Nigerian J. Anim. Sci. 2021, 23 (3): 258-270

Microbial quality of meat floss 'dambun nama' processed from broiler chickens fed graded levels of 'sabara'(*Guiera senegalensis*) leaf meal

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***Target Audience:** Meat Processors, Handlers, Consumers, Entrepreneurs*

Abstract

This study evaluated the microbial quality of meat floss processed from broiler chickens fed graded levels of Guiera senegalensis leaf meal (GSL) at 0.0% (GSL1), 7.0% (GSL2), 14.0% (GSL3) and 21.0% (GSL4). These were packaged and stored into four (4) different packaging media; Foil Paper Pack (FPP), Wrapped Newspaper Pack (WNP), Plastic Container Pack (PCP) and Disposable Container Pack (DCP). These products were stored and monitored for contaminations at 0, 4, 8 and 12 week intervals. Means were analysed and compared with passable and safe limits of 10^7cfu/g. The results showed that at 1st day of storage, there were no fungal counts in GSL3 and GSL4 was having the least count of 2.0 x 10^5. The control (GSL1) had the highest total bacterial count of 24.0 x 10^5cfu/g. At 12th week of storage, the results showed that the total fungal counts were 0.00, 0.00, 0.00, and 2.0 x 10^5cfu/g for GSL2, GSL3, GSL4 and GSL1, respectively. The overall effects showed that the total microbial load of meat floss decreased as the concentrations were increased. The results showed that GSL2 (2.0 x 10^5cfu/g) and GSL3 (3.0 x 10^5cfu/g) had lower total bacterial counts than GSL1 (24.0 x 10^5cfu/g) and GSL4 (8.0 x 10^5cfu/g) across the packaging media at first week (0 week) of storage. WNP had the least bacterial counts (1.0 x 10^5cfu/g). Conversely, DCP had the highest counts (21.0 x 10^5cfu/g) across the treatment groups and packaging media. At higher week of storage (12th week), GSL2 (15.0 x 10^5cfu/g) and GSL3 (18.0 x 10^5cfu/g) were lower than GSL1 (20.0 x 10^5cfu/g) and GSL4 (26.0 x 10^5cfu/g) for bacterial counts. WNP (10.0 x 10^5cfu/g) had the least counts across the treatments. Storage at higher weeks (8th and 12th) reduced fungal growth in most of the packaging media. This study concludes that the packaging method had suppressive effects against microbial growth. It is suggested that meat floss processed from broiler chickens fed graded levels of GSL should be evaluated for storage above the 12-week period.

***Key words:** Meat floss, packaging, storage*

Description of Problem

Innovations in food technology play a crucial role in translating nutritional information into consumer products to produce new healthy food ingredients and added specific nutrient or functional ingredients (1). Meat quality is the key criterion of food product evaluation, whereas shelf-life has a direct impact on quality changes. Meat preservation is more difficult than other kinds of food as it may result in oxidative rancidity, discolouration, mouldiness, off-flavour and sliminess (2). It has also been shown that processing of meat to products facilitates the packaging, handling, distribution and marketing of the product (3). Herbal plant leaves and extracts as antioxidant have been reported to combat oxidative stress (4). The natural plant leaves improved meat quality and its nutritional value. Natural antioxidants have been found in various substances with different chemical characteristics, which are widely present in plants.

Guiera senegalensis (family: *Combretaceae*) commonly known as 'sabara' in Hausa Language is a shrub of the Savannah region of West and Central Africa. *G. senegalensis* is being widely used in traditional medicine for the remedy of many ailments/diseases. The leaf extract is used against dysentery, diarrhoea, gastrointestinal pain and disorder, rheumatism and fever (5). This leaf can be used in meat preservation in order to reduce the prevalence of food borne diseases. *G. senegalensis* has been shown to positively contain alkaloids, tannins, flavonoids, amino acids, ascorbic acid and anthraquinones and also displayed antimicrobial activities (6).

Meat floss is a dried meat product produced mainly by Hausas in Northern part of Nigeria (7, 8). Due to its low moisture content, meat floss can be kept without refrigeration and will not drastically change in room temperature for long storage period of time (9).

Previous research works using leaf extracts of *Guiera senegalenses* were mostly on the suppression of microbial (fungal and bacterial) activities and growth in meat products. For instance, (10, 11) dissolved leaf powder of *Guiera senegalenses* at 3.0g/100ml of water in cooking both red and white meat (beef, mutton, chevon, camel and broiler chicken meat) to process five different types of meat floss (*dambun nama*) for their effects on shelf-life and storage quality over a 5-week period. Furthermore, (12) investigated the inclusion levels of 2.0. 3.0 and 4.0g/100 ml of water in cooking of beef to process meat floss and determined the shelf-life and storage quality up to 12 week period. It is investigated that the quality and shelf life of *dambun nama* processed using different types of white meat for up to 5-week storage (13).

