PHYSICOCHEMICAL PROPERTIES AND MICROBIOLOGICAL EVALUATION OF BREAKFAST SAUSAGE PREPARED FROM DIFFERENT PROPORTION OF CHICKEN AND BEEF MEAT

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ABSTRACT
The focus of the poultry industry has shifted from marketing live bird as a commodity to value-added products in other to facilitate trade in poultry products. Hence, this study was conducted to evaluate the effects of different proportion of beef and chicken in breakfast sausage. Meat homogenates were prepared using five mixing ratios between chicken breast and beef. Physicochemical, microbiological and sensory properties were analyzed. The analyses were carried out using SAS software while the means were separated with LSD at 5%. The influence of beef and chicken on breakfast sausage was significant in proximate composition, the treatment I had the highest percentage of crude protein (31.77±0.65 %) compared to the lowest percentages of treatment V (27.57±0.55%). Product yield ranged from 68.05±0.84 % in V to 75.32 ±1.86 in I, product yield of samples increased with the amount of beef incorporated. Meat is a nutrient-dense medium ideal for spoilage microbes to colonise. Total Aerobic Counts for raw sausages was highest in treatment V (4.63± 0.39 cfu/g) and the lowest value was recorded in I (1.38± 0.08 cfu/g) This study revealed that the use of chicken meat in sausage production would enhance high cooking yield and nutritional values

Keywords: Homogenates, sausage, physicochemical, microbiological and yield

INTRODUCTION
Different sources of meat have different protein characteristics and different physicochemical properties. The popularity of poultry meat among consumers is due to the sensory properties and the mild flavour profile allowing consumers to impart desired flavours to the meat (Petracci *et al*., 2013). Chicken meat is considered a highly nutritious food because it contains relatively high protein and low-fat percentages (Jung *et al*., 2015). Beef is used extensively in meat products; however, the scientific properties of white meat have generated interest among processors. The potential of beef and chicken meat in value addition technologies has not been explored. Such-up-date information is important to assure the safety and quality of processed poultry products for public consumption and increase trade in beef and chicken products. Different types of meat used for sausage raw material may yield different quality characteristics in the sausages produced. Hence, it is important to evaluate the effects of the incorporation of different ratios of beef and chicken on the physicochemical, microbiological and sensory evaluation of the breakfast sausage.

MATERIALS AND METHODS
Preparation of breakfast sausages
Chicken (*Pectoralis major* muscle) and beef (*Adductor* muscle) were procured one-hour post-mortem at the Teaching and Research Farm, Slaughter house of the Department while the processing and laboratory analysis were conducted in the central laboratory of the Department. The formulation of breakfast sausages and composition of non-meat ingredients are presented in Table 1. The meat was chopped separately and minced using a 5mm sieve in a tabletop mincer (Breville, Model UTP141, United Kingdom). The minced meat was apportioned into five groups of 2 kg based on the proportion of the two varieties of meat. All other ingredients were added in equal amounts (g/100g) as shown in Table 1. The minced meat and the other ingredients were mixed thoroughly in a mixer (Oster 8-Speed Blender Model, MG—MB E103TI -Mexico) for 5 minutes. The mixed meat sample were stuffed into the natural casing (conditioned sheep intestine) of about 2cm diameter. The stuffed casings were twisted at 10cm intervals to obtain a shorter linked unit. Each treatment was replicated four times in a completely randomized design.

Table 1: Sausage formulation with different ratios of chicken and beef meat Percentage

Proportion of ingredient composition					
Ingredient	**Proportional Ratio of Chicken and Beef**				
	I (100/0)	**II (75/25)**	**III (50/50)**	**IV (25/75)**	**V (100/0)**
Chicken	70.00	52.50	35.00	17.50	0.00
Beef	0.00	17.50	35.00	52.50	70.00
Fat (Lard)	15.00	15.00	15.00	15.00	15.00
Soya Bean Flour	4.00	4.00	4.00	4.00	4.00
Refined salt	2.00	2.00	2.00	2.00	2.00
Sugar	1.00	1.00	1.00	1.00	1.00
$NaNo_3$	0.01	0.01	0.01	0.01	0.01
STPP	0.30	0.30	0.30	0.30	0.30
Ice water	3.00	3.00	3.00	3.00	3.00
Dry Spices	2.00	2.00	2.00	2.00	2.00
Onion	1.31	1.31	1.31	1.31	1.31
Garlic	0.69	0.69	0.69	0.69	0.69
Ginger	0.69	0.69	0.69	0.69	0.69
Total	100.00	100.00	100.00	100.00	100.00

$NaNo_3$: Sodium Nitrate; STPP: Sodium tripolyphosphate

Determination of Cooking Properties

Cooking loss

Cooking loss was determined as described by Honikel (1998).

