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Sensory and Physicochemical Characteristics of Rabbit Meat Sausages Produced with Refined Palm Stearin (RPS)

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ABSTRACT

Rabbit meat (RM) is lean and rich in protein of high biological value, yet with limited processed products. This study was aimed at processing rabbit meat into frankfurter-type sausages to help diversify its use and improve its economic value. The sausages were made with RM and substitutions of Refined Palm Stearin (RPS) at 0, 10, 20, and 30% respectively. Beef and lard were used to produce sausages to serve as control. Moisture, ash, fat, protein and mineral contents (Ca, Na and Fe) as well as pH and percentage cooking loss of the sausages were determined. Sensory evaluation of the products revealed that, the control sausages had significantly higher overall acceptability ($p<0.05$) compared to the RM sausages. However, no significant differences ($p>0.05$) were observed among the 4 formulations of RM:RPS sausages in terms of overall acceptability. There were significant differences ($p<0.05$) in the moisture, protein and fat contents between the control sausages (50.70%, 25.22% and 21.90%, respectively), the 100:0 (62.52%, 28.69% and 5.68% respectively), 90:10 (63.15%, 23.73% and 8.77%, respectively), 80:20 (60.52%, 22.47% and 12.54% respectively) and 70:30 (57.17%, 21.13% and 16.79% respectively). Rabbit meat sausages produced with RPS had acceptable sensory attributes, higher protein and lower fat contents than sausages produced with beef and lard.

Keywords: Mineral content, Nutrition, frankfurter-type, Food Processing, Proximate composition

1. INTRODUCTION

The increase in knowledge and awareness of the link between diet and health of consumers has resulted in heightened demand for highly nutritive foods of acceptable quality (Nistor *et al.,* 2013). Meat, although being a component in most of our foods as a major source of proteins, essential amino-acid, B-complex vitamins, minerals and other bioactive compounds, are also associated with negative components. These include fats with high levels of saturated fatty acids, cholesterol and caloric contents which are common in beef and pork and are linked to obesity, hypertension and some cardiovascular diseases (Dalle Zotte and Szendro, 2011; Campbell, 2013). As a result, the food processing industry is currently advancing towards the introduction of healthy products to meet consumer expectations. This has led to the processing, utilization and diversification of underutilized sources of proteins/meats which are healthier than the already existing ones such as pork and beef.

Rabbit meat is consumed worldwide and highly recommended by nutritionist. It is valued over other meats because of its nutritional properties which include proteins of high biological value, low fat and cholesterol contents compared to beef and pork (Nistor *et al.,* 2013). Comparatively, rabbit meat also contains higher potassium and lower sodium levels. Another characteristic is that, rabbit meat is closely similar in colour and texture to chicken or turkey meat, and with such a high nutritional value, it is an ideal candidate as a "healthy white meat".

According to Fullerton (2000), a rabbit can produce 2.72 kg of meat as compared to 0.45 kg of meat produced by a cow when given the same levels of feed and water. The rabbit also has several characteristics and the most significant of which is its prolificacy. With a gestation period of 30-32 days, a healthy female (doe) is able to kindle up to about 13 kittens at a time, with an average of 8 live kittens. A doe can therefore easily give 25 or more off springs per year (Moreki, 2007).

Despite all these good health profiles of the rabbit and its meat there are very few products manufactured with rabbit meat aside its use in soups and stews in whole or cut-up parts. Hence there is little diversification in the use of rabbit meat compared to other conventional meats like chicken, beef and pork which are processed and consumed in different forms like sausages, corned meats, hams, patties and luncheon meats.

Rabbit meat is mild flavored, fine grained, tender and bright pearly pink in colour. A deboned, cooked commercial rabbit is similar to chicken in appearance and taste, and turns out as a tender whitish meat with delicate flavor (Spencer, 2013). The consumption of rabbit meat can be boosted by utilizing it as a potential meat ingredient in a variety of processed foods including ready-to-eat meals and ready-to-cook foods (Cavani and Petracci, 2012).

One of most common forms of processed meat consumed worldwide presently, is sausage; especially the frankfurter-types. Sausage is among the oldest meat products which were developed for purposes of preservation. Their manufacture became associated with the country or city of origin. An example is Bologna, which originated in the town of Bologna, Northern Italy (Martin and Garden, 2004). Today, more than 250 varieties of sausages are sold, many of which can be traced back to the town and country of origin.

