NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 52 Number 3, December 2021 Pg. 202-208
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

UTILISATION OF CHICKEN INTESTINES AS EXTENDER IN FRANKFURTER SAUSAGE

[1]Oppong, G.M., [2*]Adediran, O.A., [2]Awodoyin, O.R. and [2]Omojola, A.B.
[1]Department of Animal Science, Kwame Nkrumah University of Science and Technology, Ghana
[2]Department of Animal Science, University of Ibadan, Nigeria
[*]Corresponding Author's email: dimu4ever@yahoo.com

Abstract
Chicken intestines are high in nutrients; however its consumption is limited due to aesthetic and hygienic reasons. There has been little documentation on its use in product formation. Therefore, yield and nutritional quality of frankfurter-type sausage with different levels of chicken intestine was evaluated. Frankfurter-type sausages were produced using chicken intestines to substitute ground beef in treatments 2, 3, 4 and 5 at 5%, 10%, 15% and 20% respectively with treatment 1 serving as the control. A completely randomised design (CRD) was used. Proximate composition, texture profile analysis and microbial load were carried out using standard procedures. Data were analysed using descriptive statistics and ANOVA ($p<0.05$). Crude protein, crude fibre, ash, dry matter, moisture and ether extract all had significant ($p<0.05$) differences. Chicken intestine had significant effects ($P<0.05$) on the microbial load on the various treatments with treatment 1 recording the highest amount of colony count. The texture profile analysis revealed the increase in chicken intestine along the treatments had significant differences ($P<0.05$) with adhesiveness, chewiness, cohesiveness, gumminess, hardness, resilience and springiness. The results suggest that chicken intestine has promising potential as an extender in Frankfurter-type Sausage. Chicken intestine has a potential to be used in meat formation especially frankfurter-type sausage.

Keywords: Chicken intestines, Sausage, Extender, Frankfurter

Introduction

Meat is known to contain the highest quality protein source for human consumption. The taste of meat is often based on its nutritional characteristics such as protein, cholesterol, and water among others. Meat, when consumed is reduced to its ultimate amino acids. The assimilation of amino acids helps in repair of cells and tissues and also for growth (Taylor and Field, 1998). There are other meat by-products which also contain these valuable protein such as the chicken intestine. Intestines, which amounts for 20-30% of the processing wastes (Panda and Singh, 1980) is potential source of proteins and lipids (Raju *et al*., 1997). This commodity is mostly rejected by consumers, mainly due to aesthetic and hygienic reasons. Hence, presently, the bulk of this waste is being either discarded or partly used in animal feeds. According to World Bank report (De Haan *et al*., 2001), the total global demand for meat is expected to grow by 56% between 1997 and 2000. In the last few years, concern has grown regarding adequate supplies of food for the current and growing world population of nearly 7billion (Boye *et al*., 2010). It is estimated that 800million malnourished people exist in the least developed countries (Myers, 2002). From this, including more intestines of broilers in the preparation of meat products would help increase the amount of products on the market and reduce cost of products for majority of people to be able to afford and attain the required levels of proteins in their body. A major food derived from meat is sausage. Since consumers keep discarding the intestines of broilers due to their various reasons on hygiene and nutritive value, ways to help consumers appreciate intestines is needed through the use of the intestines as an extender in sausage production. There are several extenders such as *gari* flour among others but the use of chicken intestine has not yet been reported in literature. This study therefore sought to determine whether or not chicken intestine could be used as an extender in sausage production. The objective of this study was to use broiler intestines in producing low-cost sausages which would be equally nutritive to the consumer as the whole meat sausages, evaluate effects of broiler intestines on sausages, determine water holding capacity, pH and also microbial load of the products.

Materials and Methods

Location

The research was carried out at the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University Of Science and Technology (KNUST), Kumasi, Ghana.

Raw Materials

Broiler chicken intestines were obtained from the Akate Farms at the Department of Animal Science, KNUST. Beef and pork fat were purchased at the Kumasi Abattoir Company Limited. The non-meat ingredients were also purchased at the Ayigya market at TECH junction in Kumasi.

