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Physicochemical Properties of Malaysian Commercial Chicken Sausages

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Abstract: Sausage is becoming more popular to the Malaysian consumers. A study on quality characteristics for chicken sausages marketed in Malaysia was conducted to gauge the trend of marketed sausages today. A total of ten samples of chicken sausages from different brands were analyzed to determine the proximate composition, calcium and sodium contents, colour, folding test and textural properties (hardness, springiness, cohesiveness, gumminess, chewiness and shear force). The moisture, protein, fat and ash contents for chicken sausages were significantly different, in the range of 56.48-68.85%, 7.03-14.14%, 4.91-18.48% and 2.17-3.30%, respectively. The range of carbohydrate content was 6.69-21.59%. The calcium and sodium contents were varied in chicken sausages. The lightness value (L*) of sausage was significantly different among the samples in the range of 44.42-65.54. All chicken sausages samples tested in this study show good gel strength with their folding test at more than 4.0. The hardness, springiness, cohesiveness, gumminess, chewiness and shear force ranged between 3.84-7.25 kg, 12.79-15.65 mm, 0.25-0.41 ratio, 1.28-2.58 kg, 16.81-33.01 kg.mm and 0.58-1.95 kg, respectively. The results of this analysis showed that sausages produced by different manufacturers will varied significantly in quality and physicochemical properties.

Key words: Commercial sausages, proximate composition, calcium content, sodium content, textural properties, colour

INTRODUCTION

Sausages are one of the popular western style meat-based products amongst the Malaysian consumers. Sausages have gained popularity in Malaysia after being introduced in 1963 by the A&W fast-food restaurant (Babji *et al*., 1998). Commercial sausages produced in Malaysia, mostly in frozen form, are generally made from chicken, beef and fish. Besides eaten as a combination with buns, sausages are also eaten as a mixture in different kinds of daily soup or gravy. Sausages (frankfurters) are also familiar as one of the ready-to-eat breakfast menu items among schoolchildren. In the earlier days, chicken sausages production originated from small family-based enterprises. However, increasing demand for chicken sausages products in recent year have changed chicken sausage manufacturing into large-scale production. Many factories have been established in Malaysia to increase output and to fulfil the increasing demand for chicken sausages in the country. Malaysia has one of the highest per capita consumption rates in the world for poultry meat and chicken is the most popular poultry meat and contribute about 95% of poultry meat consumption. Per capita consumption of poultry meat is reported at 26.18 kg in 1999 and increased to 34.39 kg in 2008 (MOA, 2009). Small amount of other poultry meat such as duck and quail meat are also consumed among Malaysians and has shown increasing popularity. This study was conducted to determine the quality characteristics associated with chicken sausages available in the Malaysian markets at present. These data could be used as references for better understanding of the quality characteristics of chicken sausage products produced by local manufacturers.

MATERIALS AND METHODS

Sampling: Ten commercial chicken sausages (A-J) from different brands or manufacturers were collected from supermarkets located in Penang, in the northern part of peninsular Malaysia. Two packets of each brand were picked randomly and brought to the laboratory for analysis. The sausages were prepared by thawing at room temperature for about 4 h and heated in boiling water for 5 min.

Proximate analysis: Moisture, protein, fat and ash contents were determined in accordance with standard AOAC methods of (AOAC, 2000). Protein determination involved a Kjeldahl assay (Nx6.25). Fat was determined by extracting samples in a Soxhlet apparatus using petroleum ether as a solvent. Moisture was quantified by oven-drying 10 g samples at 100°C overnight. Ash was determined after incineration in a furnace at 500°C and carbohydrate content was calculated by computing the

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difference. For calcium and sodium contents determination, the samples were digested in 30% H_2O_2 and 65% HNO_3. Ca and Na were measured using a flame atomic absorption spectrophotometer (Perkin Elmer 3110, USA).

Folding test: The folding test was conducted to analyze the gel strength of the heated chicken sausages and was determined according to Lanier (1992). Heated samples were cut into 3 mm thick portions. The slices were held between the thumb and the forefinger and folded to observe the way that they broke. The scale used was as: (1) breaks by finger pressure, (2) cracks immediately when folded in half, (3) cracks gradually when folded in half, (4) no cracks showing after folding in half and (5) no cracks showing after folding twice.

