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Some Quality Characteristics of Malaysian Commercial Fish Sausage

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Abstract: Five brands of Malaysian commercial fish sausages were analyzed for proximate and physicochemical properties. The proximate contents showed significant differences ($p<0.05$) among the samples. The protein and fat contents ranged from 8.18-10.77% and 0.93-6.53%, respectively. There were significance differences ($p<0.05$) among the fish sausages in the lightness value. A folding test showed no significant differences among the fish sausages, with all samples receiving the highest score. Hardness, elasticity, cohesiveness, gumminess, chewiness and shear force were significantly different ($p<0.05$) among the samples. This study showed that physicochemical properties among the sample were relatively different, but most of the samples fulfilled the requirements of a good-quality sausage.

Key words: Fish sausages, proximate composition, physicochemical properties, folding test, textural properties

INTRODUCTION

Sausage is a product in which meat flesh is mixed with additives, stuffed into suitable casings and heat processed (Raju *et al*., 2003). The word *sausage* comes from the Middle English *sausige*, which came from sal, Latin for salt. In France they are called *sausissons* and in Germany, *wurst*. There are several basic categories of sausages, namely, fresh sausage, cooked sausage, cooked and smoked sausage, uncooked and smoked sausage, dry sausage and specialty meats (Fillppone, 2009).

Consumers today eat sausages for convenience, variety, economy and nutritional value. Sausage products take little time in preparation, with some sausages being ready to serve and others needing only to be warmed before serving. Sausages can be easily and quickly prepared and they often find favor with working women or men. The great variety of sausages makes it possible to serve many different products, each having its own characteristic appeal and flavor. Sausages are commonly served for breakfast, lunch, dinner or snacks (Pearson and Gillett, 1999).

Malaysia has achieved rapid growth in the food-industry sector, especially in the development of value-added meat products dominating the chilled and frozen section of retail outlets, supermarkets and fast-food chain restaurants (Babji and Yusof, 1995). The market size for local chilled and frozen foods has increased from RM3.1 billion in 2005 to RM6.0 billion in 2010. Malaysia's chilled and frozen food consumption is projected to increase to 11.7 kg per capita by 2010 (Agri-Food Business Development Center, 2010). There are many varieties of sausages available in the Malaysian market, mainly produced from chicken and beef. Due to changing consumer preferences toward healthier lifestyles and safer and cheaper foods, sausage manufacturers have turned to meat alternatives such as fish (Panpipat and Yongsawatdigul, 2008; Nowsad and Hoque, 2009). The significant expansion of the fast-food industry and the increased consumption of processed-meat products make it necessary to reevaluate the quality characteristics of fish-sausage products currently available in the Malaysian market.

MATERIALS AND METHODS

Sample collection and preparation: Five brands of fish sausages (A-E) produced and marketed around Penang Island, in the northern part of Malaysia were collected. Samples were immediately placed into an ice box after collection to minimize the effects of thawing and they were brought to the laboratory for analysis.

Proximate and mineral composition: The proximate composition of the fish sausages was determined according to the AOAC (2000). The crude protein and crude lipid contents were measured by Kjeldahl and Soxhlet methods respectively. The ash content was determined by ashing the samples overnight at 550°C. The moisture content was determined by drying the samples overnight at 105°C and the carbohydrate content was calculated by computing the difference. For mineral 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, US).

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Color measurement: The color of the fish sausages samples was measured using a colorimeter (Minolta spectrophotometer CM 3500d, Japan) and the color reading includes lightness (L), redness (a) and yellowness (b). The equipment was standardized with a white color standard. The mean of five measurements was taken for each L, a and b values.

Cooking yield: Cooking yield was determined by measuring the difference in the sample weight before and after cooking and was calculated according to Serdaroglu (2006).

Cooking yield (%) = (weight of fish sausages balls/ weight of uncooked fish sausages) x (100)

Folding test: The folding test was conducted to analyze the gel strength of the cooked fish sausages and was determined according to Lanier (1992). Cooked samples were cut into three-millimeter 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 follows: (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.

