



PHYSICO-CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS, SENSORY QUALITY AND ACCEPTABILITY OF NATIVE CHICKEN AND RABBIT SAUSAGE PRODUCED WITH CORN OIL, MARGARINE AND BEEF FAT

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ABSTRACT

In this paper, we evaluated the effect of certain oils or fats (corn oil, margarine and beef fat) on the physico-chemical, microbiological characteristics and sensory quality of native chicken and rabbit sausages as low fat sausages. The sausages were evaluated by physicochemical analysis of pH, a_w , moisture content, protein and fat, TPC and Salmonella as microbiological characteristics, as well as flavor, juiciness and overall acceptability as sensory quality, and with regards to diversification of meat products in Indonesia. Three formulations for native chicken (FA) and rabbit (FB) sausages were prepared: FA1 and FB1 (with 10% corn oil); FA2 and FB2 (with 10% margarine); FA3 and FB3 (with 10% beef fat). Results indicated no significant difference ($p < 0.05$) between the pH and a_w values of native chicken and rabbit sausages using different fat sources. The moisture content was significantly different ($p < 0.05$) both between the native chicken and rabbit sausages and the types of fat source (corn oil, margarine and beef fat) added. No effect on protein content was found both in native chicken and rabbit sausages. The lowest fat content was found in rabbit sausages ($18.79 \pm 0.70\%$) where corn oil was added as a fat source. Lowest TPC was also observed. Salmonella were not detected in any of the sausage groups. There was no significant difference ($p < 0.05$) in various sensory attributes. In conclusion, native chicken and rabbit meat seems to be a suitable alternative for low fat sausages production, particularly with corn oil as fat source.

Key words: native chicken sausages, rabbit sausages, corn oil, margarine, beef fat

INTRODUCTION

The potential of native chickens in Indonesia is big as egg and meat producers, with this sector expanding rapidly (1), while the chicken carcass fat content does not exceed 7.8% (2). Rabbit meat also contains only 7.4% fat. Rabbit meat is high in protein, but low in fat content. It has a low content of saturated fatty acid and tends to have low cholesterol. Thus, it is a highly nutritious meat and is suitable for special diets (3). Traditionally, native chicken is a common dish in Indonesia, while the same goes for rabbit in West Java. Native chicken and rabbit are cooked

as fried, grilled, or processed as satay, meat balls and sausages. Sausages are one of the oldest forms of processed food. Many sausage products provide a variety of fat and meats. The flesh of any food animal can be used in making sausages. The meat is halal covered not only with regards to the kinds of food consumed, but also concerning the conditions for their preparation and use. The native chicken and rabbit are halal when they are slaughtered according to Moslem rules. They are not stunned and are killed and bled simultaneously by one clean stroke of the knife blade applied to the throat of the animal. The sausage industry has brought about modification to recipes and procedures. The potential health risks associated with the consumption of high fat foods has led to the development of new formulations to modify traditional food products to contain less fat (4). Several alternative strategies have been used to produce low fat sausages, such as the substitution of saturated fat with vegetable oil (5, 6, 7). Corn oil and margarine represent vegetable oil or fat. In Indonesia corn and coconut are abundant, so there is no problem to use them as animal fat replacement.

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Corn oil and margarine have lower fat content than animal fat. Native chicken and rabbit are halal and a good choice for Indonesian dishes. Studies have explored possible fat reduction in sausages, using partial fat replacement by lean meat as a formulation strategy. However, these reformulation processes often increase the toughness due to higher water loss during processing. Visual differences in the product appearance also occur as there is less granulated fat, as the fat content is reduced (8). The World Health Organization have drawn up the following nutritional recommendations, fat should provide between 15-30% of the calories in the diet, saturated fat should not provide more than 10% of these calories and cholesterol intake should be limited to 300 mg/day. This resulted in an increased demand for fat reduced and low-fat meat products.