In the manufacture of sausages, an assemblage of various ingredients in the right proportion is required, in order to produce not just a desired quality and safe product but also a cost-effective one (Essien, 2003). One of the main ingredients in sausage making is animal fat, which makes up mostly about 20-30% of the product (Essien, 2003). Therefore, in order to preserve the healthy characteristics of rabbit meat, an alternative to high cholesterol-animal fat, such as plant fat and other fat replacers can be employed. (Cavani and Petracci, 2012).

The objective of the study was to assess the sensory and physicochemical characteristics of rabbit meat sausages produced with refined palm stearin. This will help promote the intake of rabbit-based food products in convenient forms other than the little patronage in its carcasses (whole or cut up parts) to ultimately promote, the rearing and production of rabbits in our agricultural sector and improve the economic value of rabbit meat.

2. MATERIALS AND METHODS

2.1 Source of raw materials

New Zealand male and female breed rabbits were obtained live from a local rabbitry at Fumesua, Ghana whilst boneless beef topside, lard and hog casings were obtained from a local abattoir in Kumasi, Ashanti Region of Ghana. Refined Palm Stearin was also obtained from Wilmar® Africa Limited, Tema – Greater Accra Region, Ghana.

2.2 Preparation of Rabbit Meat Sausages

The live rabbits were slaughtered, skinned and dressed. The carcasses were chilled overnight in a cold room at 2 °C after which they were deboned manually. The deboned carcasses were subjected to freezing in a deep freezer (GHT- 40CF, China) at a temperature of about -18 °C for 24 h before processing into sausages.

The rabbit meat sausages were made with substitutes of refined palm stearin at 0 %, 10 %, 20 % and 30 % for the animal fat component. The fat component in the beef sausage as control, was 30 % lard which is the commonest formulation of sausages found on the Ghanaian market. All other ingredients for the sausage making were the same for each treatment.

2.3 Sensory Evaluation of Sausages

Sensory evaluation was conducted by 50 untrained panelists made up of students of KNUST (21-23 years) using the consumer acceptability test at the sensory laboratory of the Department of Food Science and Technology. Each person was seated comfortably in a booth with lighting from white fluorescent bulbs. The products were sliced to approximately equal lengths of 2cm, coded with 3-digit random numbers and microwaved for 2 minutes before serving. The panelists assessed the sausages on the attributes of appearance, colour, taste, juiciness, mouth feel and overall acceptability using a 5 – point hedonic scale (5= Like very much, 4= Like moderately, 3= Neither like nor dislike, 2= Dislike moderately, 1= Dislike very much). Bread and water were offered alongside test samples for panelists to eat and drink between testing samples in order to neutralize the sensory profile of each sample.

2.4 Physicochemical Analysis of Sausages

The analysis of moisture (using the Binder FD115 model oven, Germany), protein (macro-Kjedahl protein method), fat (using Soxhlet Extraction) and ash content (using the Thermdyne F48010-33 model muffle furnace, United States) were performed using the standard methods of the Association of Official Analytical Chemists (AOAC, 1990). Also, the mineral analysis (Ca, Fe and Na) of beef, rabbit meat, beef sausage and the rabbit sausages were done using the Atomic Absorption Spectrophotometer (nov AA 400P model, Germany).

The pH of the sausages was determined using the probing pH meter (Mettle Toledo AG model, Switzerland) while cooking loss of the beef and rabbit meat sausages were determined as described by Akwetey *et al*. (2012) and Essien (2003).

Cooking loss(%) =

$$\frac{weight\ before\ cooking - weight\ after\ cooking}{weight\ before\ cooking} \times 100$$

2.5 Data Analysis

All data obtained were analyzed by One-way Analysis of Variance (ANOVA) using SPSS (2011) software version 20 and all the experiment was replicated thrice.

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation of Sausage Samples

The appearance of the beef sausages before and after cooking were different from the formulated rabbit meat sausages, with rabbit meat sausages appearing whiter due to its bright pearly pink colour and the Refined palm stearin which is also white in colour. The sensory evaluation results (Table 1) shows significant differences ($p<0.05$) between the beef sausage and all the formulated rabbit meat sausages in the attributes evaluated except for colour, juiciness and tenderness.