Textural measurements: The texture measurement of the fish sausages was conducted using a computer-assisted TA-XT2i Texture Analyzer (Stable Micro Systems, UK). Two types of tests were carried out in order to compare the texture profile of the fish sausages. Firstly, a compression test was used to determine hardness, elasticity, cohesiveness, gumminess and chewiness (Bourne, 1978). Secondly, a knife blade was used to determine the shear force required to cut through the sample. A compression test was carried out with a Compression Platen 75 mm and 25 kg load cell. The sample was placed under the probe that moved downward at a constant speed of 3.0 mm/s, test speed of 1.0 mm/s, post test speed of 3.0 mm/s and prefixed strain 75%. The shear test (kg) was measured with the knife blade and a 25 kg load cell. The settings were: pre test speed of 2.0 mm/s, test speed of 2.0 mm/s, post test speed of 10.0 mm/s and target distance of 30.0 mm. The blade was fitted loosely with the heavy duty slot and moved downward in order to cut the sample through the slit. The mean of five measurements was taken for each texture test.

Statistics: An analysis of variance was used to evaluate the data and significant differences among the means were determined by the one-way ANOVA and Duncan's multiple test ($p = 0.05$) by using a computer based program of SPSS 11.5 for Windows. Each analysis was replicated three times for proximate and mineral composition and five times for color, cooking yield, folding test and textural measurement.

RESULTS AND DISCUSSION

Labeling information: Table 1 shows the ingredient information for the Malaysian fish sausages. There are several ingredients commonly used among the samples. On the label, the sausages are stated to contain fish, minced fish, surimi and minced salmon and tuna. Some of the manufacturers labeled their raw material (fish) as fresh fish to give the impression of quality to their raw material. The use of the term "minced fresh fish" is probably to provide information for consumers who are not familiar with the term *surimi*. The word *fresh* is emphasized because the freshness of the fish is very important in the manufacture of sausages in particular and gel-based products generally. Some of the manufacturers mixed their main fish meat with more expensive fish meat such as salmon or tuna. While salmon and tuna meat were used, it is possible that very little of these meats were used and the largest percentages were likely fish meat or surimi, because the price of salmon and tuna fish is expensive when used as a raw material. The percentages of the fish meat(s) used in the sausages purchased from the commercial outlets is not stated.

Proximate compositions and mineral contents: The proximate compositions, i.e., moisture, protein, fat, ash and carbohydrate and the mineral contents of the sausages are shown in the Table 2 and 3. The fish sausages showed significant differences ($p<0.05$) in all the proximate compositions among the samples. The proximate compositions were in the ranges of 67.33-73.36% for moisture, 8.18-10.77% for protein, 0.93-6.53% for fat, 1.71-2.61% for ash and 12.30-19.59% for carbohydrate. Significant differences ($p<0.05$) were also found in the Ca and Na contents among the samples.

Sample A had a higher moisture content than the others. The range of moisture contents in Malaysian fish sausages was similar to the fish sausage evaluated by Raju *et al.* (2003) (68.64%). Park (2000) reported that the moisture content of a meat based product will affect the qualities of the product such as gel strength and whiteness. The protein content of Malaysian fish sausage (8.18-10.77%) was lower than the protein contents of fish sausage reported by Raju *et al.* (2003) (16.76%). The lower protein contents of the samples were related to the lower percentages of fish flesh used in their preparation. Based on the Malaysia Food Regulation of 1985, article 167 states that fish balls and fish cakes shall contain not less than 50 percent fish. However, the Malaysian Food Regulation did not state a specific protein content required for fish sausage or fish

Table 1: Ingredient information for the Malaysian commercial fish sausages

Sample	Ingredients
A	Fresh fish meat, flour, vegetable fats, salt and permitted flavoring
B	Fresh fish meat, surimi, cooking oil, starch, salt, sugar, spices, polyphosphate and permitted flavor enhancer
C	Fish meat, surimi, vegetable oil, soy protein, starch, salt, sugar, polyphosphate, flavor and MSG
D	Fish meat, salmon meat, water, vegetable oil, starch, salt, sugar, flavor enhancer and natural coloring (E120, E160)
E	Fish meat, tuna meat, water, vegetable oil, starch, salt, sugar and flavor enhancer MSG (E621)

