PROXIMATE COMPOSITION, SENSORY AND PHYSICOCHEMICAL PROPERTIES OF CHICKEN SAUSAGES PRODUCED IN KUMASI

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ABSTRACT
Sausages are considered one of the most popular and appetizing of all processed meat products. A study of the proximate composition, sensory profile and physicochemical properties of chicken sausages produced by three firms in Kumasi was conducted in order to suggest possible solutions for product quality improvements. A total of three different production batches of chicken sausages (each consisting of 3 kg) were obtained fortnightly from three different firms and evaluated for proximate compositions (fat, moisture, protein and ash) and sensory characteristics (appearance, texture, flavour, taste, juiciness and overall acceptability), as well as pH, water holding capacity and cooking loss at the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST). Colour analyses was performed at the Clinical Analyses Laboratory of the Department of Biochemistry, KNUST. Sausages obtained from the different manufacturers were distinguished using letter codes (A, B and C) in order to conceal enterprise identity. Warmed products were served to 30 random consumer panelists for evaluation of eating characteristics using a 7-point hedonic scale. A Completely Randomized Design was utilized and data obtained from sensory and proximate analyses were subjected to Analysis of Variance (ANOVA) using Statistix (Version 8.0). Means from both analyses were separated using All-Pairwise Comparisons Test at 5%. The fat, moisture and protein contents were significantly different ($p<0.05$). Sensory analyses did not show any significant differences ($p>0.05$) in terms of appearance, taste, texture and juiciness amongst all samples. There were significant differences ($p<0.05$) in the water holding capacity of sausages with B (25.38%) retaining the highest moisture after oven cooking. No significance ($p>0.05$) existed in the pH and weight losses after cooking. There were significant differences in the lightness (L*), redness (a*) and yellowness (b*) values of the sausages with C (65.46) appearing lighter than both A (56.63) and B (57.37). Sausages from enterprise A (7.98) and C (6.19) also appeared more reddish than those from processor B (6.02). Sausages from processor C (14.31) looked more yellowish than those from processors A (13.27) and B (13.58). It was concluded that there were variations in moisture, fat and protein contents which resulted in differences of consumer acceptability of chicken sausages produced in Kumasi.

Keywords: *Chicken sausages, proximate composition, sensory evaluation, physicochemical properties, colour profile.*

INTRODUCTION

Meat is defined as the flesh or other edible portions of animals that are suitable for human consumption and is regarded as a high-quality source of protein, minerals and vitamins. It is commonly referred to as lean muscle tissue and is obtained from slaughtered animals by most consumers. However, fat, offal, kidney, liver, heart, and other edible parts can also be classified as meat (Adzitey *et al.,* 2015; Lautenschlaeger, and Upmann, 2017). Reports by Dario *et al.* (2016) revealed that meat has a significant impact on human diet and its consumption is linked to the lifestyles, economic positions and health status of people. According to Biesalski (2005), meat provides easily absorbed iron, zinc, concentrated quantities of high-quality protein, B-vitamins, as well as essential amino acids. It is obtained from a variety of species based on religious and cultural beliefs, as well as accessibility and convenience (Paredi *et al.,* 2013). According to Warriss (2010), animal used as meat across the world do not only include mammals such as cattle, sheep, goats, pigs, buffaloes, camels, yaks, llamas, deer and rabbits but also birds, especially domestic fowls and turkeys, geese and ducks, fish and various invertebrates. In Ghana, meat is mainly obtained from cattle, sheep, goats and chicken (Adzitey, 2013).

Owing to the availability of important amino acids, meat has a significant impact on human growth and development (Warriss, 2010). Lawrie and Ledward (2006) further added that meat is a major source of high-quality protein, which is necessary for human growth and the repair of worn-out body tissues. The fat in meat is also a vital source of energy, and it varies widely depending on the animal species from which it is obtained. Fat also determines the taste, flavour, juiciness, texture, tenderness, and even the price of meat (Ospina *et al.,* 2012).