However, natural antioxidants especially of plant origin have greater application for consumer acceptability, palatability and increase shelf life of meat products and improves on the nutritional quality of the product too (14). Of such plant is *Guiera senegalenses.* This, therefore, triggered the current interest in the use of natural plants in feed of broiler chickens and further processing of the chicken meat into meat floss, to delay lipid oxidative degradation, which deteriorates the quality of meat and reduces its shelf life.

The limitation of the earlier studies was in the manner of incorporation of these extracts (*Guiera*), which were only used during cooking processes of meat to process meat floss (*dambun nama*), as opposed to dietary inclusions of leaf meal (*Guiera*) in feed of broiler chickens, and subsequent evaluation of the meat for processing into meat products, storage and preservation. Therefore, the objective of this study was to evaluate the effects of dietary levels of *Guiera senegalensis* leaf meal on the microbial quality of meat floss 'dambun nama' stored over a period of 12 weeks.

Materials and Methods

Study area

The study was conducted at the Department of Animal Science, Faculty of Agriculture, and at the General Microbiology Laboratory, Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Samaru, Zaria. Samaru is part of the Northern Guinea Savannah Ecological Zone of Nigeria. It is on latitude 11^{o}C 19' North, longitude 7^{o}C 37'45 East and at an altitude of 610 meters above sea level (15). The temperature ranges between 26^{0}C -

40^{o}C, depending on the season while the relative humidity during the dry and wet seasons ranged between 21% and 72%, respectively (16). The wet period in Zaria starts between May and October with annual rainfall of about 1500mm.

Sourcing and processing of *Guiera senegalensis* leaf meal

Leaves from apparently healthy plants of *Guiera senegalensis* were sourced in Samaru and Sabon Gari markets of Zaria, Kaduna State, and shade-dried for 2-3 days. The dried leaves were ground into powder form at Labar Feedmill, Samaru to produce leaf meal of the plant.

Analysis for chemical composition

The leaf powder of 'Sabara' (*Guiera senegalensis*) used in the study was analysed for chemical composition (Table 1) according to the methods of (17).

Table 1: Chemical composition of *Guiera senegalensis* leaf meal

Parameter	*Guiera Senegalensis*
Dry Matter (%)	87.04
Crude Protein (%)	19.52
Crude Fibre (%)	9.15
Fat (%)	2.97
Nitrogen Free Extract (%)	60.07
Ash (%)	5.18
Ca (%)	0.23
Mg(%)	0.87
K (%)	0.55
Na (%)	0.52
P (%)	0.09
Fe (mg/kg)	1254.08
Mn (mg/kg)	577.67
Cu (mg/kg)	98.17
Zn (mg/kg)	132.74

Experimental Design and Management of Birds

Two hundred and forty (240) day old broiler chicks (Cobb 500) were allotted into four different dietary treatments comprising of a control (GSL1; 0) and different proportions of *Guiera senegalensis* (7.0, 14.0 and 21.0% of diet to serve as treatments GSL2, GSL3 and GSL4, respectively) and replicated four (3) times of 20 chicks per replicate in a Completely Randomized Design (CRD). The trial lasted for 8 weeks (0 – 4 weeks starter phase and 5 – 8 weeks finisher phase). The compositions of the diets are shown in Tables 2 and 3.

Feed and clean water were given *ad libitum* to the birds throughout the experimental period. Vaccinations against Newcastle and Gumboro diseases were done at appropriate time, as recommended by the Veterinary Teaching Hospital (VTH) of Ahmadu Bello University, Zaria. Other standard procedures such as fumigation, sanitation and prophylactic medications were given to ensure good health of the birds.

Table 2: Composition of broiler starter diets containing graded levels of *Guiera senegalensis*
Leaf meal (0 – 4 weeks)

Ingredients	GSL 1	GSL 2	GSL 3	GSL 4
Maize	50.00	46.00	43.00	41.00
FSBM	15.00	15.00	15.00	15.00
GSL	**0.00**	**7.00**	**14.00**	**21.00**
Maize offal	3.50	3.50	3.50	3.50
GNC	27.00	24.00	20.00	15.00
Bone Meal	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.40	0.40
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.35	0.35
Salt	0.25	0.25	0.25	0.25
Vit. Premix	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis				
ME (Kcal/kg)	2911	2901	2903	2900
Crude Protein (%)	23.11	23.32	23.28	23.13
Crude Fibre (%)	4.61	4.81	4.91	5.00
Ether Extract (%)	6.45	6.55	6.63	6.71
Calcium (%)	1.34	1.34	1.31	1.31
Phosphorus (%)	0.63	0.63	0.62	0.62
Lysine (%)	1.21	1.18	1.20	1.17
Methionine (%)	0.56	0.54	0.52	0.51

GSL= *Guiera senegalensis* Leaf Meal, GNC= Groundnut cake, FSBM= Full fat soya bean meal. *Bio-mix broiler starter premix per 2.5kg of diet: Vit A, 10,000 I.U; Vit D_3, 2,000 I.U; Vit E, 23,000mg; Vit K_3, 2000mg; Vit B1,(thiamine) 1,800; Vit B_2(riboflavin), 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit B6(pyridoxine),3000mg; Vit B_{12}, 15.00; Folic acid, 750.00mg; Biotin H_2, 60.00mg; Cholin Chloride, 300,000mg; Cobalt, 200mg; Copper,3000mg; Iodine, 3,000mg; Iron, 1,000mg; Manganese, 40,000.00mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250mg . M.E= Metabolisable energy