Table 2: Proximate compositions of the fish sausages

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	CHO (%)
A	$73.36^{d}\pm0.35$	$8.18^{a}\pm0.61$	$2.60^{b}\pm0.14$	$1.73^{a}\pm0.14$	$14.13^{a}\pm0.52$
B	$66.56^{a}\pm0.58$	$9.48^{abc}\pm1.01$	$3.90^{c}\pm0.43$	$1.83^{a}\pm0.06$	$18.24^{b}\pm1.31$
C	$67.43^{b}\pm0.41$	$10.77^{c}\pm0.84$	$6.53^{d}\pm0.66$	$2.61^{b}\pm0.62$	$12.30^{a}\pm1.73$
D	$68.63^{c}\pm0.21$	$9.20^{ab}\pm0.21$	$2.02^{b}\pm0.28$	$1.72^{a}\pm0.02$	$18.43^{b}\pm0.38$
E	$67.33^{b}\pm0.41$	$10.45^{bc}\pm0.93$	$0.93^{a}\pm0.29$	$1.71^{a}\pm0.06$	$19.59^{b}\pm0.60$

Data presented as means ± SE/SD; means within a column with different letters are significantly different (p<0.05)

Table 3: Mineral compositions of the fish sausages

Sample	Ca (mg/g)	Na (mg/g)
A	$0.59^{c}\pm0.05$	$5.74^{ab}\pm0.19$
B	$0.35^{a}\pm0.04$	$6.12^{b}\pm0.31$
C	$0.44^{ab}\pm0.02$	$7.13^{c}\pm0.37$
D	$0.53^{c}\pm0.03$	$5.52^{a}\pm0.26$
E	$0.52^{bc}\pm0.08$	$5.38^{a}\pm0.35$

Data presented as means ± SE/SD; means within a column with different letters are significantly different (p<0.05)

Table 4: Color characteristics of the sausages

Sample	L	a	b
A	$65.23^{c}\pm0.54$	$1.32^{b}\pm0.06$	$15.58^{b}\pm0.65$
B	$79.56^{d}\pm0.95$	$-0.58^{a}\pm0.07$	$12.69^{a}\pm0.42$
C	$58.73^{a}\pm0.22$	$17.14^{d}\pm0.05$	$26.55^{e}\pm0.13$
D	$59.17^{a}\pm0.58$	$17.43^{d}\pm0.32$	$20.65^{c}\pm0.48$
E	$62.90^{b}\pm0.77$	$5.99^{c}\pm0.24$	$22.96^{d}\pm0.51$

Data presented as means ± SE/SD; means within a column with different letters are significantly different (p<0.05)

balls or fish cakes. These conditions make it difficult to decide whether the commercial fish sausage fulfills the requirements or not because the manufactures also did not mention the percentage of raw materials used on the product label. A similar scenario also occurred with the fat contents. The fat contents of Malaysian fish sausage were similar to the fish sausage prepared by Raju *et al.* (2003), which contained about 5.64% fat.

The addition of salt during processing will contribute to increased ash content. Normally 2.5% salt is added during fish-sausage preparation (Venugopal, 2006). The resulting ash contents in the Malaysian fish sausages were similar to that reported by Raju *et al.* (2003) (2.67%). The addition of starch and sugar contributed to the carbohydrate contents. Venugopal (2006) reported the concentrations of sugar and starch added during fish-sausage preparation are around 1.5% and 9.0%, respectively. Fawzya *et al.* (1998) reported that the carbohydrate content of Indonesia fish sausage made from yellow pike conger (*Congresox talabon*) was 15.15%, an amount similar to the Malaysian fish sausages.

Minerals are very important for humans; calcium is essential for bone maintenance and while sodium is an important ingredient in the formulation of sausage, if too much salt used it may present a health risk. Calcium may be found naturally in the meat or added as a salt and sodium is often added to the formulation in the form of sodium chloride and/or sodium nitrite. According to the results, the calcium contents ranged from 0.35 to 0.59 mg/g and the sodium contents ranged from 5.38 to 7.13 mg/g. Turkey frankfurter showed similar results for calcium and lower sodium contents, at 0.44 and 13.27 mg/g, respectively (Ferreira *et al.*, 2000). The higher sodium content was likely contributed by the amount of added salt.