Preparation of Chicken Intestines

The intestines were turned inside-out and all the faecal content was thrown away. Clean water was used to wash the intestines severally to make sure it was clean of all its contents. Brine was prepared and the intestines were soaked in it for 3hours. Afterwards, clean water was used to wash intestines again and kept refrigerated at 4°C until it was used for sausage production.

Sausage Production

The frozen beef, pork fat and intestines were thawed and chopped into smaller sizes. During the chopping, all excess fat in the beef was discarded. The beef, pork fat and intestines were minced separately using a table top meat mincer with a mesh diameter of 5 mm. The mincer was washed and cleaned in-between the grinding of beef, pork fat and intestines. Weights of 700g, 665g, 630 g, 595 g and 560 g were weighed from the minced beef with each weight representing treatments 1, 2, 3, 4 and 5 respectively. Minced intestines of weights 35 g, 70g, l05 g and l40g were allocated to treatments 2, 3, 4 and 5 respectively. This represented 5%, 10%, 15% and 20% replacement of beef across the respective treatments in a completely randomised design (CRD). Treatment 1 served as the control. After, the non-meat ingredients were mixed with the meat into a paste in a bowl cutter, meat batter was filled into casing and hand-linked. All the treatments were hung on wooden sticks with its labelling and then placed in the smoking chamber. The treatments were smoked for 3hours between the temperatures of 70 - 76°C. After the smoking, the products were immediately cooked in water until they attained internal temperatures of 72°C. The internal temperature was taken using a cooking thermometer. The weight of the products was recorded after each stage they passed through from the stuffing, smoking and cooking. The treatments were labeled well again and packaged for refrigeration until further studies and tests were conducted on them.

Parameters Measured

Product Yield and Cooking Loss

The individual weights of the treatments were measured after stuffing in casing (W1) and after cooking (W2). The percentage yield of products were calculated as;

$$\frac{W2}{W1} \quad X \ 100$$

Cost of Products

The cost was expressed per percentage yields of respective treatments;

$$\frac{\text{Cost of formulating /kg (l00\% yield) of each treatment}}{100} \text{ X(\% yield of treatment)}$$

pH

The pH of the cooked and uncooked product was determined at the animal science laboratory at the faculty of Agriculture in KNUST with a Santex pH Meter (SP - 701). Each treatment had 20 grams weighed and dissolved in l000mls of distilled water in a rubber tube. The electrode of the pH meter was dipped into each of the solutions and the readings were recorded. This was performed thrice for each treatment.

Microbial Count

The microbial test was performed at the microbiology laboratory in the Department of Animal Science, KNUST. 10g of each treatment was weighed and mashed in 90 m1 of distilled water to give a uniform mixture. Serial dilution method was used in which 10ml of 10^4 and 10^5 of each sample was pipetted onto a media. The procedure was conducted for 0, 7 and l4days as described by Goszezynsaka *et al.* (1990).

Incubation and Colony Counting

The plated samples were incubated for 24hours at room temperature after which the colonies were counted. A Stuart scientific colony counter was used in the counting of the colonies.

Chemical Analysis

The chemical analysis for protein, ash, fat, fibre and moisture were conducted at both the Food science laboratory and Nutritional laboratory of the Department of Animal Science (KNUST). The procedure described by the Association of Official Analytical chemist (AOAC, 1990) was used in the analysis.

Sensory Evaluation

Twenty-eight untrained sensory panelist which consisted of students of KNUST evaluated the treatments using a 9-point Hedonic scale with 9, 8, 7, 6, 5, 4, 3, 2, 1 representatively, like extremely, like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, dislike very much and dislike extremely respectively. The panelists graded the treatments on appearance, after taste, flavour, tenderness, juiciness, mouth feel and acceptability. All the treatments were warmed in an oven of temperature 180°C for 5minutes. Afterwards, products were cut into equal sizes of about $3cm^2$ and served on disposable plates for the panelists. The treatments had random codes of 3-digits to represent them on the plates. The panelists were given portable water to rinse their mouth each time they tasted a treatment. Panelists were made to sit in an independent way to ensure independence throughout the whole analysis exercise. The atmosphere at the time of evaluation was ensured to be serene

without bad doors and noise to prevent any distraction during the evaluation.