Table 1: Mean sensory scores of beef sausage (control) and rabbit meat sausages (±SD)

Attribute	Rabbit meat sausages (RMS)				
	BS	100:0	90:10	80:20	70:30
Appearance	4.32 ±0.81[a]	3.72 ±1.03[b]	3.16 ±0.99[bc]	2.88 ±1.14[c]	2.24 ±1.16[d]
Colour	3.94 ±1.07[a]	3.60 ±1.02[ab]	3.12 ±1.05[bc]	2.82 ±1.11[cd]	2.50 ±1.25[d]
Taste	4.40 ±0.92[a]	3.44 ±1.33[b]	3.42 ±1.23[b]	3.34 ±1.31[b]	3.34 ±1.24[b]
Juiciness	4.20 ±0.80[a]	3.32 ±1.19[b]	3.64 ±1.14[ac]	3.34 ±1.09[b]	3.50 ±1.00[b]
Tenderness	4.00 ±0.92[a]	3.32 ±1.17[b]	3.58 ±1.12[ab]	3.54 ±1.17[ab]	3.52 ±1.15[ab]
Mouthfeel	4.16 ±1.01[a]	3.30 ±1.24[b]	3.40 ±1.17[b]	3.36 ±1.25[b]	3.10 ±1.3[b]
Overall acceptability	4.26 ±0.74[a]	3.66 ±1.12[b]	3.44 ±1.00[b]	3.30 ±1.04[b]	3.10 ±1.24[b]

Means with common superscripts in the same row are not significantly different (p>0.05). ; SD is Standard Deviation; BS –Beef sausage, RM – Rabbit meat, RPS–Refined Palm Stearin, RM%: RPS% – 100:0, 90:10, 80:20 and 70:30; [1-Dislike very much, 2-Dislike moderately, 3- Neither like nor dislike, 4- Like moderately, 5- Like very much]

The appearance of the rabbit meat sausages was influenced by the increasing substitution of RPS (thus at 0%, 10%, 20% and 30%) causing the sausages to have a lighter colour than the control, hence the control was most preferred followed by the 100% RMS, in that order with 70% RMS being the least preferred. In terms of juiciness, there was no significant difference between BS and 90:10, but for tenderness BS was significantly different from 100:0. Juiciness and tenderness are two very important sensory quality attributes for meat and meat product quality and are influenced by the cut of meat chosen and duration of cooking. Rabbit meat is tender than beef, hence processing it into sausages under the same conditions as beef caused it to have a longer smoking and cooking times, and as a result, lost more liquid and becoming less juicy.

From Table 1, although there were no significant differences among the formulated rabbit meat sausages in terms of juiciness, the mean scores of 90:10, 80:20 and 70:30 were slightly higher than that of 100:0, showing the effects of substitution of rabbit meat with RPS. The tenderness and juiciness are also influenced by the animal's age at slaughter, the amount of fat and collagen contained in particular cuts, and to a small degree, brining (Lebas *et al.,* 1997).

Similarly, the panelists did not find any significant difference among all the formulated rabbit meat sausage in terms of taste, mouthfeel and overall acceptability. This could be due to the fact that, rabbit meat has a unique flavor of gamy meat which could not be masked by the addition of other ingredients, processing and the substitution of the RPS.

3.2 Physicochemical Characteristics of Sausages

According to Klont *et al.* (1998), the quality of rabbit meat and its carcass is mostly influenced by breed, age of animals, diet, ante and postmortem factors. From Table 2, there was no significant difference (p>0.05) between the beef and rabbit meat in terms of moisture, ash, fat and protein contents. However, beef had a slightly lower fat content than that of the rabbit meat. This was due to the type of beef used which was the extra lean part taken from the deep muscle of the cow (top side/region), in order to appropriately quantify the fat (pork lard) ratio for the sausage, unlike the enteric region where most of the beef fat are formed.