Apart from these general descriptions of meat, there are detailed specific characterizations of meat raw material used for the manufacture of processed meat products in terms of the content of fat and connective tissue (Leitsätze für Fleisch und Fleischerzeugnisse, 2015).

Meat is processed by adding ingredients and/or using mechanical action to convert it into specialized products, such as sausages and burgers, to prevent spoilage and to suit market demands (Teye, 2007). Raw meats are very exposed to microbiological contaminants during processing, and heat treatment alone is often insufficient to entirely eliminate these microbes in the industry (Trindade *et al.,* 2010). Adzitey and Huda (2012) also reported that, processing meats can help to add value to poor quality meats like pale soft exudative (PSE) and dark, firm and dry (DFD) meats. Examples of processed meats are sausages, bacon, ham, burgers, meatballs and steaks.

Sausages are one of the earliest meat products consumed worldwide. Fresh sausages are meat products that have not been heat-treated and are formulated using a variety of meats like chicken, pork or beef. They are more or less coarsely minced or emulsified, and may contain additives together with ingredients like salt, spices, colouring and flavouring agents, depending on local demands (Pearson and Gillet, 2012).

Without any additives, converting chicken into sausages often result in colourless products (Abdulhameed *et al*., 2016). This is why most chicken sausage producers use synthetic colour additives to enhance the appearance of their products. However, there are growing consumer concerns about such additives used in the meat processing industry generally due to perceived and real threats to human health in spite of their contributions to sensory and eating quality of processed meat. A good example is witnessed in the use of tartrazine; an artificial food dye made from petroleum products, and used by manufacturers to give their products bright colours. There has been rising concerns on its inclusion in food products because of the numerous adverse effects it has on human health, particularly behavioural problems like attention-deficit/hyperactivity disorder (ADHD) in children.

The use of different ingredients by different processors in the manufacture of a specific product may result in differences in physical and chemical characteristics as well as sensory perceptions of such products.

The objective of this study was to evaluate the proximate composition, sensory profile and physicochemical properties of chicken sausages produced and sold by firms in the Kumasi Metropolis of Ghana.

The specific objectives were the determination of moisture, ash, protein and fat contents, as well as colour profile, cooking loss, pH and water holding capacity of chicken sausages obtained from three processing firms.

MATERIALS AND METHODS

Location of experiment and experimental procedure

The experiment was conducted at the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi and it lasted for a period of 18 weeks. Proximate analysis and colour measurement were carried out at the Nutrition Laboratory at the Animal Science Department and the Clinical Analyses Laboratory of the Department of Biochemistry respectively. Fresh chicken sausages were obtained fortnightly for 10 weeks from three processing firms: Kumasi Abattoir, Speedway Groceries and Santinos, all in Kumasi. However, before settling on the processors to obtain the sausages from, a survey was first conducted to know the types of sausages produced by firms in the metropolis and it was discovered that these three processors were the only firms producing chicken sausages. In order to conceal the identity of sausages obtained from the three firms, the products were coded in no particular order as A, B and C.

Parameters measured

Proximate composition

Proximate analysis of raw sausages was performed according to procedures described by AOAC (2023) for moisture, crude ash, fat and protein. All the evaluations were performed in triplicate.

Sensory attributes

The sausages from each of the three processors were microwaved separately to 77°C internal temperature in order to determine their sensory characteristics using the method described by Schmidt *et al*. (2016). Thirty (30) consumer panellists from the University were randomly selected to evaluate each treatment in a well-lit environment. Appearance, taste, juiciness, flavour, texture and overall acceptability of the sausages were evaluated using a 7-point hedonic scale. Water was made available to the panellists to rinse their mouths thoroughly before and after tasting each sausage sample to nullify any carry-on effects from tasting samples served.

Water holding capacity (WHC), pH and cooking loss

The procedure for determining the pH of the sausage samples was as described by Akwetey *et al*. (2014) using a digital pH meter (Gorrey Hills Technologies, PHS-3E). Water holding capacity was determined as described by Lee *et al*. (2008). Percentage cooking losses were calculated as the difference in weight between the raw and cooked sausages expressed as a percentage of raw weight.