Table 5: Cooking yield and folding–test results for the sausages

Sample	Cooking yield (%)	Folding test
A	$104.24^{ab}\pm1.07$	$5.00^{a}\pm0.00$
B	$103.31^{ab}\pm0.77$	$5.00^{a}\pm0.00$
C	$104.70^{b}\pm0.96$	$5.00^{a}\pm0.00$
D	$102.69^{a}\pm1.02$	$5.00^{a}\pm0.00$
E	$104.54^{b}\pm0.81$	$5.00^{a}\pm0.00$

Data presented as means ± SE/SD; means within a column with different letters are significantly different (p<0.05)

Color, cooking yield and folding test: Table 4 and 5 lists the values for the color, cooking-yield and folding tests of Malaysian commercial fish sausage. Most of the samples showed higher lightness (L) values (above 58) and cooking yields (above 100). The folding test also showed excellent scores (all 5.00, which is considered to be the highest score of the folding test). Color appearance is one of the main physical attributes determining the acceptability of sausage products by consumers. Myoglobin is the predominant meat pigment and accounts for 80% of meat color. Myoglobin is an unstable compound and it is converted into the oxidized brown metmyoglobin when oxygen is present (Dolatowski and Olszak, 2007). The lightness value of Malaysian fish sausage was in the range of 58.73 to 79.56. Lightness is a one of the main attributes that is well correlated with consumer acceptability. The low lightness value of sausage sample D may have been

Table 6: Texture Profiles Analysis (TPA) values of the sausages

Sample	Hardness (kg)	Elasticity (mm)	Cohesiveness	Gumminess	Chewiness (kg mm)
A	$3.28^{a}\pm0.58$	$15.57^{c}\pm0.42$	$0.28^{a}\pm0.03$	$0.93^{a}\pm0.23$	$14.52^{a}\pm3.82$
B	$5.67^{bc}\pm0.87$	$13.47^{a}\pm0.32$	$0.34^{b}\pm0.02$	$1.91^{b}\pm0.31$	$25.74^{b}\pm4.49$
C	$5.01^{b}\pm0.82$	$14.27^{b}\pm0.24$	$0.34^{b}\pm0.04$	$1.73^{b}\pm0.39$	$24.68^{b}\pm5.44$
D	$6.81^{cd}\pm1.76$	$13.22^{a}\pm0.31$	$0.35^{b}\pm0.06$	$2.40^{b}\pm0.79$	$31.72^{b}\pm10.38$
E	$7.83^{d}\pm1.18$	$13.40^{a}\pm0.46$	$0.42^{c}\pm0.04$	$3.31^{c}\pm0.73$	$44.18^{c}\pm9.50$

Data presented as means ± SE/SD; means within a column with different letters are significantly different ($p<0.05$)

due to the use of natural colors during its preparation. The use of soy protein in sample C likely caused its lower redness value and increased yellowness value. This is consistent with the results reported by Thomas *et al.* (2008) that the use of 3% textured soy protein in pork sausage significantly lowered ($p<0.01$) the redness while increasing yellowness. The addition of soy protein should not exceed 2% otherwise it may distort the flavor of the product. Soy protein also prevents the melting of fat (Marianski and Marianski, 2008) and fat also contribute to the color of sausage. Crehan *et al.* (2000) reported the decreasing lightness of frankfurters made of pork with increasing levels of added fat (5, 12 and 30%) and a significant ($p<0.05$) increase in redness was evident. Dingstad *et al.* (2005) also reported that at least 60% of consumers tested were willing to buy sausage when lightness was between 62.3 and 68.5.

The weight gain or loss on cooking depends on the Water-Holding Capacity (WHC) of sausages. A cooking yield more than 100% means weight is gained, while that below 100% shows a weight loss. The overall cooking yields of the fish sausages were in range of 102.69-104.54%. Sehgal *et al.* (2008) reported that starch did not have significant effect on the cooking yield of fish patties, but increasing the fish meat content in the range of 5075% had significant effects on water-holding capacity. It was concluded that protein content was the variable that most influenced WHC. Additionally, the use of salt and phosphate also influenced water binding by protein. Marianski and Marianski (2008) stated that the addition of phosphate increased the water-holding capacity of protein and prevents water loss on cooking.