Colour measurement: Samples were heated at 90°C for 5 min and sliced into pieces 4 mm thick (Huda *et al*., 2000). The colour of heated samples was measured using a colorimeter (Minolta CM 3500d, Japan). The colour reading includes lightness (L*), redness (a*) and yellowness (b*). The colorimeter was calibrated throughout the study using a standard white ceramic tile.

Texture analysis and shear test: Samples were heated at 90°C for 5 min and were uniformly cut into 1.5 cm pieces. Texture of samples were measured by using Texture Analyzer TA-XT2 (Stable Microsystem, UK), Compression Platen (SMS P/75) with a heavy duty platform and the following settings: load cell, 25 kg; speed, 3.0 mm/s; test speed, 1.0 mm/s; post test speed, 3.0 mm/s; prefixed strain, 75%; time before second compression, 2 s. The following parameters were determined: Hardness, springiness, cohesiveness, gumminess and chewiness. Shear test of the samples were done by using a Blade Set (HDP/BSW) with a heavy duty platform and the following settings: load cell, 25 kg; pre-test speed, 2.0 mm/s; test speed, 2.0 mm/s; post-test speed, 10.0 mm/s; target distance, 3.0 mm. The parameter to be determined was cutting force.

Hardness (kg): The area of the curve (in mm^2) during the first downstroke, which is proportional to the work performed by the probe on the sample during the first compression or the work performed during the first bite.

Springiness (mm): The force at maximum compression during the second compression cycle. It represents the hardness of the sample at second bite.

Cohesiveness (ratio): The ratio (dimensionless) of positive force during the second to that of the first compression cycle (downward strokes only). The strength of the internal bonds making up the body of the sample.

Gumminess (kg): The force necessary for disintegrate a semisolid sample for swallowing (Hardness × cohesiveness).

Chewiness (kg mm): The energy required to chew a solid sample to a steady state of swallowing (gumminess x springiness).

Shear force (kg): A test to measures the force necessary to shear a piece of meat.

Statistical analysis: The data from three replications were analyzed using one-way Analyses of Variance (ANOVA) and the Duncan test for multiple mean comparisons. The data was processed using SPSS version 17.0 and significance was defined at $p<0.05$.

RESULTS AND DISCUSSION

As shown in Table 1, the general information of the beef frankfurters is labeled on each package. Proximate compositions, calcium and sodium content of selected brands of chicken sausages marketed in Malaysia are shown in Table 2. The range of moisture content in current commercial chicken sausage is 56.48%-68.85%. This result is similar with the previous report by Rahman *et al*. (1997), of which the range of moisture content in chicken sausages was reported as 58.18-71.30%. The range of protein content in current commercial chicken sausage is 7.03%-14.14%. The results obtained is lower than of Rahman *et al*. (1997), where the protein content was from 11.14-16.52%. The protein content of Malaysian commercial chicken sausages was also lower than commercial chicken sausages from Brazil which is reported at 13.2% (Pereira *et al*., 2000). The lower protein content may be due to lower meat content, probably substituted by starch, to produce a lower cost sausage, while maintaining the texture and water holding capacity. According to Malaysian Food Regulation 1985 manufactured meat in sausage form should not be less than 65%. As a major ingredient in sausage, the % of meats in samples was not determined because no such information was available. However, it can be referred to the regulation based on the nitrogen analysis result, which contain more than 1.7% of nitrogen in organic combination. Most samples achieve more than 1.7% of N, except for sample B (1.54%), D (1.49%) and I (1.12%). Carbohydrate content in chicken sausages has a wider range, with values from 6.69-21.59%. These results are higher than data reported by Rahman *et al*. (1997), which were at 2-10.28%. The increase in carbohydrate content in sausages could be due to the increase of starch content (act as extender) to substitute for raw meat in the manufacturing of sausages. The main reason behind this is the manufacturer plans to reduce processing cost to increase their marginal profit. The replacement of raw