Instrumental colour measurement

Colour was measured at the Clinical Analyses Laboratory, KNUST using chromameter CR 400 (Konica, Minolta, Inc, Japan) according to American Meat Science Association (Hunt *et al.,* 2012) procedures. CIE lightness (L*), redness (a*) and yellowness (b*) values were measured on the internal portions from 3 different randomly selected spots of the sausage samples.

Experimental design and analysis

A Completely Randomized Design was used and data obtained were analysed by one-way Analysis of variance (ANOVA) using Statistix (Version 8.0). Significant differences between treatment means were declared at 5% using Duncan's test of homogeneity.

RESULTS AND DISCUSSION

Table 1 shows the results of the proximate composition of the chicken sausages from the three

different processors. There were significant differences ($p<0.05$) in fat, moisture and protein contents. According to Suleimenova (2016), moisture constitutes the major component of meat, making up about 75% of their weight. Moisture in meat and meat products, plays a crucial role in the assessment of its quality assessment because it influences the texture, colour, eating quality and Water Holding Capacity of the products. The range of moisture content in the chicken sausages was 59.47% to 72.09%. This result is similar to those previously report by Rahman *et al*. (1997), for which the range of moisture content in chicken sausages was reported as 58.18% to 71.30%.

The content of protein indicates the nutritional status of food samples (Naveen *et al.,* 2016), and it is very important in sausages since meat constitutes the major raw ingredient used in the manufacture of sausages. Protein contents in the chicken sausages in this study were between 14.08% and 21.16%. sausages obtained from processor B were significantly lower ($p<0.05$) in protein compared those from processors A and C; which were similar in protein.

The results obtained for protein contents in this study were higher than those of Rahman *et al*. (1997), where protein contents were between 11.14% and 16.52%. The protein contents of chicken sausages were also higher than commercial chicken sausages from Brazil, which was reported to be 13.2% (Pereira *et al*., 2000). The higher protein contents in this study suggests the use of higher lean chicken meat portions to non-meat ingredients in sausage formulations compared to those reported previously. Non-meat ingredients such as corn syrup solids, and various flours and starches may be utilized in sausage formulations to reduce product formulation costs however, their use may be accompanied with reductions in protein and fat contents (Akwetey and Yamoah, 2013; FAO, 2007). Fat contents in meat and meat products such as sausages influence their eating quality as well as textural properties (Ali et *al.,* 2011). Higher fat contents were observed in the sausages obtained from processors B and C compared to those from processor A, while the fibre contents in B were significantly (<0.05) lower than for processors A and C sausages.

Results obtained for sensory profiles of the different chicken sausages are shown in Table 2. Significant differences ($p<0.05$) were observed in flavour and acceptability amongst the three sausage brands, but all other parameters did not differ significantly ($p>0.05$).

The observed differences in flavour and acceptability could be due to the use of different spices by the different firms in similar product formulations (Peters *et al.,* 2014).

Results for pH, cooking loss and water holding capacity as well as the colour measurements of lightness (L*), redness (a*) and yellowness (b*) of the sausages are presented in Table 3. There were significant differences *(*$p<0.05$) in the water holding capacity. Sausages obtained from

Table 1: Proximate composition of chicken sausages

Parameter	Type of sausage			SEM	p-value
	A	B	C		
Protein	21.16[a]	14.08[b]	19.29[a]	1.52	0.01
Fat	6.67[b]	24.67[a]	22.20[a]	1.39	<0.00
Moisture	72.09[a]	59.47[b]	67.55[a]	2.54	0.01
Ash	1.98	1.76	1.79	0.07	0.11

[ab]Means in the same row with different superscripts are significantly different (p<0.05); A, B and C are sausages from different firms in Kumasi; SEM= standard error of means.

processor B (25.38%) held more water than those from processors A (13.94%) and C (15.36%). Water holding capacity of meat products is a very important quality attribute which has an influence on the yield of products, eating quality as well as economic implications and consumers usually prefer juicier and more tender products to dry and tough products. Weight losses due to liquid and soluble matter exudation from meat during cooking can results in loss of essential fats, soluble proteins and vitamins.