Fat is important for sausages, because it acts as a source of essential fatty acids, fat soluble vitamins and constitutes a source of energy. Fat also contributes to the flavor, texture, juiciness, which determine the quality and acceptability of sausages (4). The substitution of animal fat with vegetable oils has been suggested to improve the fatty acid profile and to decrease the cholesterol levels of meat products, with several vegetable oils already having been used as fat substitutes. The development of products, including sausages, containing raw poultry meat is complicated by issues that could become serious public health risks, such as the presence of *Salmonella* spp. in the chicken carcass (9).

The food industry is mostly concerned with food pathogens, *Listeria monocytogenes*, *Salmonella* spp., *Campylobacter* and *Escherichia coli*. *Listeria monocytogenes* has been described in several sausages product (10), as a result of unsuccessful proper processing, or due to high initial contamination of the raw material.

The objectives of this study was to determine the physico-chemical and microbiological characteristics, as well as the sensory quality and acceptability of native chicken and rabbit sausages; to evaluate the quality characteristics of formulation process that contains low fat by using healthier ingredients, such as corn oil and margarine. Furthermore, it is concerned with the diversification of meat products in Indonesia.

MATERIAL AND METHODS

Raw Materials

Native chickens breast fillets, rabbit meats, corn oil, margarine and beef fat were used in these experiments. Native chicken meat and rabbit meat was purchased from traditional farm in Lembang, ii

West Java, Indonesia. The meat was kept overnight in a refrigerator and manually deboned. Each meat was deboned into portions weighing 3kg and immediately stored at 4°C. The other materials were purchased from a local wholesaler, Griya Supermarket in Jatinangor, West Java.

Formulations

Three formulations of native chicken (FA) and rabbit (FB) sausages were prepared, FA1 and FB1 (with 10% corn oil); FA2 and FB2 (with 10% margarine) and FA3 and FB3 (with 10% beef fat); this was repeated five times in a completely randomized design. Physico-chemical (pH, a_w , moisture content, protein and fat), microbiological (TPC and *Salmonella*) and sensory analyses (flavor, juiciness and overall acceptability) were performed on production day (day 0).

Sausage Preparation

In Table 1, the formulation of the sausages is presented. Each sausage was produced from 1kg native chicken meat (100%) and 1kg rabbit meat (100%). The meat was chilled overnight at 4°C, and minced separately in the food processor. Afterwards, each minced meat was separated into three parts and then each part was added 10% corn oil, margarine and beef fat successively. The beef fat was frozen, tempered at -2°C, chopped and mixed in a rotating bowl meat cutter before added to the minced meat. The sausage batter was added with the same amount of ingredients: 10% flour as filler, 2% salt, 2% sugar, 0.1% garlic powder, 0.2% white pepper, and then mixed carefully. The resultant mixture was filled in casings, and then hung on sticks. Sampling was carried out on production day.

Physico-chemical analysis

The physico-chemical analysis (pH, a_w , moisture content, protein and fat), determined according to AOAC standard procedures (11), was performed in duplicate. For the determination of pH, 10 g of each sample was homogenized with distilled water in the ratio of 1:10. The homogenate was subjected to a pH test using a pH-meter (3310 Jenway pH meter). The pH value was determined on production days by taking the average of two readings. Water Activity System apparatus (Aqualab lite) was used to measure the water activity (a_w). The a_w values were determined in duplicate in order to optimize the weights of samples at 25°C until equilibrium was reached. The chemical composition of the sausage with regards to moisture, protein and fat content was determined as per AOAC (11), using a hot air oven (JEIO tech IB-05G), Kjeldahl and soxhlet extraction apparatus, respectively.

Table 1. Formulation and treatments of sausages with various fat and oil

Ingredients	Native Chicken Sausages			Rabbit Meat Sausages		
	Treatments					
	FA-1	FA-2	FA-3	FB-1	FB-2	FB-3
Raw meat	1.00kg	1.00kg	1.00kg	1.00kg	1.00kg	1.00kg
Fat/Oil*	0.10kg	0.10kg	0.10kg	0.10kg	0.10kg	0.10kg
Flour	0.10kg	0.10kg	0.10kg	0.10kg	0.10kg	0.10kg
Salt	0.02kg	0.02kg	0.02kg	0.02kg	0.02kg	0.02kg
Sugar	0.02kg	0.02kg	0.02kg	0.02kg	0.02kg	0.02kg
Garlic powder	0.001kg	0.001kg	0.001kg	0.001kg	0.001kg	0.001kg
White pepper	0.002kg	0.002kg	0.002kg	0.002kg	0.002kg	0.002kg