Texture Profile Analysis

The texture profile analysis was carried out at the Food science laboratory at KNUST using a CT3 Texture analyser by Brookfield. Deformation, trigger and speed parameters of 10.0mm, 0.5g and 10.0ms respectively were basis on which the analysis was performed. The analysing programme yielded responses of peak load, deformation at peak, work and final load based on the normal test of CT3 texture analyser. Basically, normal test performs a single compression of the sample and then immediately returns to "home" starting point.

***Deformation Peak*;** is the distance at which the sample was compressed when the peak load occurred and describes softness of a product.

***Peak load*;** is the maximum load measured during test which shows bite to determine crispy and gumminess as a result of cooking.

***Work*;** is used to describe the area under the compression strike. This is measured in mille-joules.

***Final Load*;** is the load at maximum deformation, however the peak load and final load will be same value.

Statistical Analyses

The data collected under the texture profile analysis was analysed using SPSS (2007) version 16.0 statistical package. The Duncan's test of homogeneity was used to show differences between treatment means at 5%. For the sensory evaluation, the data collected was analysed with GENSTAT version 12.1.

Results and Discussion

As shown in Table 2, Treatment three (T3) had the highest moisture content, followed by T2, T4 and TI with T5 recording the lowest moisture content. This is an indication that chicken intestines have the ability to retain moisture to some point but unable to hold moisture when used in excess. Comparing all the treatments, treatment three had the highest amount of ash. However, the control recorded the lowest ash content followed by treatment four, two and five. Protein content increased highly in treatment three (58.10%) which had 70g of chicken intestines but was low in treatment two recording 40.25% which also had 30g of chicken intestines. Treatment four, one and five followed respectively in order of increasing protein content. It was observed that the control and treatment five recorded the lowest amount of fibre content even though one had no intestines and the other had the highest amount of chicken intestines. The reason for this is not known. Treatment four recorded the highest fibre content amongst the treatments, but there were differences between treatment two, three and four. The fat content in treatment two was seemingly high as compared to the other treatments. Treatment three recorded the lowest fat content in the experiment.

Microbial Load

On day seven, the control was high in microbes but increase in chicken intestine led to minimum microbes in T3. The fourteenth day showed low microbial count in treatments as compared to day seven. Treatment four and the control recorded the highest and lowest counts respectively. This showed that as storage of the products increased the microbial counts of the treatment also decreased meaning prolonged storage decreased the amount of microbes in the product. The microbial count increased as the level of chicken intestine increased despite the cleaning and washing in salt water. The handling technology (washing and turning) seems not to be sufficient enough, because even the control treatment had higher microbial load than the recommended level of 10^4 for good microbiological standard in fresh meat (NSW/FA/ CP02810906, 2009). It was however noted that the microbial load reduced as the storage days increased from 7th day (8.0×10^8) to 7.0×10^8 on the 14th day. The probable answer to this puzzle might not be unconnected with the condition microbes are subjected to during refrigeration. The higher than normal microbial load could also be due probably to the handling of the products during investigation (microbial analysis).

Sensory Evaluation

The results of the sensory evaluation of the frankfurter-type sausages which were assessed by the panellists are reported in the Table above. There were no significant differences ($p<0.05$) in the overall acceptability with treatment two recording the highest score of 7.15 acceptability and treatment one recorded the lowest. The appearance of treatment two which had 30g of chicken intestines was more preferred to the other treatments. However, no significant differences occurred among the treatment means. Treatment two recorded the highest in juiciness and after taste and there were no significant ($p<0.05$) differences with the other treatments. The increase in chicken intestines reduced the flavour of the products as treatment five read the lowest figure in flavour and the control having the highest. Score recorded for mouth-feel was also lowest in treatment five probably due to increased amount of chicken intestines whiles the control read the highest amongst the treatments. These observations agreed partially with that reported by Garcia-Santos *et al.* (2019) who reported no significant differences in frankfurter sausages that had resistant starch as extender. Juiciness which is an impression of wetness and the release of fluids during mastication or chewing is not affected significantly by the emulsion of chicken intestine. This lays credence to the fact that chicken intestine could be used in sausage without any adverse effect on the juiciness rating of the product. Tenderness is an important attribute that determines the repeatability of purchase. The tenderness scare for the control and all the treated sausages were similar however, it was noted that as the chicken intestine levels increased, the numerical values for tenderness score increased. Treatment 2 (6.25) has the highest score for juiciness and incidentally this was where the highest for appearance,

