sold in Sokoto and concluded that the product (*Dambun-Nama)* was unsafe and constitutes a food safety risk to the numerous ever-increasing consumers.

Manyi *et al*. (2014) isolated *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella spp*, *Streptococcus spp*, *Bacillus spp* and *Pseudomonas* spp from Suya (roasted beef) sold in Makurdi, Benue State, Nigeria. High prevalence of *E. coli* in retail meat market had also been reported by Kumar *et al*. (2001). Isolation of *Bacillus, Streptococcus*, *Staphylococcus*, *Proteus*, *Aureus* and Yeast were reported from beef and pork *kilishi* subjected to different packaging media (Ogunsola and Omojola, 2008). Similarly, Abubakar *et al*. (2011) isolated four fungal species (*Aspergillus niger, Aspergillus fumigatus, Rhizophus nigricans* and *Hansenula anomala)* after seven days storage of meat products at ambient temperature. Other workers such as Ologhobo *et al*. (2010) and Salihu *et al*. (2010) have also reported that meat products sold in Nigeria were contaminated with various species of bacteria and fungi.

Conclusion

The microbial load obtained in the current study (4.53–8.30 x 10^4cfu/g) fall within the safe limits of 10^7cfu/ g specified for meat products by the ICMSF. Therefore, appropriate packaging of meat products to eliminate air and subsequently lengthen the shelf life is indispensable. Care should be taken to avoid raw meat from being contaminated by harmful microbes before, during and after processing, because their spores are known to endure heat treatment, so as to ensure delivery of safety meat products to consumers. It can be recommended that aluminium foil should be used to package meat floss as it has the least bacterial and fungal load.

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