Processing of meat floss (*Dambun nama)*

At the end of the experiment, birds were randomly selected from each of the four dietary treatments, sacrificed, eviscerated and dressed. The fresh broiler meat from these four treatments was cut into pieces of approximately 4 cm by 2.5 cm dimensions and washed with water, mixed with spices (ginger, pepper, onion, cloves, garlic, seasoning cubes, thyme, salt, curry etc.), boiled for about 35 minutes at 100^0C and pounded into shreds using a mortar and pestle. This was then shallow-fried using groundnut oil in a stainless steel pot to obtain meat floss (*dambun nama)*, which is usually brownish in colour (18, 19).

Storage and packaging of meat floss 'dambun nama'

Meat floss processed from broiler chickens fed graded levels of *Guiera senegalensis* (GSL1, GSL2, GSL3, and GSL4) leaf meal were packaged and stored into four (4) different packaging media each, as previously described by (20). These media are Foil Paper Packaging (FPP), Wrapped Newspaper Packaging (WNP), Plastic Container Packaging (PCP) and Disposable Container Packaging (DCP) to give a total of four (4) products. These products were stored and monitored for contaminations at 0, 4, 8 and 12 week intervals. The analysis of total counts (bacterial and fungal counts) was carried out (at 0, 4, 8 and 12 weeks intervals) at the General Microbiology Laboratory, Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria.

Table 3: Composition of broiler finisher diet containing graded levels of *Guiera senegalensis* Leaf meal (5- 8 weeks)

Ingredients	GSL 1	GSL 2	GSL 3	GSL 4
Maize	55.00	51.00	48.00	44.00
FSBM	10.00	10.00	10.00	10.00
GSL	**0.00**	**7.00**	**14.00**	**21.00**
Maize offal	8.50	8.50	8.50	8.50
GNC	22.00	19.00	15.00	12.00
Bone Meal	3.00	3.00	3.00	3.00
Limestone	0.40	0.40	0.40	0.40
Methionine	0.25	0.25	0.25	0.25
Lysine	0.35	0.35	0.35	0.35
Salt	0.25	0.25	0.25	0.25
Vit. Premix	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis				
ME (Kcal/kg)	2972	2963	2963	2954
Crude Protein (%)	20.08	20.29	20.15	20.26
Crude Fibre (%)	4.63	4.83	4.93	5.13
Ether Extract (%)	5.63	5.73	5.81	5.91
Calcium (%)	1.29	1.29	1.29	1.29
Phosphorus (%)	0.60	0.60	0.59	0.59
Lysine (%)	1.13	1.10	1.05	1.01
Methionine (%)	0.53	0.51	0.48	0.48

GSL= *Guiera senegalensis* Leaf Meal, GNC= Groundnut cake, FSBM= Full fat soya bean meal. *Bio-mix broiler starter premix per 2.5kg of diet: Vit A, 10,000 I.U; Vit D_3, 2,000 I.U; Vit E, 23,000mg; Vit K_3, 2000mg; Vit B1,(thiamine) 1,800; Vit B_2(riboflavin), 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit B6(pyridoxine),3000mg; Vit B_{12}, 15.00; Folic acid, 750.00mg; Biotin H_2, 60.00mg; Cholin Chloride, 300,000mg; Cobalt, 200mg; Copper,3000mg; Iodine, 3,000mg; Iron, 1,000mg; Manganese, 40,000.00mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250mg . M.E= Metabolisable energy

Fungal analysis

Total fungal counts (yeast/moulds) were determined (17). This was done by plaiting 0.1ml of the representative of the sample using potato dextrose agar which was incubated at 25°C for 5 days. Fungal colonies were then counted and averaged, which was expressed as total number of colonies counted multiplied by the dilution factor and volume of inoculum to give the colony forming unit per gramme (cfu/gm x 10^5).

Bacterial analysis

This analysis was conducted to determine total aerobic mesophilic counts (cfu/g x 10^5) as per the procedures of (17, 21). Total aerobic mesophilic counts were made by plating dilutions of samples on plate count agar and incubated aerobically at 37°C for 24 hours. After incubation, bacterial colonies were counted and averaged, which was expressed as total number of colonies counted multiplied by dilution factor and volume of inoculum thereby giving the colony forming unit per gramme (cfu/gm x 10^5).

Data analysis

Data obtained from the experiments were subjected to the analysis of variance (ANOVA) using the general linear model procedure of Statistical Analysis System (22). Significant means were used to separate using Duncan's Multiple Range Test (DMRT) in the SAS version 9.0 Package.