Table 2: Some proximate composition of beef and rabbit meat sausages with their respective meats (±SD)

Meat/Sausage type		Parameter (%)		
	Moisture	Ash	Fat	Protein
Beef (raw)	69.31 ±0.85[a]	0.74 ±0.003[a]	1.32 ±0.24[a]	27.32 ±0.04[a]
RM (raw)	67.16 ±0.39[a]	0.83 ±0.05[a]	3.29 ±0.18[ac]	27.09 ±0.01[a]
BS	50.70 ±0.15[b]	0.83 ±0.06[a]	21.90 ±0.76[b]	25.22 ±0.02[b]
100:0	62.52 ±0.22[c]	1.71 ±0.51[ab]	5.68 ±0.45[c]	28.69 ±0.01[c]
90:10	63.15 ±0.95[c]	2.29 ±0.01[b]	8.77 ±0.16[cd]	23.73 ±0.13[d]
80:20	60.52 ±0.05[cd]	2.18 ±0.03[b]	12.54 ±1.21[e]	22.47 ±0.05[e]
70:30	57.17 ±1.48[d]	1.97 ±0.04[b]	16.79 ±0.48[f]	21.13 ±0.09[f]

Means with common superscripts in the same column are not significantly different (p>0.05)
BS – Beef sausage, RM - Rabbit meat, RPS–Refined Palm Stearin, RM%: RPS% – 100:0, 90:10, 80:20 and 70:30

The moisture contents of both rabbit meat and beef sausages reduced after processing due to operations involved – (grinding, mixing, stuffing; which increased the bulk densities of the final products as a result of binding and compaction of the fat and protein matrix. There was however no significant difference (p>0.05) in the ash contents of the beef and rabbit meat sausages. The slight increase in ash contents in both sausages can be attributed to the addition of salt and spices as part of the formulation during processing which contained some levels of minerals such as sodium and iron.

For the protein contents, there was no significant difference between the beef and the rabbit meat. However, after processing them into sausages, the protein content of the beef reduced significantly from 27.32 ±0.04 % to 25.22 ±0.02 % in the beef sausage. This could be due to the substitution of beef with 30 % pork lard in the processing of sausage in order to obtain a similar formulation of what exist commonly on the local market.

Contrarily, the protein content of the rabbit meat increased significantly from 27.09 ±0.01 % to 28.69 ±0.01 % in the 100:0 RMS, but decreased significantly to 23.73 ±0.13, 22.47 ±0.05 and 21.13 ±0.09 % in the 90:10, 80:20 and 70:30 formulations, respectively. Also, except for the 100:0 formulation, the protein contents of all the formulated rabbit meat sausages reduced significantly with increasing substitution of RPS which vividly shows the effect of the addition of the respective percentages of RPS.

The protein contents of the beef (27.32 %) and rabbit meat (27.09 %) in this study were higher than those recorded by Whiting and Jenkins, (1981) and Nistor *et al.* (2013) who reported (20.8% and 21.1%), (26.3% and 21.2%) for beef and rabbit meat, respectively. In addition, several other studies also reported relatively lower protein content (18.60 – 22.40%) for rabbit meat samples than what was reported in this study (Pla *et al.,* 2010; Dalle Zotte and Szendro 2011; Cavani and Petracci, 2013). This could be due to the type of breed, age of animals, diet and postmortem factors as stated by Klont *et al.* (1998).

Similarly, there was no significant difference in the fat content of the beef and rabbit meat, but however, after processing them into sausages, the fat content of the beef increased significantly from 1.32 ±0.24 to 21.90 ±0.76% in the beef sausage. This was clearly due to the substitution of beef with 30% pork lard which is the amount commonly used in most beef sausages found on the market.

The lower fat content of the beef (1.32%) than rabbit meat (3.29%), obtained in this study agrees with Whiting and Jenkins, (1981) who had 4.6% and 6.8% fat contents for beef and rabbit meat respectively.

Unlike beef, fat in rabbit is not deposited in the muscle, but in very thin layers or insignificantly found subcutaneously, and thus benefiting consumers with 'fat-free muscle' regime. This prevents the deposition of fat in consumers and thus reduces the risk of cardiovascular disease (Tărnăuceanu *et al.,* 2011). In rabbit meat, unsaturated fatty acids (UFA) represent around 60% of the total fatty acids (FA), and the polyunsaturated fatty acids (PUFA) represent 32.5% of the total FA – which is much higher than in other meats; poultry inclusive (Salma *et al.,* 2007; Wood *et al.,* 2008). Refined palm stearin on the other hand is cholesterol free and it can therefore be said that rabbit meat and its sausage could be healthier than beef (which is mostly not the extra lean part of the deep muscle) and beef sausages commonly found on the market.

