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# Quality characteristics of Malaysian commercial beef frankfurters

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**Abstract:** Five different brands of Malaysian commercial beef frankfurters were analyzed for quality characteristics. The proximate contents showed significant differences among the samples. The range of moisture content was 63.0-73.9%; the protein content was 10.63-16.43% while the fat content was 1.71-12.22%. The lightness value (L*) of the uncooked frankfurters, which was in the range of 47.02-52.28, was significantly different among the samples. The lightness of the cooked frankfurters, showed a decrease in all the samples compared to the uncooked samples. No significant differences were observed for the folding test; where all samples showed no cracks after they were folded in half. However, significant differences were observed for the texture analysis. The hardness, cohesiveness, chewiness, springiness, gumminess and shear force ranged between 4.59-10.30 kg, 0.26-0.35, 16.15-51.72 kgmm, 12.73-14.79 mm, 1.17-3.49 kg and 1.67-7.08 kg respectively. The results of the study showed that Malaysian commercial beef frankfurters were significantly different in their physicochemical properties.

**Keywords: Beef frankfurter, physicochemical properties, Malaysian products**

## Introduction

Frankfurters, a type of small size fully-cooked, cured or smoked sausage, are one of the popular western style meat-based products. In some countries, frankfurters are usually eaten in combination with buns and are called hot dogs (Babji, 1998). In general, the raw materials for frankfurters and other sausages are pork, beef and chicken. However in recent years due to changing dietary preferences and animal protein insufficiency, scientists and manufacturers have turned to meat alternatives such as fish, turkey (Pereira *et al.,* 2000), buffalo (Sachindra *et al.,* 2005), ostrich (Chattong *et al.,* 2007), goose (Gulbaz and Kamber, 2008) and duck (Bhattacharyya *et al.*, 2007).

In Malaysia, frankfurters are common sausage-type products available in the commercial market. Other sausage-type products are only available as part of the menu at international hotels and restaurants in the city. These frankfurters, which are locally called *sosej,* have gained popularity in Malaysia after being introduced in 1963 by the A&W fast-food restaurant (Babji, 1998). Frankfurters are one of the most popular western style meat-based products beside burgers and nuggets. Commercial frankfurters produced in Malaysia, mostly in frozen form, are generally made from chicken, beef and fish. Besides eaten as a combination with buns, frankfurters are also eaten as a mixture in different kinds of daily soup or gravy. Frankfurters are also familiar as one of the ready to eat breakfast menu items among schoolchildren. In the past, frankfurter production in Malaysia and other Asian countries originated from small family-based enterprises. However, the increasing demand for frankfurter products in recent years have changed frankfurter manufacturing into a large-scale production to increase output and to fulfill the increasing demand for frankfurters in the country (Srihanam, 2008). Due to increasing competition among manufacturers, more advanced technologies have been imported from other countries and fully-automated machineries have been invested to produce high quality products. Malaysian researchers have also tried to increase the utilization of local ingredients such as palm oil

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and palm stearin in the frankfurter formulation (Tan *et al.,* 2006). They have also given some attention to the utilization of local plant extracts for retarding the oxidation rate and prolonging the shelf life of frankfurters (Noriham *et al.,* 2005). This study was carried out to determine some quality characteristics which are associated with the beef frankfurters currently available in the Malaysian markets. This data can be a reference for the better understanding of the physicochemical properties of beef frankfurter products produced by local Malaysian manufacturers. It can also show the comparison of the products from different manufacturers for further product research and development.

## Materials and Methods

*Sampling*

Five commercial beef frankfurters (A - E) from different brands or manufacturers were collected from supermarkets located in Penang, the northern part of Malaysia. Two packets of each brand were picked randomly and brought to the laboratory for analysis. The frankfurters were thawed at room temperature for about four hours and cooked in boiling water (100ºC) for five minutes.

*Proximate analysis*

The proximate composition was determined according to the AOAC (1990) methods. Moisture content was determined by drying the samples overnight at 105ºC until constant weight was achieved (Memmert UL 40, Germany). Crude protein content was determined using the Kjeldahl method (Kjeltec System 1002, Sweden); crude lipid content was determined using the Soxhlet method. Ash content was determined by ashing samples overnight at 550ºC (Thermolyne Sybranm model: 6000, USA) and carbohydrate content was calculated based on the difference.

*Colour*

The colour of the beef frankfurter samples was measured using a colourimeter (Minolta spectrophotometer CM 3500d, Japan) and the colour reading includes lightness (L), redness (a) and yellowness (b). The equipment was standardized with a white colour standard. The mean of five measurements was taken for each L, a and b values.