Results

Data on storage period on shelf life of meat floss processed from broiler chickens fed graded levels of GSL are shown in Table 4. The results depicted that at 1st day (0 week) of storage, there were no fungal counts in GSL3 and GSL4 was having the least count of 2.0 x 10^5, followed by GSL2 (3.0 x 10^5cfu/g) and highest in GSL1 (4.0 x 10^5cfu/g). Similarly, the total bacterial counts were lowest in GSL2 (2.0 x 10^5cfu/g) and was followed by GSL3 (3.0 x 10^5cfu/g). The control (GSL1) had the highest total bacterial count of 24.0 x 10^5cfu/g. There were significant differences ($P<0.05$; $P<0.01$) in GSL1, GSL3 and GSL4. At 4th week storage of meat floss, the results revealed that total number of microbes were statistically ($P<0.01$) different across all the treatment groups. GSL2, GSL3 and GSL4 have the lowest total fungal counts (each having 1.0 x 10^5cfu/g) compared to GSL1 (2.0 x 10^5cfu/g). Similarly, the lowest total bacterial count was in GSL1 and GSL4 (each having 20.0 x 10^5cfu/g) followed by GSL3 (23.0 x10^5cfu/g). Treatment 2 (GSL2) had a total bacterial count of 24.0 x10^5cfu/g, as depicted in Table 4.

Table 4: Effects of week of storage and type of microbes (cfu/g x 10^5) on quality of meat floss from broiler chickens fed graded levels of *Guiera senegalensis* leaf meal

	GSL Levels (%)			
SP/TM	**(0%)**	**(7%)**	**(14%)**	**(21%)**
0				
Fungal	4.0	3.0	0.0	2.0
Bacterial	24.0	2.0	3.0	8.0
Total	28.0	5.0	3.0	10.0
LOS	**	**NS**	*	*
4				
Fungal	2.0	1.0	1.0	1.0
Bacterial	20.0	24.0	23.0	20.0
Total	22.0	25.0	24.0	21.0
LOS	**	**	**	**
8				
Fungal	2.0	1.0	0.0	0.0
Bacterial	18.0	8.0	8.0	7.0
Total	20.0	9.0	8.0	7.0
LOS	**	**	**	**
12				
Fungal	2.0	0.0	0.0	0.0
Bacterial	27.0	15.0	6.0	5.0
Total	29.0	15.0	6.0	5.0
LOS	**	**	*	*

* $P<0.05$; ** $P<0.01$; NS = Not Significant at 5%; LOS = Level of Significance, GSL= *Guiera senegalensis* Leaf Meal, SP = Storage Periods, TM = Type of Microbes (bacterial and fungal)

Furthermore, at 8th week storage of meat floss, the results showed that the value of total fungal count was highest in GSL1 (2.0 x 10^5cfu/g) with GSL3 and GSL4 each having 0.0 x 10^5cfu/g. The results on total bacterial count revealed that the control (GSL1) had the highest (P<0.05) counts of 18.0 x 10^5 cfu/g. Whereas GSL2, GSL3 had total bacterial counts of 8.0 x 10^5cfu/g each, as observed in this study (Table 4). At 12th week of storage, the results showed that total microbial counts were significantly different (P<0.05; GSL3 and GSL4) and (P<0.01; GSL1 and GSL2). Total fungal counts were 0.00, 0.00, 0.00, and 2.0 x 10^5cfu/g for GSL2, GSL3, GSL4 and GSL1, respectively. Similarly, the total bacterial counts showed that GSL1 had the highest (17.0 x 10^5cfu/g) followed by GSL2 (15.0 x 10^5cfu/g), GSL3 (6.0 x 10^5cfu/g) and GSL4 (5.0 x 10^5cfu/g), as presented in Table 4.

The total fungal and bacterial counts decreased as the inclusion levels of GSL were increased. The overall effects showed that the total microbial load of meat floss decreases as the concentration (level of inclusions) were increased; GSL1 (89 x 10^5cfu/g), GSL2 (49 x 10^5cfu/g), GSL3 (40 x 10^5cfu/g) and GSL4 (40 x 10^5cfu/g) for total bacterial counts. Similarly fungal counts were; 10 x 10^5cfu/g, 5 x 10^5cfu/g, 1 x 10^5cfu/g and 3 x 10^5cfu/g for GSL1, GSL2, GSL3 and GSL4, as shown in Table 5. However, all the microbial counts observed were within the safe limit (10^7cfu/g) specified by (23).

Table 5: Total microbial load (cfu/g x 10^5) of meat floss from broiler chickens fed graded levels of *Guiera senegalensis* leaf meal

Treatments	Fungi	Bacterial	Description
GSL1 (0%)	10.0 x 10^5	89.0 x 10^5	Satisfactory
GSL2 (7%)	5.0 x 10^5	49.0 x 10^5	Satisfactory
GSL3 (14%)	1.0 x 10^5	40.0 x 10^5	Satisfactory
GSL4 (21%)	3.0 x 10^5	40.0 x 10^5	Satisfactory

GSL= *Guiera senegalensis* leaf meal, Satisfactory = Passable and safe limits (10^7cfu/g) specified by (23).