$$\text{Cooking loss \%} = \frac{\{\text{Raw weight - Cooked weight}\}}{\{\text{Raw weight}\}} \times 100$$

$$\text{Cooking yield (\%): } = \frac{\{\text{Weight of cooked sausage samples}\}}{\{\text{Weight of raw sausage samples}\}} \times 100$$

Dimensional shrinkage % was calculated using the following equation as reported by Murphy *et al.* (1975).

$$\text{Dimensional Shrinkage \%} = \frac{\{\text{Raw sausage diameter - Cooked sausage diameter}\}}{\{\text{Raw sausage diameter}\}} \times 100$$

Proximate Analysis:

The pH of cooked breakfast was determined using a digital probe pH meter (Hanna, Italy) Moisture, ether extract, ash and protein content of raw and cooked samples were analyzed according to procedure described by AOAC (2000). Oxidative rancidity was determined by using the 2-thiobarbituric acid (TBA) test according to the procedure of Tarladgis *et al*. (1960). Results were expressed as milligrams of malonaldehyde per kilogram of sample.

Evaluation of microbiological characteristics

The microbiological quality of raw and cooked sausage were assessed on the basis of Total Aerobic Count (TAC) and Total Coliform Count (TCC) using Nutrient agar and MacConkey agar, respectively. Diluted samples in normal saline were spread onto these plates and incubated at 37°C for 24 hours, following the procedures described by ICMSF (1986), APHA, (1992) and AOAC, (2000). Microbial counts were expressed as mean colony forming unit per gram (cfu/g).

Sensory evaluation

Sensory evaluation was conducted on freshly prepared sausage. A total of twenty panellists with age ranging between 22 and 40 years were trained to evaluate the products for colour, aroma, juiciness, flavour, tenderness, pungency and overall acceptability on a nine-point hedonic scale (1 for extremely dislike and 9 extremely like).

Statistical analysis

All data generated were analyzed using statistical analysis system software (SAS, 2000). Treatments were compared using LSD for significant main effects at $P<0.05$.

RESULTS AND DISCUSSION

Cooking Properties

The effect of mixing ratio of chicken breast and beef on pH value and physicochemical parameters of breakfast sausages are shown in Table 2. The pH values of samples in treatments I and II were 6.42±0.14 and 6.00±0.05, respectively. The pH of meat is greatly associated with water retention and textural properties of the final product (Zorba and Kurt 2006); thus, our result is expected to cause an improvement in the properties of samples with added chicken breast due to the high pH value of chicken breast. The lowest cooking loss was found in treatment I (24.69±1.86) followed by II (27.45±1.32) and III (29.45±1.24). No significant difference was observed for cooking loss among samples in treatments IV (31.05±1.32 %) and V (31.95±0.84 %) but showed the highest cooking loss among the treatments. Cooking loss in meat product is influenced by the changes in muscle cells and extracellular components of the meat used during the processing [Leygonie *et al*., 2012]. Cooked sausage samples in treatment I (0.01±0.01) had significantly lowest TBARS values than samples in treatments II (0.02± 0.02), III (0.02± 0.01), IV (0.04± 0.01) and V (0.04±0.01). Lipid deterioration could be related to the susceptibility of PUFA-rich fats to oxidation (Vargas-Ramella *et al*., 2020), considering that in the present study sausage samples consists of meat from different species of animals.

Table 2: Physicochemical Properties of Breakfast Sausages with Different Ratios of Chicken and Beef

Treatments	I	II	III	IV	V
Variable	I (100%)	II (75%)	III (50%)	IV (25%)	V (0%)
Ph	6.55± 0.21^{a}	6.49± 0.05^{a}	6.42± 0.137^{ab}	6.16± 0.59^{b}	6.28±0.228^{ab}
Cooking Yield	75.32 ±1.86^{a}	72.55± 1.32^{b}	70.55±1.24^{c}	68.95±1.32^{d}	68.05±0.84^{d}
Cooking Loss	24.69 ± 1.86^{d}	27.45± 1.32^{c}	29.45±1.24^{b}	31.05±1.32^{a}	31.95± 0.84^{a}
Dimensional Shrinkage	13.34± 0.58^{c}	14.44± 0.45^{b}	14.73±0.08^{b}	15.48±0.28^{a}	15.71±0.21^{a}
TBARS	0.01± 0.01^{c}	0.02± 0.02^{bc}	0.02± 0.01^{b}	0.04± 0.01^{a}	0.04±0.01^{a}

abcd: Means on the same row with different superscripts are statistically significant (P< 0.05); TBARS: Thio-Barbituric-Acid–Reactive Substances

Proximate Composition

Proximate composition of the experimental sausages is presented in Table 3. Cooked sausages in treatments III (62.58±0.23), IV (62.54±0.2763) and V (62.41± 0.43) had higher moisture content than samples in treatments I (60.86±0.63) and IV (61.89±0.43). It was found that samples in treatment V had the greatest capacity to retain water while samples from the treatment I having the least. The retention of water during further processing of meat is necessary to obtain a product that is juicy and higher yields. Crude protein in cooked sausages decreased significantly (P<0.05) as the inclusion of beef increased in the formulation; this might be due to higher moisture content. Sampaio *et al*. 2004) also found reduced protein content in beef frankfurters depends on various factors such as the ingredients and meat properties.