Notes : *1 – corn oil, *2 – margarine, *3 – beef fat

Microbiological analysis

To evaluate the microbiological characteristics on days 0, three sausages per batch were used. Aliquots of 25g were collected, homogenized with 225 mL of 0.1% peptone water, and serially diluted on a decimal scale. The microbiological analyses were performed in duplicate. The data was transformed into logarithm of the number of colony-forming units (cfu^g⁻¹) (12). Total Plate Count (TPC) for determination of the number of viable microorganisms in the sample (13), and for Salmonella as per AOAC (11).

Sensory analysis

The sensory characteristics for native chicken and rabbit sausages regarding flavor, juiciness and overall acceptability was evaluated by 30 students that had previous experience in sausages evaluation. The coded formulations were evaluated in randomized fashion, as per a hedonic scale of 9 points (14). The presented data are the mean values of the panelist.

Statistical analysis

The experiment, used a completely randomized design and was repeated five times. All analyses were performed in duplicate, and the data was evaluated through an analysis of variance (ANOVA). The means were compared by Tukey's test at a confidence level of 5% ($p \leq 0,05$).

RESULTS*Physico-chemical characteristics*

The results obtained of various physico-chemical characteristic (pH, a_w, moisture content, protein and fat) of native chicken and rabbit meat sausages are shown in Table 2. The initial mean pH values of the sausages (both native chicken and rabbit) were between 5.49 – 5.66 with no significant differences between the six sausages. There was significant difference ($p < 0,05$) between a_w of native chicken and rabbit sausages with the use of different fat sources.

Table 2. Physico-chemical characteristic of native chicken and rabbit sausages

Treatments	Formulation					
	FA1	FA2	FA3	FB1	FB2	FB3
pH	5.49±0.09 ^a	5.63 ± 0.05 ^a	5.61 ± 0.05 ^a	5.51 ± 0.05 ^a	5.65 ± 0.05 ^a	5.66 ± 0.02 ^a
a _w	0.83 ± 0.01 ^a	0.84 ± 0.01 ^a	0.87 ± 0.01 ^b	0.84 ± 0.01 ^a	0.86 ± 0.01 ^b	0.89 ± 0.01 ^c
Moisture	60.30± 1.50 ^c	61.52± 1.60 ^d	64.03± 1.60 ^e	50.07± 1.70 ^a	51.20± 1.60 ^b	51.52± 1.80 ^b
Protein	19.02± 0.50 ^b	18.48± 0.48 ^a	19.05± 0.49 ^b	18.37 ± 0.48 ^a	18.05 ± 0.45 ^a	19.22 ± 0.47 ^b
Fat	19.60± 0.70 ^{ab}	19.51± 0.90 ^{ab}	19.38± 0.80 ^{ab}	18.79± 0.70 ^a	20.00± 0.70 ^{ab}	20.29 ± 0.80 ^b

Note: Means ± SD in the same row followed by different lowercase letters indicates significant differences ($p \leq 0,05$) among formulations (n=9, each). Dry basis values. The physico-chemical analyses were performed in duplicate

Formulations: FA: native chickens sausage, FB: rabbit sausages, 1: 10% corn oil, 2: 10% margarine, 3: 10% beef fat

Table 3. Microbiological characteristics (Total Plate Counts and Salmonella in the sausages)

Parameters	Formulation					
	FA1	FA2	FA3	FB1	FB2	FB3
TPC	5.25±0.01 ^b	5.33±0.01 ^c	5.37±0.02 ^c	5.10±0.05 ^a	5.20±0.05 ^b	5.30±0.06 ^c
Salmonella	-	-	-	-	-	-

Note: Dry basis values. The microbiological analyses were performed in duplicate

Formulations: FA: native chickens sausage, FB: rabbit sausages, 1: 10% corn oil, 2: 10% margarine, 3: 10% beef fat