Table 6 depicts data on the effects of packaging media and storage period on total bacterial counts of meat floss processed from broiler chickens fed graded inclusion levels of GSL. The results showed significant differences (P<0.05) of bacterial counts among the packaging media throughout the storage period. However, GSL2 (2.0 x 10^5cfu/g) and GSL3 (3.0 x 10^5cfu/g) had lower total bacterial counts than GSL1 (24.0 x 10^5cfu/g) and GSL4 (8.0 x 10^5cfu/g) across the packaging media at first week (0 week) of storage. And WNP had the least bacterial counts (1.0 x 10^5cfu/g), followed by FPP (5.0 x 10^5cfu/g). Conversely, DCP had the highest counts (21.0 x 10^5cfu/g) across the treatment groups and packaging media. At 4th week storage, GSL2 and GSL4 were better (total bacterial counts) than GSL1 and GSL3. FPP (19.0 x 10^5cfu/g) maintained the superiority of having lower bacterial counts across the treatment groups at week 4, as compared to other packaging media (Table 4). However, there were variations of bacterial growth at 8th week of storage, bacterial counts were increased, with GSL2 (8.0 x 10^5cfu/g) having lower counts than GSL1, GSL3 and GSL4; (86.0 x 10^5cfu/g, 43.0 x 10^5cfu/g and 28.0 x 10^5cfu/g) in terms of total bacterial counts. DCP (30.0 x

10^5cfu/g) had lower total bacterial counts than FPP (42.0 x 10^5cfu/g), WNP (45.0 x 10^5cfu/g) and PCP (39.0 x 10^5cfu/g) across the treatment groups. At higher week of storage (12th week), GSL2 (15.0 x 10^5cfu/g) and GSL3 (18.0 x 10^5cfu/g) were lower than GSL1 (20.0 x 10^5cfu/g) and GSL4 (26.0 x 10^5cfu/g) with regards to their bacterial counts. Meat floss packaged in WNP (10.0 x 10^5cfu/g) had the least counts, and DCP (31.0 x 10^5cfu/g) was having the highest counts across the treatment groups, as presented in Table 6.

Table 7: Effects of storage period and packaging media on total fungal loads (cfu/g x 10^5) of meat floss from broiler chickens fed graded levels of *Guiera senegalensis* leaf meal

	GSL LEVELS			
SPXPM	**(0%)**	**(7%)**	**(14%)**	**(21%)**
0				
FPP	3.0	1.0^b	1.0^b	0.0^a
WNP	3.0	0.0^a	0.0^a	0.0^a
PCP	4.0	1.0^b	2.0^b	2.0^b
DCP	2.0	0.0^a	0.0^a	0.0^a
LOS	**NS**	*	*	*
4				
FPP	2.0^a	0.0^a	0.0^a	0.0
WNP	7.0^b	7.0^c	10.0^b	1.0
PCP	2.0^a	2.0^b	0.0^a	0.0
DCP	3.0^{ab}	0.0^a	0.0^a	0.0
LOS	*	*	*	**NS**
8				
FPP	3.0^b	1.0^b	0.0^a	1.0^b
WNP	1.0^a	0.0^a	0.0^a	0.0^a
PCP	1.0^a	0.0^a	0.0^a	0.0^a
DCP	13.0^c	10.0^c	7.0^b	4.0^c
LOS	**	**	*	*
12				
FPP	2.0^b	3.0^{bc}	0.0^a	0.0^a
WNP	0.0^a	0.0^a	10.0^b	5.0^b
PCP	1.0^b	1.0^b	0.0^a	0.0^a
DCP	8.0^c	0.0^a	0.0^a	0.0^a
LOS	**	*	*	*

[abc]Means with superscripts across column within a subset are significantly different * $P<0.05$; ** $P<0.01$; NS = Not Significant at 5%; LOS = Level of Significance, GSL = *Guiera senegalensis* Leaf Meal, SP = Storage Periods, PM = Packaging Media, FPP = Foil Paper Packaging, WNP = Wrapped Newspaper Packaging, PCP = Plastic Container Packaging, DCP = Disposable Container Packaging

Data on the effects of storage period and packaging on total fungal counts of meat floss processed from broiler chickens fed graded levels of GSL is shown in Table 7. The results showed that at first week of storage (0 week), GSL1 was not statistically

(P<0.05) affected. GSL2, GSL3 and GSL4 had few fungal counts (2.0 x 10^5cfu/g) as compared to GSL1 (12.0 x 10^5cfu/g). All the packaging media had suppressive effects on fungal growth and multiplications; having lower counts across the treatments. At 4th week of storage, there were variations in total fungal growths in all the four treatments where GSL1, GSL2 and GSL3 were statistically (P<0.05) different among the packaging media investigated. FPP (2.0 x 10^5cfu/g) had the least count followed by DCP (3.0 x 10^5cfu/g) and PCP (4.0 x 10^5cfu/g) than WNP (28.0 x 10^5cfu/g) across the treatments. Storage at higher weeks (8th and 12th) fungal growth (P<0.05; P<0.01) were reduced in most of the packaging media across the treatment groups investigated, as they recorded low total fungal counts with PCP (2.0 x 10^5cfu/g) having the least counts and WNP (15.0 x 10^5cfu/g) with the highest counts at 12th week of storage period across the treatment groups and packaging media investigated, as shown in Table 7.