flavour and overall acceptability was obtained. By reference, treatment 2 with 35g of chicken intestine could be concluded as the best among the five treatments. After taste was highest in treatment 2 followed by the control. The after taste probably had been influenced by the high juiciness score and high flavour perception of the samples in treatment 2. After taste decreased as the inclusion level of chicken intestine increased. The flavour score was highest for the control treatment. It was noted that the flavour score decreased significantly with increases in the chicken intestine component of the product. Although, this was not expected as chicken intestine with a lot of fat was expected to release more flavour compounds into the product**.**

Texture profile Analysis

The data from the texture analysis (Table 5) showed hardness of the product decreased when the chicken intestines was increased to the highest level in treatment five while treatment one which had no chicken intestines remained the hardest which probably was due to the inability to retain enough moisture since there was no chicken intestines. Gumminess, resilience and cohesiveness recorded low values in treatment three as compared to the other treatments but there was no significant difference in the other treatments. Chewiness is the mouthfeel sensation of laboured chewing due to sustained elastic resistance from the food. It is empirically measured by the metric of chew count and chew rate. As the chewiness value increased, more energy is required to completely masticate a given weight of food, although, in Africa we prefer a food commodity with higher mouthfeel and longer stay in the mouth. Apart from treatment 2, with higher chewiness value than treatment 3 samples, the chewiness increased as the level of chicken intestine increased. This observation was in agreement with report by with Zhao *et al.,* (2018) who reported increase in chewiness of fat-reduced emulsified sausages, but differed for cohesiveness and gumminess, which may be attributable to unique differences in formulations.

Cohesiveness is a measure of how well a product withstands a second deformation relative to its resistance under the first deformation. Here the higher the value the higher the resistivity of the product to deformation. Indicating probably how compact the product is. The result obtained in this study indicates higher value for the cholesterol (without chicken intestine). However, there was no consistent pattern in the influence of chicken intestine on the cohesiveness value of the product. Treatment 3 had the least value of 0.71 followed by treatment 2, 5 and 4 with 1.95, 2.09 and 2.60 respectively.

Product Yield and Cooking Loss

From the above table, it was observed that the treatment five recorded the highest figure pertaining to loss after cooking. However, Treatment one recorded the lowest. This was probably due to inability of treatment one to retain enough moisture as compared to the other treatments which had some amount of chicken intestines in them. The intestines helped in the retention of water in the products so form the table it was observed cooking loss increased as the amount of chicken intestines was increased in the treatments. The yield of the product decreased as the chicken intestines were increased in the treatments. This observation was at variance with research by Nkrumah and Akwetey (2018). The control of the experiment recorded the highest in product yield since there was no chicken intestine in it. Due to this, the product was not able to hold up too much water in it.

pH of Sausage

The pH of the uncooked products appeared to be very low in acidity but after the products were cooked, the acidic level turned to be more lower in the products. The pH values reported were all similar to observations reported by Nkrumah and Akwetey (2018), who utilised fish in the production of frankfurter sausages However, they became more stabilized in the products probably due to the phosphate which was added during the product formulation.

Water Holding Capacity and Production Cost

The cost in producing sausage with chicken intestines reduced cost from 16.50cedis in treatment one to 16.10cedis in treatment three, though higher than cost reported by Nkrumah and Akwetey (2018) which is likely due to the type of animal protein used in sausage formulation and natural inflation trends. When the use of chicken intestines is adopted by manufacturers, some saving could be made by the producer and even the consumer which would also increase purchase of the product by the consumer.

The water holding capacity of the treatments kept rising as there was increase in the chicken intestines, which was in partial agreement with report by Zapata and Pava (2017) but dropped with treatment 4 and rose again with treatment 5. This means the more chicken intestine is increased, water holding capacity would also keep rising.

Conclusion

The study indicates that chicken intestines is a good extender in Frankfurter sausages and it can be up to 10% in frankfurter-type sausage without any detrimental effect in yield, quantity and sensory attributes. It can be recommended that chicken intestines can be included in sausages for frankfurter sausages up to 10 % without any detrimental effect on quality.