The folding test is a simple and fast method to measure the quality of gel springiness in sausages. In the folding test all the sausages reached the highest score of 5.0. Myofibrillar proteins were also contribute to a good folding-test result, which generally indicates that a sample will have a good gel strength as well. The use of a cryoprotectant (e.g., sugar) can protect myofibrillar protein from denaturation. It was reported by Montero *et al.* (1999) that adding cryoprotectant to minced fish (*Sardina pilchardus* W.) generally improves the stability of myofibrillar proteins during storage and improves gel-forming capacity (folding test).

Texture-Profile Analysis (TPA) and shear-force: The texture profiles of the Malaysia fish sausages are listed at Table 6 and 7. The fish sausages showed significant differences ($p<0.05$) among the samples in all the texture-profile parameters. Hardness, elasticity, ohesiveness, gumminess, chewiness and shear-force values tended to be lower in the samples with higher moisture contents. Samples with higher carbohydrate contents showed higher value for hardness, cohesiveness, gumminess, chewiness and shear force. The hardness values of Malaysian fish sausages were in the range of 3.28-7.83 kg. According to Dingstad *et al.* (2005), sausage with firmness (hardness) of 47.3 N (4.73 kg) and above will have least 60% consumer acceptance. Thus, the hardness values of the Malaysian fish sausage would generally be considered desirable for the consumer. From the data we found a correlation between the moisture content and the hardness value. The hardness value decreased as the water level increased. As reported by Yang *et al.* (2006) for sausage made from pork with the addition of hydrated oatmeal, its hardness was decreased due to the higher water-retention properties of oatmeal in response to heat treatment. Additionally, starch content also influences the hardness of sausage. Rahman *et al.* (2007) reported that the hardness of fish sausage increased when the starch level was increased from 4% to 8% and the formulation with 8% starch was preferred over the formulations with other levels of starch.

Table 7: Shear-force values of the sausages

Sample	Knife-blade shear force (kg)
A	$0.67^{a}\pm0.18$
B	$0.97^{bc}\pm0.13$
C	$0.54^{a}\pm0.04$
D	$0.89^{b}\pm0.17$
E	$1.12^{c}\pm0.16$

Data presented as means ± SE/SD; means within a column with different letters are significantly different ($p<0.05$)

The Malaysian commercial fish sausages had elastic values in the range of 13.22-15.57 mm. The freshness of fish affects the elasticity of fish sausage produced from it. Kreuzer (2008) noted that the elasticity decreased when deteriorated fish was used as a raw material. Additionally, Intarapichet *et al.* (1995) reported that lower fat levels produced tougher and more elastic emulsion sausages than did higher fat levels. The cohesiveness of Malaysian fish sausages was in the range of 0.28-0.42. Farouk *et al.* (2002) reported that both sarcoplasmic and myofibrillar proteins affected the cohesiveness of cooked batter as the amount of both proteins were affected by washing. Gumminess values were in the range of 0.93-3.31. These results were quite different compared to the fish sausage made of prefermented silver carp. That sample showed a gumminess value around 0.28 and when the sausages were fermented with mixed cultures of *L. plantarum*, *S. xylosus*, *P. pentosaceus* and *L. casei*, the gumminess was decreased to 0.49-0.54 (Hu *et al*., 2007).

The Malaysian commercial sausages had chewiness values in range of 14.52-44.18. Pietrasik (1999) reported protein content was the variable that most influences chewiness, along with the other characteristics such as hardness and gumminess. Fat also affected the chewiness, with a reduction in fat resulting in an increase in chewiness values. The shear-force values of Malaysian fish sausages were in the range of 0.54-1.12 kg mm. Chantarat *et al*. (2005) reported that the shear-force values of fish sausage prepared from bigeye snapper and lizardfish kept on ice were lower than those produced from fresh fish. This indicates that the freshness of fish is also important in maintaining a good shear-force value.

Conclusion: The physicochemical properties of the fish sausages varied among brands due to differing use of raw materials, formulation and processing. According to the proximate and mineral analysis results, fish-sausage products in Malaysia contained protein, carbohydrate and calcium at levels that are considered high in nutritional value. Most of the samples fulfilled the requirements for commercial fish sausages with desirable folding-test, lightness and hardness values.

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