Table 1: Ingredient information for the Malaysian commercial chicken sausages

Samples	Ingredients
A	Chicken meat, soy protein, salt, spices extract, permitted food conditioner and sodium nitrite.
B	Chicken meat, salt, dextrose, spices extract, permitted food conditioner and sodium nitrite.
C	Chicken meat, soy protein, modified corn starch, spices, permitted flavour enhancer (E450, E451, E452) and preservative (E250, E252).
D	Chicken meat, soy protein, food starch, salt, sugar, spices and permitted food conditioner.
E	Chicken meat, soy protein, salt, sugar, spices, permitted food conditioner and permitted flavour enhancer (MSG, disodium inosinate, guanylate).
F	Chicken meat, salt, dextrose, permitted food conditioner, MSG, white pepper, colouring (Ponceau 4R.E124/C1/6255) and sodium nitrite.
G	Chicken meat, vegetable oil, protein hydrolysis, salt, dextrose, sugar, spices, food conditioner, taste enhancer and permitted preservative.
H	Chicken meat, vegetable oil, protein hydrolysis, salt, dextrose, sugar, spices, food conditioner, taste enhancer and permitted preservative.
I	Chicken meat, chicken fat, potato starch, spices, frankfurter spices and salt.
J	Chicken meat, salt, dextrose, spices, permitted food conditioner and sodium nitrite.

Table 2: Proximate composition, calcium and sodium content of chicken sausages

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Calcium (mg/g)	Sodium (mg/g)
A	66.39±0.22^{b}	13.17±0.37^{a}	7.79±0.10^{e}	2.55±0.19^{abcd}	10.10±0.15^{de}	1.16±0.09^{a}	8.14±0.52^{cd}
B	64.05±0.48^{c}	9.60±0.16^{c}	12.56±0.35^{d}	2.96±0.12^{abcd}	10.82±0.52^{d}	0.77±0.08^{ab}	8.83±0.18^{bc}
C	59.97±0.48^{e}	11.68±0.25^{b}	18.48±0.23^{a}	3.18±0.36^{abc}	6.69±0.28^{f}	0.27±0.00^{c}	8.61±0.59^{c}
D	58.86±0.22^{f}	9.30±0.26^{c}	7.81±0.18^{e}	2.44±0.79^{bcd}	21.59±0.27^{a}	0.58±0.03^{bc}	7.79±0.34^{d}
E	56.48±0.60^{g}	13.27±0.90^{a}	16.76±0.30^{b}	3.23±1.00^{ab}	10.26±1.75^{de}	0.52±0.05^{bc}	10.36±0.05^{a}
F	61.19±0.21^{d}	11.41±0.25^{b}	15.16±1.07^{c}	2.42±0.18^{cd}	16.55±1.00^{b}	0.71±0.08^{b}	6.82±0.12^{e}
G	58.49±0.05^{f}	13.39±0.32^{a}	11.79±0.41^{d}	3.30±0.50^{a}	9.66±1.21^{de}	1.11±0.12^{a}	9.47±0.38^{b}
H	59.68±0.42^{e}	13.35±0.17^{a}	15.00±0.52^{c}	2.55±0.03^{abcd}	12.62±0.28^{c}	1.13±0.00^{a}	8.36±0.68^{cd}
I	64.60±0.31^{c}	7.03±0.54^{d}	4.91±0.67^{f}	2.17±0.44^{d}	11.19±0.74^{cd}	0.88±0.34^{ab}	5.80±0.62^{f}
J	68.85±0.21^{a}	14.14±0.96^{a}	8.43±1.42^{e}	2.37±0.33^{d}	8.74±1.62^{e}	0.83±0.53^{ab}	6.52±0.16^{ef}

Mean ± Standard Deviation. Means within a column with different letters are significantly different ($p<0.05$)

meat by starch can be further supported by the decreasing of protein content of present chicken sausages, as compared to the study by Rahman *et al.* (1997).