Fig 1 shows data on the effects of packaging media and storage period on total microbial load (fungal and bacterial) of meat floss processed from broiler chickens fed graded levels of GSL. The results revealed that FPP (44 x 10^5) had the least total microbial counts, followed by PCP (47 x 10^5), WNP (53 x 10^5) and DCP (69.0 x 10^5) having the highest total microbial counts across the four packaging media in GSL1 (0%). In GSL2 (7%), PCP (12.0 x 10^5cfu/g) and FPP (13.0 x 10^5cfu/g) had the least counts than WNP (18.0 x 10^5cfu/g) and DCP (23.0 x 10^5cfu/g). FPP had the highest counts (32.0 x 10^5cfu/g) in GSL3, and WNP had the least counts of 20.0 x 10^5cfu/g. GSL4 recorded lower values of total counts in FPP and WNP (18.0 x 10^5cfu/g), where DCP (38.0 x 10^5cfu/g) recorded highest counts among the packaging media (Figure 1).

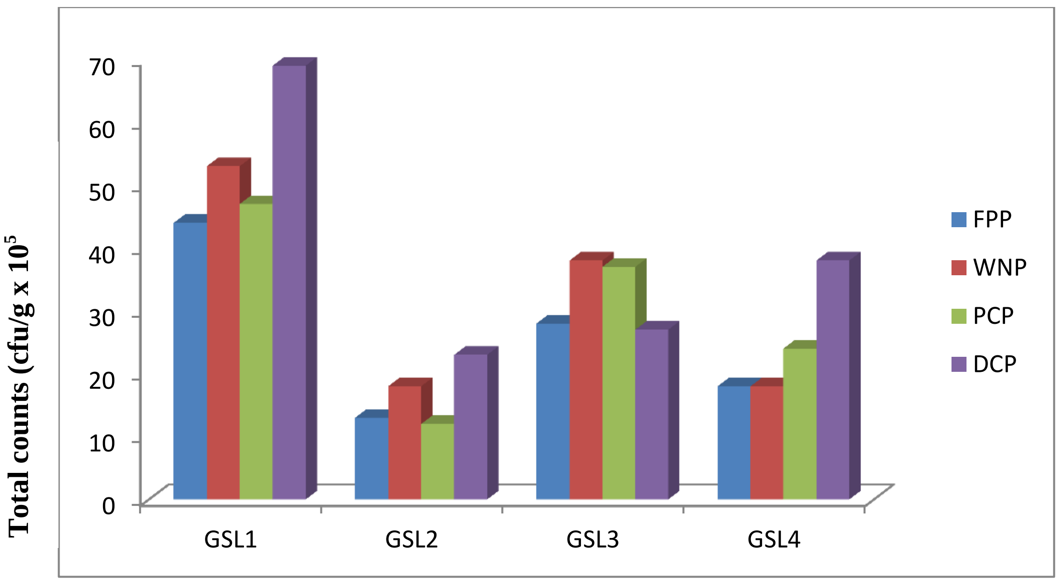

Fig. 1: Overall effects of packaging media and treatment groups on total counts (cfu/g x 10^5) of meat floss from broiler chickens fed graded levels of *Guiera senegalensis* leaf meal

Treatments

Discussion

At the first day of storage (0 week), there were no total fungal counts in GSL3 and GSL4 (2.0×10^5 cfu/g) had the least among the treatment groups. Total bacterial count was highest in GSL1 (24.0×10^5 cfu/g), and lower in GSL2 (2.0×10^5 cfu/g), respectively. However, there were variations of total bacterial and fungal counts across the treatment groups at 4th week of storage with GSL1 having high fungal counts and GSL2 with high bacterial counts among the treatment groups observed. At 8th week of storage, meat floss from 14% (GSL3) and 21% (GSL4) were having no fungal growth, and GSL2 and GSL3 had the highest bacterial counts among the treatment groups which are at par. The variation could be due to the effect of concentration of the leaf meal and temperature changes, as similarly reported by (12, 24,25). There were no total fungal counts in GSL2 (7%), GSL3 (14%) and GSL4 (21%) at the 12th week of storage period, with GSL1 (0%) having (2.0×10^5 cfu/g). Total bacterial count was high in GSL1 as compared to the other treatment groups. This shows that *Guiera senegalensis* leaf has more effect in suppressing fungal counts than bacterial counts. This was in contrast to the report of (12) that *Guiera senegalensis* extract had more potential in suppressing bacterial growth. Positive effect of low total fungal counts was reported when a range of spice extracts were tested on chicken nuggets storage quality (26). This worker attributed the low total fungal counts to the inhibitory action of these spice extracts on fungal activities.

The results on combined effects of storage period and packaging media of both total fungal and bacterial counts for GSL were observed in the present study. Both fungal and bacterial counts were decreased as the inclusion level of GSL is increased at storage period for up to 12 weeks, respectively. This was due to the suppressive effect of the plant leaf (GSL) on microbial growth and improved shelf life of meat floss.