Data presented in Table 2. shows that the physico-chemical parameters (pH and a_w) in both sausages (native chicken and rabbit) were quite similar. The small differences between native chicken and rabbit sausages with same formulations was not a significant difference in pH, but has significance in a_w . The pH of the sausages was significantly lower ($p < 0.05$), both in native chicken sausages; between 5.49±0.09 to 5.63±0.05; and also in rabbit sausages, between 5.51±0.05 to 5.66±0.02. The a_w varied significantly in all formulations; in native chicken sausage it was between 0.83±0.01 to 0.87±0.01; and in rabbit sausages it was between 0.84±0.01 to 0.89±0.01. Lowest a_w values of native chicken sausages (0.83±0.01) and rabbit sausage (0.84±0.01) were found in the group where corn oil was used, while the highest values of native chicken sausage (0.87±0.01) and rabbit sausage (0.89±0.01) were observed in groups having beef fat as fat source.

sausages products, including that contained native chicken and rabbit meat in all of the six formulations, All samples were free of *Salmonella* spp.

Total Plate Count was observed in all of the six formulation of sausages on the day of processing. In native chicken sausages between 5.25 ± 0.01 (with corn oil) to 5.37 ± 0.02 (beef fat) and in rabbit sausages between 5.10 ± 0.05 (with corn oil) and 5.30 ± 0.06 (with beef fat).

Sensory analysis

No obvious differences have been found in sensory analysis between the sausages (native chicken and rabbit sausages) and also in fat formulations (10% corn oil, margarine and beef fat). Even fat contributes to the flavor and juiciness which determine the quality and acceptability of sausages, but the acceptance of all sausages in this experiment was non-significant ($p < 0.05$). The

Table 4. Sensory analysis of native chicken and rabbit sausages

Parameters	Formulation					
	FA1	FA2	FA3	FB1	FB2	FB3
Flavor	7.70 + 0.40	7.80 + 0.66	7.70 + 0.87	7.60 + 0.40	7.80 + 0.65	7.60 + 0.60
Juiciness	7.60 + 0.66	7.70 + 0.80	7.70 + 0.60	7.70 + 0.60	7.70 + 0.80	7.70 + 0.66
Acceptability	7.70 + 0.87	7.60 + 0.80	7.73 + 0.66	7.60 + 0.60	7.70 + 0.65	7.80 + 0.60

Note: The presented data are mean values of the panelist. The data were non significance.

Formulations: FA: native chickens sausage, FB: rabbit sausages, 1: 10% corn oil, 2: 10% margarine, 3: 10% beef fat

The chemical composition of the native chicken and rabbit sausages - the moisture content of native chicken sausages was between 60.30 ± 1.50 to 64.03 ± 1.60, while for rabbit sausage it was between 50.07±1.70 to 51.52±1.80. The protein content of native chicken sausage varied between 18.48±0.48 to 19.05±0.49%. and that of rabbit sausage from 18.05±0.45 to 19.22±0.47%. For fat content, the lowest was found in rabbit sausage (18.79±0.70%), wherein corn oil was added as a fat source.

Microbiological characteristics

The microbial characteristics of native chickens and rabbit sausages are presented in Table 3. The

acceptability was around seven (7.69 to 7.73), indicating that the panelists moderately liked the sausages. Although the sensory acceptability depended on some preference of the panelist, from the acceptance of the sausages, it can be concluded that both native chickens and rabbit sausages were accepted by the panelist.

DISCUSSION

Although there were differences between the two meat sausages (native chicken and rabbit) with three type of fat (margarine, corn oil and beef fat) in

the sausages; they were not statistically significant for pH. The pH value of both native chicken and rabbit (between 5.49 ± 0.09 to 5.63 ± 0.05 and 5.51 ± 0.05 to 5.66 ± 0.02) was even lower in all treatment groups, though they were well within the normal range, the normal pH of meat products ranged from 4.8-6.8, while the pH of fresh sausage was at least 5.5 (10, 15). The low pH is desirable in order to assure the stability of microorganisms in the sausages, especially when the sausages are stored at room temperature. This condition was supported by (16). Findings were also reported in the experiment on hurdle treated pork sausages (17) where the pH ranged from 6.1 to 6.4, depending on the sample. The lower pH value of sausages could be attributed to the low pH of native chicken and rabbit meat.