3.3 Mineral Composition of beef and rabbit meat sausages

The results in Table 3 shows that the mineral content varies considerably and that their elemental composition appears to be affected by genetic, physiological and environmental factors. Doyle, (1980) proposed that some of these non-genetic factors may include the dietary concentration of elements and other nutrients, interactions between elements, hormones, age, sex, the chemical form of elements, temperature and regional variations. The genetic factors may include the animal species or breed, differences within animal species and certain inherited diseases, hence the variation in the Calcium (Ca), Iron (Fe) and Sodium (Na) concentrations determined can be attributed to these factors. Furthermore, the differences in the mineral compositions maybe attributed to the feed composition given to the animals.

There was significant difference between the Ca and Na, comparing beef with rabbit meat. There was no significant difference between the beef and rabbit meat in terms of Fe content. Although, both meats contain myoglobin and hemoglobin which is responsible for its red colour (Vaclavik and Christian, 2008). However, The Fe content recorded for beef (24.88mg/100g) was slightly higher than that of rabbit meat (11.96mg/100g).

Also, according to Nistor *et al.* (2013), rabbit meat is characterized by low contents of hemoglobin which could be the reason for such outcome in Table 3. The iron content of the rabbit meat (23.674 mg/100g) decreased significantly in the formulated rabbit meat sausages. However, the iron content of beef (33.290 mg/100g) decreased in the beef sausage produced (27.911 mg/100g) which may be due to the substitution of the pork lard as the fat component in the beef sausage. The iron contents of beef and rabbit meat were within the Recommended Daily Intake (RDI) as proposed by WHO; 9-24 mg/100g (Robertson *et al.,* 2003). However, the iron contents of all the formulated rabbit meat sausages and the control were significantly higher than the RDI's. This may be attributed to the high level of proteins extracted during processing and the addition of the various ingredients in the formulation of the products.

Table 3: Mineral composition of beef and rabbit meat sausages with their respective meats

		Type of Mineral (mg/100g)	
Sausage type	**Ca**	**Fe**	**Na**
Beef	6.955 ±0.02^{a}	33.290 ±0.00^{a}	11.825 ±0.04^{a}
RM	4.324 ±0.03^{b}	23.674 ±0.00^{b}	5.114 ±0.02^{b}
BS	4.866 ±0.03^{b}	27.911 ±0.00^{c}	4.676 ±0.11^{c}
100:0	0.695.12 ±0.00^{d}	1.996 ±0.00^{d}	6.846 ± 0.02^{d}
90:10	6.071 ±0.06^{e}	14.872 ±0.15^{e}	8.952 ±0.03^{e}
80:20	7.200 ±0.04^{f}	4.624 ±0.01^{f}	4.420±0.02^{ce}
70:30	6.703 ±0.02^{g}	10.195 ±0.02^{g}	6.858±0.02^{d}

Means with common superscripts in the same column are not significantly different (p>0.05).
BS–Beef sausage, RM – Rabbit meat, RPS–Refined Palm Stearin, RM%: RPS% – 100:0, 90:10, 80:20 and 70:30

The calcium content of rabbit meat (4.324 mg/100g) was lower than beef (6.955 mg/100g), but increased in all the formulated rabbit meat sausages except 100:0. However, there was a significant increase in the calcium content of the beef sausage due to the reduction of moisture and increased bulk density, causing a high concentration effect on the calcium content. In addition, the calcium content of the meats and the sausages were observed to be below the RDI (1000-1300mg/100g) hence can be complemented with other foods as they constitute the major part of proteins in food.

The sodium content increased significantly in the formulated rabbit meat sausages and the control due to the addition of NaCl which helps in the solubilization and binding of proteins, preservation and taste. However, the sodium contents of the sausage samples did not exceed the Recommended Daily Intake (RDI) of WHO/FAO which is 2000 mg/day (Robertson *et al.,* 2003).

3.4 pH of beef and rabbit meat sausages

The post-mortem changes that take place when muscle is converted into meat have marked effect on the quality of the meat, especially pH. The flesh of animals prior to slaughter has a pH value of 7.1 due to the almost neutral pH of blood. After slaughtering, the glycogen in the muscle is converted into lactic acid causing a decrease in pH from an initial value of pH 6.8-7.3 to about 5.4-5.8 (Bender, 1992). However, there was increase of pH from 5.71 to 6.67.