No significant differences ($p>0.05$) were however observed in the pH and percentage cooking losses of the different sausages. The pH values of the sausages ranged from 7.54 to 7.60 while percentage cooking losses were from 11.60% to 13.29%.

There were significant differences ($p<0.05$) in L* (lightness) colour coordinate values. Chicken sausages obtained from processor C (65.46) appeared to have lighter colour than those from processor A (56.63) and B (57.37). According to Dingstad *et al.* (2005), at least 60% of consumers were willing to purchase chicken sausages when the L* values were between 62.30 and 68.50. However, these observed differences in lightness of the different sausages in this study did not statistically affect how the consumers scored their appearance attributes (Table 2).

There were also significant differences ($p<0.05$) in the a* (redness) and b* values. Sausages from processors A (17.98) and C (16.19) appeared more reddish than those from processor B (16.02), while those from processor C (14.31) looked more yellowish than those from proces-

Table 2: Sensory profile of chicken sausages

Parameter	Type of sausages			SEM	p-value
	A	B	C		
Appearance	5.34	5.13	5.00	0.151	0.27
Flavour	5.09^{ab}	4.86^{b}	5.36^{a}	0.143	0.049
Taste	5.33	5.15	5.44	0.150	0.39
Texture	5.06	4.75	5.08	0.152	0.24
Juiciness	5.15	4.98	5.33	0.149	0.27
Acceptability	5.57^{a}	4.80^{b}	5.40^{a}	0.238	0.004

^{ab}Means in the same row with different superscripts are significantly different ($p<0.05$); A, B and C are sausages from different processors in Kumasi; SEM= standard error of means; Scale: 1= dislike extremely;2= dislike slightly; 3= dislike; 4= neither like nor dislike; 5= like; 6= like slightly; 7= like extremely

Table 3: pH, cooking loss, water holding capacity and instrumental colour measurement of chicken sausages

Parameter	A	B	C	SEM	p-value
pH	7.60	7.59	7.54	0.041	0.82
Cooking loss	13.09	11.60	13.29	0.334	0.07
WHC	13.94^{b}	25.38^{a}	15.36^{b}	1.127	<0.001
L*	56.63^{b}	57.37^{b}	65.46^{a}	0.846	<0.001
a*	17.98^{a}	16.02^{b}	16.19^{a}	0.211	<0.001
b*	13.27^{b}	13.58^{b}	14.31^{a}	0.099	<0.001

^{ab}Means in the same row with different superscripts are significantly different ($p<0.05$); A, B and C are sausages from different processors in Kumasi; WHC= Water Holding Capacity; SEM= standard error of means; L= Lightness; a*= redness; b*= yellowness*

sors A (13.27) and B (13.58). Bigner-George and Berry (2000) stated several factors that could reduce the redness or yellowness in meat and meat products. Among these factors are high fat contents, end-point temperature and post-cooking time before evaluation. In addition, some of the ingredients utilized in sausage production such as nitrates/nitrites, various spices and seasonings may have significant influences on the redness property of the final products. The different processors might have used different spices in formulating chicken sausages, apart from sodium nitrite-curing salt which was incorporated in all the sausage formulations.

CONCLUSIONS AND RECOMMENDATION

The results of this study shows that chicken sausages produced in the Kumasi Metropolis vary greatly in moisture, fat and protein contents. In addition, their flavour and consumer acceptability values differed depending on the type of producer. Cooking loss and pH were however found to be similar among the sausages obtained from the three processors, but sausages obtained from firms A and C looked more reddish than those from firm B. Further studies should be conducted to assess the microbial safety of chicken sausages produced in the Kumasi Metropolis.

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