The range of Ca and Na in current Malaysian chicken sausage is 0.27-1.16 mg/g and 5.80-10.36 mg/g, respectively. This result is lower than Rahman *et al.* (1997), of which the range of Ca and Na content in chicken sausages was 6.66-22.28 mg/g and 7.79-23.82 mg/g, respectively. The difference in these results is mainly due to the types of meat used (mechanical deboned meat or traditional hand deboned meat) and ingredients in the formulation (Table 1). According to Rahman *et al.* (1997), the Ca content in chicken meat was low. However, using mechanical deboned chicken meat in the processing of sausages will increase the mineral content. According to Babji and Seri-Chempaka (1995), mechanical deboned chicken meat had high content of Ca, P, Zn and other minerals. The main source of Na in sausages is NaCl (salt). NaCl affects the flavour, texture, shelf life of meat products. Overall, the sodium content found in samples was lesser than reported by Rahman *et al.* (1997), showing a trend for the past 10 years, where lower salt content is used in sausage processing due to consumers' increase health awareness.

Table 3 shows the folding test and colour characteristics of commercial chicken sausages collected from different brands. Folding test is a simple method used to measure the textural quality of sausages. Generally, all chicken sausages samples showed good gel strength because their folding test scores were more than 4.0. Five samples had a score of 5.0 in the folding test, while the rest of the chicken sausages ranged from score 4.2 (C) to score 4.8 (D). Huda *et al.* (2010) reported the folding test scores of commercial beef frankfurters at Malaysia were in the range of 4.4-5.0. The score of folding test are indicative of the freshness of meat, meat species, sources of starch, storage method and ingredients used for sausage formulation (Huda *et al.*, 2010).

The L* (lightness) value of sausages were between 44.42 and 65.54. A higher L* value indicates a lighter colour, which is desirable and has high consumer acceptance (Resurreccion, 2004). With heating, several changes in the appearance and physical properties of meats in sausage occur due heating processes. These changes include discoloration of the meats, due to the oxidization of pigment heme groups (Garcia-Segovia *et al.*, 2007). According to Cross *et al.* (1986), heat applied on meats was responsible to convert myoglobin and hemoglobin to metmyoglobin, which is brown in colour.

Table 3: Folding test and colour characteristics of chicken sausages

Sample	Folding test	Lightness (L*)	Redness (a*)	Yellowness (b*)
A	5.00±0.00^{a}	51.19±0.19^{c}	11.98±0.02^{d}	17.89±0.19^{f}
B	4.60±0.55^{abc}	53.38±0.45^{b}	10.81±0.35^{e}	19.24±0.40^{e}
C	4.20±0.45^{c}	65.54±1.27^{a}	6.51±0.34^{g}	31.80±0.87^{a}
D	4.80±0.45^{ab}	49.18±0.19^{e}	13.02±0.37^{c}	22.91±0.53^{d}
E	4.60±0.55^{abc}	44.42±0.84^{f}	15.98±0.85^{b}	27.92±0.14^{b}
F	4.40±0.55^{bc}	49.79±0.61^{de}	22.11±0.54^{a}	23.13±0.35^{d}
G	5.00±0.00^{a}	50.63±0.34^{cd}	16.24±0.21^{b}	17.62±0.46^{f}
H	5.00±0.00^{a}	49.03±0.43^{e}	10.13±0.12^{f}	24.67±0.23^{c}
I	5.00±0.00^{a}	49.80±0.30^{de}	11.39±0.09^{de}	17.21±0.32^{f}
J	5.00±0.00^{a}	51.50±0.32^{c}	11.73±0.17^{d}	16.10±0.21^{g}

Mean ± Standard Deviation. Means within a column with different letters are significantly different ($p<0.05$)