In this study, the pH values for the sausages before cooking fell within 5.71 to 6.67, with beef sausage having the least pH value (Table 4). The pH values increased steadily as RPS substitution increased. A significant difference ($p<0.05$) was observed between beef sausage and rabbit meat sausages. According to Gebarowski, (2011), the ideal pH value of meat and comminuted batter for making sausages should be 5.1 – 6.8 and the values were all within the specified pH range before cooking (Table 4.0).

However, after smoking and cooking, the pH of each sample steadily increased. The range of pH after cooking was between 6.93 and 7.31, with beef sausage having the least pH value (Table 4). This agrees with studies by Choi *et al.* (2015), who reported that the pH of meat products increases with heating due to the imidazolium that is unfolded and exposed which has basic activity due to high histidine content. It is therefore advised to use vacuum packaging as already used for sausages due to their high susceptibility to spoilage and microbial attack with respect to their pH values being close to the neutral point.

Table 4: pH values of beef sausages and rabbit meat sausages before and after cooking

Sample	pH before cooking	pH after cooking
BS	5.71 ±0.06^{a}	6.93 ±0.00^{a}
100:0	6.47 ±0.06^{b}	7.20 ±0.02^{b}
90:10	6.63 ±0.03^{c}	7.23 ±0.02^{b}
80:20	6.67 ±0.05^{c}	7.24 ±0.01^{b}
70:30	6.67 ±0.02^{c}	7.31±0.01^{c}

Means with common superscripts in the same column are not significantly different ($p>0.05$).
BS–Beef sausage, RPS–Refined Palm Stearin, RM%: RPS% – 100:0, 90:10, 80:20 and 70:30

3.5 Cooking Loss

Cooking loss is the degree of shrinkage of meat during cooking. It includes the total loss that occurs during the cooking of meat which comprises the losses known as drippings and the volatile losses. The greater part of the volatile loss is from evaporation of water. It may include volatile substances from the decomposition of fat and volatile aromatic substances. Drippings on the other hand include fat, water, salts, and both nitrogenous and non-nitrogenous extractives (Culinary Physics, 2016). The cooking loss of meat is mainly due to the contraction of the myofibrillar proteins that form the muscle, leading to the expulsion of water and, to a lesser extent. However, the proportion of these losses will depend on the type of cooking for dry, moist or mixed heat and the method used is mixed heat.

Cooking loss was observed to be highest (24.39%) in 100:0 rabbit sausage and least (5%) in 70:30 rabbit sausage sample (Table 5). No significant differences ($p>0.05$) were observed amongst the beef sausage and rabbit sausage samples. However, amongst the rabbit sausages, there was a significant difference ($p<0.05$) between 100:0 (24.39%) and 70:30 (5%).

The 100:0 formulation having the highest cooking loss may be due to the use of no external fat in its formulation which led to increase in the amount of water that was driven out as well as the amount of fat or lipid that was liquefied and allowed to excrete. Losses occurring in the other sausages were also due to the loss of water/moisture and fat or lipid liquefied and allowed to excrete.

Table 5: Cooking loss of beef and rabbit meat sausages

Sample	Cooking loss (%)
BS	14.55 ±3.28^{ab}
100:0	24.39 ±3.75^{b}
90:10	18.81 ±4.52^{ab}
80:20	10.48 ±3.81^{ab}
70:30	5.00 ±3.60^{a}

Means with common superscripts in the same column are not significantly different ($p>0.05$).
BS–Beef sausage, RPS–Refined Palm Stearin, RM%: RPS% – 100:0, 90:10, 80:20 and 70:30

Cooking loss in sausages and other meat products is affected by many factors and these factors include temperature of comminution and cooking, severity of comminution, type of fat, degree of protein denaturation, fat: protein: water ratios, fat and water binding capacities of the ingredients, pH of the muscle and the ratio of myofibrillar to collagen proteins in the mix (Brown and Ledward, 1987).

4. CONCLUSION

Rabbit meat sausages were successfully developed with acceptable sensory properties although the beef sausage (control) had higher mean scores in all the attributes. Substituting rabbit meat with RBD palm stearin resulted in reduced moisture content and reduced cooking loss with no effects on pH of the frankfurters. Compared with beef and beef sausages, rabbit meat and sausages are healthier, higher in protein (thus the 100:0 formulation) and lower in fat irrespective of the substitution with the RBD palm stearin in the four formulations than the beef sausage. Hence, rabbit meat has great potential for utilization in frankfurter-type sausages.

CONFLICTS OF INTEREST

There are no conflicts of interest for any of the authors.

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