The results revealed that GSL2 and GSL3 had lower bacterial counts across the treatment groups with WNP and FPP having the least counts among the packaging media at first day of storage (0 week). At 4th and 8th week, GSL2 had the least bacterial counts with DCP having the least value. These variations could be the presence of moisture and effect of packaging of processed meat during the storage period, which are usually the main factors that influence growth of micro-organisms in meat and meat products, also opening and closing of the package in the process of microbial count could lead to the exposure of the product to contamination. Total bacterial counts were reduced at 12th week of storage with GSL2 and GSL3 having the lowest total bacterial counts. WNP had no counts in all the treatments except for treatment 4 (GSL4) and the least counts among the packaging media investigated. The low bacterial counts observed in this study could be as a result of the effective phytochemicals (steroids, flavonoids, saponins and tannins) present in GSL which are anti-bacterial in nature. This was in line with the reports of (6, 27, 28, 29, 30, 31). These authors reported that *Guiera sensgalensis* contains phytochemicals such as flavonoids, saponins, carotenoids, tannins and steroids which were found to be anti-bacterial, anti-microbial and anti-oxidant in nature.

The result shows that there were no fungal growth in WNP and DCP in GSL2, 3 and 4 as compared to the other packaging media. And at higher inclusion level of GSL (21%), FPP and WNP had no fungal counts at 1st week of storage period (0 week). At 4th week, FPP, PCP and DCP had the least counts. WNP and PCP were having the lowest total fungal counts at 8th week as compared to the other treatment groups observed. At 12th week of storage period, PCP had the least counts as compared to all the packaging media investigated. Low values of fungal counts in meat floss, packaged and stored in similar packaging media used for this study for 5 weeks and stated that the low values were probably due to the enclosed nature of the packaging materials which prevented further contamination from the environment (24). And from this study, GSL has high effectiveness in suppressing fungal counts than bacterial counts, respectively.

However, the bacterial and fungal counts observed in this study were within the passable and safe limits (10^7cfu/g) specified by the International Commission of Microbiological Standard for Foods (23) and reported safe limit as between 2.5×10^5 and 1.0×10^8cfu/g (32).

Conclusion and Applications

This study concludes as follows:

1. Inclusion of GSL in the diet of broiler chickens revealed that total counts in meat floss decreased as the concentration of GSL was increased up to 21%.
2. However, all the packaging methods investigated had positive effects on lowering bacterial and fungal growth/multiplications of the packaged meat floss at 12-week storage period, with WNP and PCP being more promising.
3. Meat floss processed from broiler chickens fed graded levels of GSL should be evaluated for storage above the 12-week period for shelf-life.

References

1. Hsieh, Y.H.P. and Ofori, J.A. (2007), ‘‘Innovation in Food Technology for Health’’, *Asia Pacific Journal of Clinical Nutrition*, 16(1): 65-73.
2. Gandi, B. R., Olusola, O. O., and Bawa, G. S. (2014). Quality characteristics and microbial studies of beef smoked with different plant materials and suya produced from round muscles. *Nigerian Journal of Animal Science.* 16(1): 157-165.
3. Omojola, A. B., Kassim, O. R., Adewumi, M. K., Ogunshola, O. O., Adeyemo, G. O. and Deshiyan, A. B. (2004). Evaluation of the effects of variation in ingredient compostion on the eating qualities of *suya*. *African Journal of Livestock Extension*, 3: 28 – 32
4. Tanuj, T., Arvind, K. and Nrip, K. P. (2016). Oxidative stability and storage quality analysis of *Ocimum sanctum* L. extracts incorporated in chicken nuggets. *Journal of Applied and Natural Science*, 8 (4): 2182-2188
5. Sule, M. S. and Mohammed, S. Y. (2006) Toxicological studies on the leaves of Guiera senegalensis and Psidium guajava in rats. *Biology and Environmental Science Journal of the Tropics* 3: 81-83.
6. Sule, M. S, Bichi LA, Atiku MK (2001) Antimicrobial and Preliminary Phytochemical Screening of Guiera senegalensis, Euphorbia lateriflora and Mitracapus scaber. *West African Journal Pharmacology and Drug Research* 18: 12-13.
7. Ogunsola, O. O. and Omojola, A. B. (2008). Qualitative evaluation of kilishi prepared from beef and pork. *African Journal of Biotechnology*, 7 (11): 1753 – 1758
8. Eke, M. O., Ariahu C. C and Okonkwo, T. M (2013). Production and quality evaluation of *dambun nama*- A Nigerian dried meat product. *Nigerian Food Journal*, 30(2) 66-70.
9. 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.