Sensory Evaluation

Table 4 shows the sensory evaluation of sausage formulated with different ratio of chicken and beef. Flavour and other sensory characteristics in meat products are considered an important quality for the overall acceptability of the products by consumers (Brewer, 2012). Sausage formulated with 100% of chicken meat (4.74± 1.49) significantly recorded lowest scores for colour compared to other treatments (P<0.05), Samples in treatments IV (7.35± 0.57) and V (7.84± 0.83) had significantly higher values than all other sausages for colour. Therefore, samples in treatment I was lighter and less red than other samples. These differences are probably due to the low myoglobin content of chicken. No significant difference (P>0.05) was found between treatments I (5.59± 0.08), III (4.25± 0.20) and IV (4.69± 0.28), V (4.50± 0.24) except II (4.67±0.28) was found for the attribute juiciness.

Table 3: Proximate Composition of Breakfast Sausages with Different Ratios of Chicken and Beef

Treatment		Proportion of chicken and beef meat				
Variable	Sample	I (100%)	II (75%)	III (50%)	IV (25%)	V (0%)
Moisture Content	R	69.20±0.99^{d}	70.44±0.07^{c}	71.61±0.95^{b}	73.09±0.43^{a}	73.39± 0.13^{a}
	C	62.54±0.27^{a}	62.58±0.23^{a}	61.89±0.43^{b}	60.86±0.63^{c}	62.41± 0.43^{a}
Crude Protein	R	22.35±0.13^{a}	22.02±0.44^{a}	21.59± 0.01^{b}	21.57±0.05^{b}	21.09 ±0.93^{c}
	C	31.77±0.65^{a}	29.96± 0.79^{b}	28.98± 0.43^{c}	28.20±0.41^{d}	27.57±0.55^{e}
Ether Extract	R	3.33±0.16^{a}	2.86± 0.51^{b}	2.45±0.54^{c}	1.76±0.03^{d}	1.79± 0.01^{d}
	C	4.46±0.33^{d}	5.49± 0.16^{a}	5.09±0.19^{b}	4.78±0.01^{c}	5.40± 0.29^{a}
Ash	R	3.13±0.31^{a}	2.64± 0.09^{b}	2.64±0.16^{b}	2.68±0.07^{b}	2.55± 0.05^{b}
	C	2.37±0.31^{a}	2.28±0.19^{a}	2.17±0.43^{a}	1.88±0.18^{b}	1.86± 0.12^{b}
NFE	R	3.45±0.32^{a}	1.72± 0.56^{b}	1.38±0.26^{b}	1.41±1.32^{b}	0.68± 0.14^{c}
	C	3.06±0.06^{a}	1.48± 0.44^{b}	0.89±0.41^{c}	0.74±0.19^{c}	1.35± 0.23^{b}

abcde: Means on the same row with different superscripts are statistically significant (P<0.05); NFE: Nitrogen Free Extract; R: Raw; C: Cooked

Table 4: Sensory Evaluation of Breakfast Sausages with Different Ratios of Chicken and Beef

Treatments	I	II	III	IV	V
Variable	I (100%)	II (75%)	III (50%)	IV (25%)	V (0%)
Colour	4.74± 1.49^{c}	5.83± 0.41^{b}	6.53± 0.25^{b}	7.35± 0.57^{a}	7.84± 0.83^{a}
Flavour	5.31± 0.09^{d}	5.65± 0.22^{b}	5.73± 0.11^{ab}	5.78± 0.10^{a}	5.44± 0.14^{c}
Tenderness	5.34± 0.13^{b}	5.59± 0.08^{a}	5.22± 0.08^{c}	5.16± 0.13^{cd}	5.07± 0.10^{d}
Juiciness	4.67± 0.28^{b}	5.18± 0.35^{a}	4.25± 0.20^{c}	4.69± 0.28^{b}	4.50± 0.24^{bc}
Pungency	4.70± 0.05^{c}	4.90± 0.03^{a}	4.84± 0.06^{b}	4.81±0.06^{b}	4.71± 0.08^{c}
Overall Acceptability	5.52± 0.19^{c}	5.57± 0.07^{c}	5.80± 0.09^{b}	5.78± 0.13^{b}	6.29± 0.31^{a}

abcde: Means on the same row with different superscripts are statistically significant (P < 0.05)