Table 4: Texture analysis results of chicken sausages

Sample	Hardness (kg)	Springiness (mm)	Cohesiveness (ratio)	Gumminess (kg)	Chewiness (kgmm)	Shear force (kg)
A	5.71±0.40^{bc}	13.36±0.51^{cde}	0.41±0.02^{a}	2.34±0.23^{ab}	31.21±2.68^{a}	1.13±0.18^{bc}
B	4.41±0.32^{de}	13.73±0.37^{bcde}	0.36±0.02^{b}	1.59±0.20^{de}	21.91±3.02^{cde}	0.76±0.11^{d}
C	3.84±0.29^{e}	12.99±0.51^{e}	0.36±0.02^{b}	1.38±0.22^{e}	17.92±1.51^{de}	0.65±0.06^{d}
D	6.59±0.46^{ab}	12.79±0.45^{e}	0.39±0.01^{ab}	2.58±0.17^{a}	33.01±3.40^{a}	0.76±0.13^{d}
E	4.62±0.20^{de}	13.14±0.07^{de}	0.28±0.03^{de}	1.28±0.11^{e}	16.81±2.25^{e}	1.11±0.12^{bc}
F	5.71±0.69^{bc}	13.25±0.19^{de}	0.25±0.02^{e}	1.43±0.25^{e}	18.92±1.73^{de}	1.03±0.19^{c}
G	5.78±0.70^{bc}	14.51±0.21^{bc}	0.32±0.02^{c}	1.85±0.44^{cd}	26.89±3.91^{abc}	1.93±0.17^{a}
H	6.46±1.01^{ab}	14.32±0.41^{bcd}	0.32±0.03^{c}	2.06±0.37^{bc}	29.47±5.71^{ab}	1.95±0.26^{a}
I	4.84±1.03^{cd}	15.65±2.42^{a}	0.31±0.03^{cd}	1.51±0.56^{de}	23.59±6.23^{bcd}	0.58±0.12^{d}
J	7.25±1.24^{a}	14.62±0.15^{ab}	0.31±0.05^{cd}	2.25±0.51^{abc}	32.94±8.52^{a}	1.31±0.24^{b}

Mean ± Standard Deviation. Means within a column with different letters are significantly different ($p<0.05$)

Therefore, colour of meat will generally become darker after heating. Lightness is a main attribute which correlates well with consumer acceptability. According to Dingstad *et al.* (2005), at least 60% of consumers were willing to buy the sausages when L* was between 62.3 and 68.5. The results showed that many of the samples did not reach the desirable lightness, even becoming darker after heating. There are several factors which contribute to the colour of the sausages: increasing fat content, end point temperature and the post-cooking time before evaluation will decrease the redness of cooked meat samples (Bigner-George and Berry, 2000). Table 4 shows the texture analysis results of commercial chicken sausages collected from different brands. Hardness (kg) is the maximum force required to compress the sample during the first compression or first bite. The highest hardness value for chicken sausages was obtained in sample J at 7.25 kg, while the lowest value was obtained in sample C at 3.84 kg. The higher hardness value within the sample J may be related to the higher protein content and lower content of fat, as compared to sample C. Meat type (young or old meat), meat part (breast or thigh), deboning method (hand or mechanically), water added and additives (Table 1) could also influence the hardness of the samples. Among texture attributes, hardness is the most important to the consumers as it determine the commercial value of a meat. According to Dingstad *et al.* (2005), sausages with hardness of 4.73 kg and above will have at least 60% of consumers willing to buy it. As a result, the hardness of all the sausages in the local market was found to be desirable.

The springiness, cohesiveness, gumminess and chewiness of Malaysian chicken sausages were varied significantly. The differences could be due to the ingredients used for example salt. Salt significantly increased meat product cohesiveness (Hsu and Chung, 2001). Applications of mechanical deboned chicken meat into sausage processing could reduce hardness, springiness and cohesiveness of the chicken sausage. Mechanically deboned chicken meat has the ability to retain water and therefore would reduce the hardness, springiness and cohesiveness of the chicken sausage (Li *et al.*, 1998). The secondary parameters of gumminess and chewiness behaved similarly to the parameters on which they are dependent which is hardness Caceres *et al.* (2006). Shear force is a test to measures the force (kg) necessary to shear a piece of meat. Sample H has the highest value of shearing while sample I has the lowest value which is 1.95 kg and 0.58 kg, respectively. A larger value indicated greater shear force and therefore, tougher meat Hoffman *et al.* (2003).

Conclusion: The results on proximate composition, calcium and sodium content and physicochemical properties of chicken sausages showed significant difference amongst the brands. The differences in chicken sausages could be mainly due to the types and amount of ingredients added, different formulation, different cooking methods and other parameters such as pH, temperature, environment humidity and post-cooking time before sample evaluation.

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