Lowest a_w values were recorded in both sausages where corn oil was used, which showed that corn oil as a fat source is desirable in sausages because of reduced a_w values. Sausages having low a_w or combination of low pH and reduced a_w had better microbial stability (18). It was also reported that pH and water activity are important factors controlling the microbiological safety of foods (19).

Fat also contributes to the flavor, texture, juiciness, which determine the quality and acceptability of sausages. The differences were only due to the modification of the sausages formulation. Obtaining lower fat sausages, through using vegetable oils, will increase the water content in the sausages. The moisture content in rabbit sausages is lower than the moisture content in native chicken sausages, because of the fat content of rabbit meat being higher than in the native chicken. The lower fat content was due to the fat content of meat. Rabbit meat is high in protein and low in fat (7.4%) (3). It also has a low content of saturated fatty acid, thus it tends to have a low cholesterol. Consequently, it is a highly nutritious meat, suitable for special diets. Native chicken carcass has low fat, and the fatness did not exceed 7.8% (2). Many studies using vegetable oil as substitutes for animal fat have reported formulations for sausages prepared with different types of oils (corn oil, and margarine) and also using beef fat. Both results for products with corn oil and margarine were lower than the animal fat, in native chicken sausage and rabbit sausages, respectively. These results indicated that vegetable oils could be used as animal fat replacers in low fat sausages. This is consistent with research which has used oil with healthier lipid combination in water emulsions as pork back-fat replacers in low-fat frankfurters (20). Animal fat has higher fat percentage than vegetable oil (8), so vegetable oil could be used to improve the fat content of sausages,

because it could reduce the fat content. The lowest fat content of rabbit sausages wherein corn oil was added as a fat source, may be attributed to the low fat content in rabbit meat compared to native chicken meat (21). Corn oil has been reported to contain less fat content than beef fat (8, 22). This suggests that vegetable oil could be used as animal fat replacer in the preparation of low fat sausages. This condition also could be used as an approach for development of functional meat products (20). With regards to the microbiological characteristics, they were detected for Salmonella and total plate count. In all formulations Salmonella was not detected, because the pH of the sausages (between 5.49 to 5.66) should be sufficient to inhibit the growth of Salmonella. The pH of FA1 (5.49) and a_w (0.83), also in FA2 the pH and a_w was even higher (5.63 and 0.84) and in FA3 the pH was 5.61 and the a_w 0.87. In this condition *Salmonella* was inhibited. This is in line with other studies, that pH 6.6 to 8.2 could inhibit the growth of Salmonella (7). Minimum pH of 5.4 will inhibit the Salmonella. As the pH decreases to minimum values, Salmonella needs higher a_w for growth. In this study, the a_w is between 0.83 to 0.89. The results show that using poultry and rabbit meat in sausage production is possible, from the stand point of microbiological characteristics. During sensory analysis, all sausages formulations indicated no significant differences. The results indicated that using corn oil, margarine and beef fat in sausage production did not affect the acceptability of the products. This is in line with the fact that reducing oil content did not affect product acceptability (9).

CONCLUSION

It can be concluded that native chicken and rabbit meat seem to be suitable for the production of low fat sausages using corn oil, margarine and beef fat. Based on the results obtained regarding the physico-chemical, microbiological characteristics and the acceptability of the use of corn oil and margarine, they can be used for the processing of native chicken and rabbit sausage; also this will represent a diversification of traditional dishes in Indonesia. The results of this study suggest that using some fat sources (10% corn oil, 10% margarine and 10% beef fat) should be considered in native chicken and rabbit sausages formulations. The sensory evaluation was similar for both sausages. Furthermore, the a_w (water activity) varied significantly ($p < 0.05$) in both native chicken and rabbit sausages with the use of different fat sources.

In comparison, the a_w value results were not significantly different between the sausages made

from both native chicken and rabbit meat. It means that using native chicken or rabbit for production of sausages will result in no significant differences in the physico-chemical characteristics. The small differences may be usual as consequences of the difference between the meats (native chicken and rabbit).

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