Microbial Quality Evaluation

Microbial growth in foods results in food spoilage with the development of undesirable sensory characteristics. The microbial characteristics of chickens and beef sausages are presented in Table 5. The sausages products in all the five treatments were observed for TAC counts on the day of processing, The highest level of TAC observed in processed sausages was observed in treatment V (3.95± 0.30Log cfu/g) and the lowest in treatment IV (1.95± 0.30Log cfu/g). Contamination may come from the ineffectiveness of hygienic measures applied during production

Table 5: Microbial Assessment of Breakfast Sausages with Different Ratios of Chicken and Beef

Microbes		I	II	III	IV	V
Variable	Sample	I (100%)	II (75%)	III (50%)	IV (25%)	V (0%)
TAC	Raw	1.38± 0.08^{d}	3.33± 0.359^{b}	4.22± 1.00^{a}	2.35± 0.38^{c}	4.63± 0.39^{a}
	Cooked	3.38± 0.23^{b}	2.31± 0.14^{c}	1.43± 0.22^{e}	1.95± 0.30^{d}	3.95± 0.30^{a}
TCC	Raw	3.52± 0.09^{b}	4.31± 0.11^{a}	1.29± 0.067^{d}	2.45± 0.17^{c}	1.24± 0.08^{d}
	Cooked	3.32± 0.15^{b}	2.06± 0.32^{d}	3.67± 0.33^{a}	2.76± 0.41^{c}	3.02± 0.54^{bc}
TFC	Raw	5.74± 0.13^{a}	3.32± 0.47^{b}	3.34± 0.38^{b}	2.68± 0.08^{c}	0.74± 0.40^{d}
	Cooked	2.01± 0.23^{c}	2.38± 0.38^{b}	1.44± 0.20^{d}	1.32±0.17^{d}	3.11± 0.70^{a}

abcde: Means on the same row with different superscripts are statistically significant (P < 0.05); TAC: Total Aerobic Count; TCC: Total Coliform Count; TFC: Total Fungal Count

CONCLUSION

The increase in the amount of chicken meat produced harder sausages and lower scores in sensory evaluation when optimum values were taken into consideration; it was found that chicken can be used with beef to improve sausage quality. Hence, chicken meat has great potential in breakfast sausages.

REFERENCES

AOAC. (2000): Official Methods of Analysis. 17th ed. AOAC Interna-tional, Gaithersburg MD.

APHA. 1992. American Public Health Association Compendium of Methods for the Microbiological Examination of Foods., pp.7-97, 239-250, and 325-422.

Brewer, M. S. Jensen, J. Prestat, C. Zhu, L. G. Mckeith, F. K. (2012) Visual acceptability and consumer purchaseintent of enhanced pork loin roasts.J. Muscle Foods, 13, 53–68.

Petracci, M. Mudalal, S. Bonfiglio, A. and Cavani, C. (2013): "Occurrence of white striping under commercial conditions and its impact on breast meat quality in broiler chickens," Poultry Science, vol. 92, no. 6, pp. 1670–1675.

Honikel, K. O. (1998): Minced meats. In C. Devine, M. Dikeman, and W. K. Jensen (Eds.),Encyclopedia of meat sciences(pp. 854−856). Oxford: Elsevier

ICMSF, International Commission on Microbiological Specifications for Foods (2002) Microorganisms in foods: Microbiological testing in food safety management. Kluwer Academic/Plenum Publishers, New York.

Jung, S. Nam, K.C.and Jo, C.: (2016) Detection of malondialdehyde in processed meat products without interferencefrom the ingredients. Food Chem., 209, 90–94.

SAS, (2000): SAS/STAT User's Guide Release 6.12 Edition. SAS Inst.Inc., Cary NC, USA

Murphy E. W, Criner P. E and Gray B. C (1975): Comparisons of methods for calculating retentions of nutrients in cooked foods. J Agric Food Chem 23:1153–1157

Tarladgis, B. G., Watts B. M and Younathan. M. T. (1960): A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc. 37:44–48.

Brewer, M. S. (2012): Reducing the fat content in ground beef without sacrificing quality: a review. Meat Science, 91. 385-395.

Vargas-Ramella, M. Pateiro, M. Barba, F. J. Franco, D. Campagnol, P.C.B. Munekata, P.E.S. Tomasevic, I. Domínguez, R. Lorenzo, J. M. (2020): Micro encapsulation of healthier oils to enhance the physicochemical and nutritional properties of deer pâté.LWT,125