10. Balarabe, S. Doma, U. D., Kalla, D. J. U. and Zahraddeen, D.(2016c). Effects of two leaf extracts and packaging method on fungal multiplications on fried minced Meat (*Dambun nama*) incubated at various storage periods. *Nigerian Journal of Scientific Research* 15(3): 495 – 498.
11. Balarabe, S. Doma, U. D., Kalla, D. J. U. and Zahraddeen, D.(2016d). Influence of two leaf extracts and packaging method on bacterial growth on fried minced meat (*Dambun nama*) at different storage periods. *Nigerian Journal of Scientific Research* 15 (3): 527 – 531.
12. Salisu, B. (2017). Effect of inclusion levels of sabara (*Guiera Senegalensis*) and Moringa (*Moringa oleifera*) leaf extracts on storage quality of fried minced beef (*Dambun Nama*). Thesis B. Agri. (Anim. Prod.) M.Sc. Thesis, Faculty of Agriculture, Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria. Pp1-41
13. Zahraddeen, D**.**, Butswat, I.S.R., Jama'a, N. A., Sir, M. S., Musa, R. S., Balarabe, S. and Aliyu, Z. I. (2020). Influence of sensory attributes and storage media on quality of meat floss 'dambun nama' processed from white meat. *Nigerian Journal of Animal Science*, 22 (2): 306-317.
14. Oshibanjo, O.D., Olusola, O. and Adepoju, G. (2019). Quality Assessment of Suya (Tsire) as affected by Moringa Leaf Powder. *International Journal of Meat Science*, 9: 1-6.
15. Ovimaps (2019). Ovi location map: Ovi earth imaginary data. Accessed April, 2019.
16. IAR (2019). Institute for Agricultural Research, Metrological Station. Samaru Weather report, Samaru office, Ahmadu Bello University, Zaria, Nigeria
17. AOAC (2005). Official Methods of Analysis. Association of Official Analytical Chemist, Washington DC, 15 (1): 931-946
18. Kalla, D. J. U., Zahraddeen, D., Abubakar, M., Oladotun, F. B. and Jibia, S. D. (2005). Influence of species and processing method on red meat acceptance among panellists of various cultural background in Bauchi. *Journal of Agriculture, Business and Technology*, 3(2):51-57
19. Zahraddeen, D**.**, Butswat, I.S.R. and Mbap, S.T. (2006). Preferences for goat meat and milk products consumption in Bauchi State, Nigeria. *Animal Production Research Advances.*2 (1): 6 - 11
20. Balarabe, S., Doma, U. D., Kalla, D. J. U. and Zahraddeen, D.(2016b). Effects of two leaf extracts on sensory quality of minced meat (*dambun nama*) processed from various animal sources. *Nigerian Journal of Animal Science*, 18 (2): 572 – 582.
21. Beyene, F. and Seifu, E. (2005). Variation in quality and fermentation properties of milk from local goats. Langston University Goat Research Extension. www.luresex.edu/international/milkferm .prop.htm
22. SAS (2008). Statistical Analysis Institution Users Guide version 9 Edition SAS Institute Inc.Calorina, USA.
23. International Commission of Microbiological Specifications for Foods (ICMSF). (2014)
24. Balarabe, S**.**, Doma, U. D., Kalla, D. J. U. and Zahraddeen, D. (2016a). Animal products and handling: A caution for consumers and entrepreneurs. *Nigerian Journal of Animal Science,* 18 (1): 266 -

274.

25. Balarabe, S., Doma, U. D., Kalla, D. J. U. (2018). Effects of chemical composition and type of panellists on sensory properties of fried minced meat (*Dambun Nama*) processed from red and white meat. *Nigerian Journal of Animal Science,* **20** (1): 220- 228.
26. Haruna, M.H. (2014). Effects of Rigour Temperature and Spice Extracts on the Quality and Shelf life of Broiler Meat Products. Unpublished M.Sc. Theses, Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.
27. Lutterodt, G.D, Ismail A, Basheer, R.H, Baharudin, H.M (1999) Antimicrobial effects of *Psidum guajava* extracts as one mechanism of its antimicrobial action on *Escherichia coli* and *Salmonella typhi*. *Malaysia Journal Medical Science* 6: 17-20.
28. Okwu, D.E (2001) Evaluation of chemical composition of medicinal plants belonging to Euphorbiaceae. *Pakistan Veterinary Journal* 14: 160-162.
29. Osadebe, P.O, Okide G.B, Akabogu I.C (2004) Study on the anti-diabetic activity of crude methanolic extract of Loranthus micranthus Linn. Sourced from five different host trees. *Journal of Ethnopharmacology* 95: 133-138.
30. Raquel, F.E. (2007) Bacterial lipid composition and antimicrobial efficacy of cationic steroid compounds. *Biochemica et Biophysica Acta*, pp: 2500-2509.
31. Al-Shafei, N. K. A, Elshafie, A. E and Nour, A. (2016) Antitoxic, Antifungal and Phytochemical Analysis of Medicinal Compounds of *Guiera senegalensis* leaves in Sudan. *Journal of Plant Biochemistry and Physiology* 4: 166. doi:10.4172/2329- 9029.1000166
32. Pearson, D. (1968). Application of chemical methods for the assessment of beef quality. Part1- General considerations, sampling and the determination of basic components. *Journal of Science Food and Agriculture*, 19: 364 – 366.