References

AOAC. (1990). *Official methods of analysis* (15th Edition). Washington, DC: Association of Official Analytical Chemists.

Boye, J., Zare, F., and Pletch, A. (2010). Pulse protein processing, characterization, functional properties and applications in food and feed. *Food Res. Int.* 43:414-31.

De Haan, Van Veen T., Brandenburg B, Gauthier J., Le Gall F., Mearns R., and Simeon M., (2001). *Implications for rural poverty, the environment and global food security.* World Bank report 23241.

Washington DC: The World Bank.
Garcia-Santos, M., Conceição, F., Boas, F., Souza, B., and Barretto, A. (2019). Effect of the addition of resistant starch in sausage with fat reduction on the physicochemical and sensory properties. *Food Science and Technology. 10.1590/fst.18918.*
Myers, W. (2002). Sustainable food security for all by 2020. *Proceedings of an international conference,* Washington DC: IFPRI p100.
Nkrumah, T. and Akwetey W. Y. (2018). Physico-chemical and Sensory Properties of Frankfurter-type Fish Sausage. *American Journal of Food Science and Technology*. , 6(**3**), 118-122. DOI: 10.12691/ajfst-6-3-6 Published online: March 23, 2018.
NSW/FA/CP028 (2009). *Microbiology quality guide for ready to eat foods.* NSW Food Authority, New South Wales, Australia. Pp 1-9. Retrieved June 18 2021 from https://www.foodauthority.nsw.gov.au/sites/default/files/_Documents/scienceandtechnical/microbiological_quality_guide_for_RTE_food.pdf
Panda, B. and Singh, R. P. (1980). Processing and utilization of poultry industrial by-products. By-products from food industries: Utilisation and disposal. In: *Association of Food Technologist, India, Symposium proceedings,* Pp. 58-68.
Raju, A. A. and Rao, N. M. (1997). Enzymatic hydrolysis of tannery fleshings using chicken intestine proteases. *Animal Feed Science Technology.* 66.:139-147.
Taylor, R. E. and Field, T. G. (1998). *Scientific farm animal production.* An introduction to animal science (6th ed). Pearson/Prentice Hall. Simon and Schuster company, New Jersey, USA, Pp. 1-764.
Zapata, José Igor Hleap, & Pava, Gloria Carmenza Rodríguez de la. (2018). Physicochemical analysis of frankfurter type sausages made with red tilapia fillet waste (Oreochromis sp) and quinoa flour (Chenopodium quinoa W.). *Brazilian Journal of Food Technology*, *21*, e2016103. Epub October 16, 2017.https://doi.org/10.1590/1981-6723.10316.
Zhao, Y Hou, Q. Zhuang, X. Wang, Y. Zhou, G.H. and Zhang, W (2018). *Effect of regenerated cellulose fiber on the physicochemical properties and sensory characteristics of fat-reduced emulsified sausage*. LWT. 97. 10.1016/j.lwt.2018.06.053.

Table 1: Formulation of the Experimental products

Ingredients	**Treatments**				
	T_1	**T_2**	**T_3**	**T_4**	**T_5**
Ground beef	700	665	630	595	560
Chicken intestine	0(%)	35 (5%)	70(10%)	105 (15%)	140(20%)
Port fat	100	100	100	100	100
Ice flakes	150	150	150	150	150
*Spices	30	30	30	30	30
Curing salt	15	15	15	15	15
Phosphate	5	5	5	5	5
Total	**1000**	**1000**	**1000**	**1000**	**1000**

: Thyme, Onion, Garlic and Red Pepper

Table 2: Proximate composition of frankfurter-type sausage as influenced by chicken intestine

Parameters (%)	Treatment				
	T_1	T_2	T_3	T_4	T_5
Moisture	5.90	8.61	17.10	7.40	5.75
Ash	5.30	6.10	8.30	5.40	7.00
Crude protein	50.05	40.25	58.10	43.75	51.45
Ether extract	20.50	22.80	17.01	21.70	20.40
Crude fibre	0.80	0.12	0.10	0.14	0.08

Table 3: Bacteria count for day seven and fourteen

Treatments	Microbial Load
T1	$5.0x10^8$
T2	$6.0 x10^8$
T3	$8.0 x10^8$
T4	$9.0 x10^8$
T5	$1.0 x10^9$
P-value	<0.001
LSD	$5.58 x10^7$
Days	
O	$9.0 x10^8$
7	$8.0 x10^{8b}$
14	$7.0 x10^{8a}$
P-value	<0.001
LSD	$3.53 x10^7$
Treatments x Days	
T1 x 0	$8. 0 x 10^9$
T1 x7	$9.0 x x10^{8a}$
T1 x 14	$1.0 x x10^{8c}$
T2 x 0	$7.0 x10^9$
T2 x 7	$7.0 x x10^7$
T2 x14	$1.0 x10^9$
T 3 x 0	$5. 0 x 10^{9b}$
T4 x0	$2.0 x10^{9a}$
T4 x7	$3.0 x10^{7c}$
T4 x 14	$2.0 x 10^8$
T5 x0	$2.0 x10^9$
T5 x7	$3.0 x 10^7$
T5 x14	$2.0 x10^8$
p-value	<0.001
LSD	$7.9 x10^7$

^{abc}***Means in the same column under similar parameter with similar superscripts are not significantly different (p>0.05)***

Table 4: Sensory evaluation of frankfurter-type sausage as influenced by chicken intestine

Parameters	Treatments					
	T1	T2	T3	T4	T5	P-Value
Tenderness	6.10	6.14	6.45	6.76	6.94	0.504
Flavour	6.89^a	6.70^b	5.95^c	5.19^c	5.03^d	0.001
After taste	6.70^a	7.25^a	5.70^b	5.55c	4.90^c	0.001
Mouth-feel	6.25	6.00	5.80	4.80	4.65	0.001
Juiciness	5.85	6.25	5.85	5.25	5.45	0.419
Appearance	6.25	6.30	5.85	6.20	5.30	0.623
Acceptability	4.73^b	7.15^a	5.90^c	5.70^c	4.84^d	0.001

^{abcd} ***Means in the same row with different superscripts are significantly different (p<0.05)***

Table 5: Texture profile analysis of frankfurter sausage

Parameters	Treatments						
	T1	T2	T3	T4	T5	P-Value	LSD
Adhesiveness	0.07^{ab}	1.21^{a}	0.13^{bc}	0.14^{bc}	0.16^{bc}	0.001	1.33
Chewiness	0.68^{c}	3.66^{b}	0.81^{c}	3.62^{b}	7.86^{a}	0.001	3.98
Cohesiveness	3.43^{a}	1.95^{b}	0.71^{c}	2.60^{b}	2.09^{bc}	0.001	1.48
Gumminess	174	98	35	129	102	0.001	7.40
Hardness	50.54	50.02	49.02	49.79	49.04	0.001	1.40
Resilience	0.49^{a}	0.34^{ab}	0.14^{a}	0.36^{b}	0.19^{a}	0.001	0.31
Springiness	1.62^{ab}	7.17^{a}	2.72^{b}	4.09^{bc}	7.89^{a}	0.001	4.18

^{abcd} Means in the same row with different superscripts are significantly different (p<0.05)

Table 6: Cooking loss and product yield of frankfurter sausage

Parameters	Treatments						
	T1	T2	T3	T4	T5	P-value	LSD
Cooking Loss	7.97	9.85	9.79	11.28	20.59	0.001	11.369
Product Yield	92.03	90.14	90.21	18.72	79.41	0.032	2.891

^{abc} Means in the same row with similar superscripts are not significant (p<0.05)

Table 7: pH of emulsion and sausage as influenced by chicken intestine inclusion

Parameters	Treatments						
	T1	T2	T3	T4	T5	P-value	LSD
pH of emulsion	5.74	5.67	5.62	5.66	5.68	0.926	0.309
pH of sausage	5.84	5.69	5.74	5.78	5.76	0.847	0.309

^{abc} Means in the same row with similar superscripts

Table 8: Water holding capacity and production cost of frankfurter sausage.

Parameters	Treatments						
	T1	T2	T3	T4	T5	P-value	LSD
Water holding Capacity(%)	12.00	16.00	20.00	19.00	23.00	0.001	28.633
Production cost (cedis)	16.50	16.20	16.10	16.8	16.6	0.010	3.417

^{abc} Means in the same row with similar superscripts are not significant (p<0.05)