*Folding test*

The folding test was carried out according to Lanier (1992). Test specimens were prepared by cutting cooked frankfurters into 3 mm thickness. They were held between the thumb and the forefinger in order to observe the way they break and were then evaluated according to the following score: 1 for breaks by finger pressure; 2 for cracks immediately when folded into half; 3 for cracks gradually when folded into half; 4 for no cracks shown after folding in half and 5 for no cracks shown after folding twice. The mean of five measurements was calculated.

*Texture analysis*

The texture measurement of the frankfurters 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 frankfurters. Firstly, a compression test was used to determine hardness, cohesiveness, chewiness, springiness and gumminess (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 75mm 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.

*Statistical analysis*

All the data obtained from the analysis was analyzed by one-way analysis of variance (ANOVA) using the SPSS software version 12.0 (SPSS Inc. Illinois, USA). In addition, the Duncan test was employed to determine the significant level at $P < 0.05$.

## Results and Discussion

*General information of beef frankfurters marketed in Malaysia*

As shown in Table 1, the general information of the beef frankfurters is labeled on each package. The prices of beef frankfurter samples are between RM9.83-13.24 per kg. The main ingredient of the beef frankfurters is beef. Different types of fat were

**Table 1.** Ingredients used and price (RM/kg) of Malaysian commercial beef frankfurters

| Sample | Ingredients | Price (RM/Kg) |
|---|---|---|
| A | Beef meat, soy protein, modified corn starch, spices, permitted flavour enhancer (E451, E452), colouring and preservative (E250, E252) | 12.91 |
| B | Fresh beef, vegetable oil, protein hydrolysis, salt, dextrose, sugar, spice, contains food conditioner, taste enhancer and permitted preservative | 9.38 |
| C | Fresh meat, soy protein, salt, spices, permitted food conditioner and sodium nitrite | 10.26 |
| D | Beef meat, beef fat, vegetable protein, salt, sugar, spices, permitted food conditioner and flavour enhancer | 9.56 |
| E | Beef meat, beef fat, potato starch, chicken stock, salt and spices | 13.24 |

**Table 2.** Proximate composition of Malaysian commercial beef frankfurters

| Sample | Moisture % | Protein % | Fat % | Ash % | Carbohydrate % |
|---|---|---|---|---|---|
| A | $68.49\pm0.25^{b}$ | $16.43\pm0.37^{a}$ | $1.71\pm0.10^{d}$ | $3.29\pm0.29^{a}$ | $10.08\pm0.12^{c}$ |
| B | $63.66\pm0.11^{c}$ | $14.58\pm0.20^{b}$ | $5.59\pm0.15^{c}$ | $2.57\pm0.09^{b}$ | $13.51\pm0.4^{a}$ |
| C | $73.90\pm0.09^{a}$ | $10.63\pm0.66^{c}$ | $1.10\pm0.23^{e}$ | $2.05\pm0.06^{c}$ | $12.32\pm0.43^{b}$ |
| D | $63.80\pm0.15^{c}$ | $11.18\pm0.47^{c}$ | $8.04\pm0.48^{b}$ | $3.04\pm0.04^{a}$ | $13.92\pm0.62^{a}$ |
| E | $63.00\pm0.05^{d}$ | $15.73\pm0.36^{a}$ | $12.22\pm0.47^{a}$ | $2.28\pm0.21^{bc}$ | $6.79\pm0.86^{d}$ |

*Values are means of 6 replications.
$^{a-e}$Mean with the same letter within the same column are not significantly different ($p<0.05$)

used in various formulations. In sample B, vegetable oil or cooking oil was added while beef fat was added in formulations D and E. The use of triphosphates (E451) and polyphosphates (E452) in sample A was to improve the water binding ability and its antioxidative properties to protect and stabilize the flavour and colour of the finished product (Romans *et al.,* 1985). However, their use as a food conditioner was limited to 0.3% (Malaysian Food Regulation, 1985). A curing agent in the form of sodium nitrite (E250) and potassium nitrate (E252) was added in samples A and C. According to the Malaysia Food Regulation 1985, a total of not more than 200ppm of nitrates and nitrites are allowed in the final product. However, the information for the amount of nitrites in each sample was not available. According to Leistner *et al.* (1980), the addition of 50 ppm nitrite seems enough in respect to colour and flavour characteristics while further amounts of nitrites are needed to give bacteriological stability. The addition of both permitted flavour enhancers (E451, E452) and preservatives (E250, E252) in commercial frankfurters in Spain is also reported by Gonzales-Vinaz *et al*. (2004). However, E451/2 was labeled as a stabilizer and not as a flavour enhancer.

Binders and extenders such as soy protein (sample A & C), vegetable protein (sample D), potato starch (sample E) and modified corn starch (sample A), are popularly used in the formulation of beef frankfurters. In this case, the usage of these ingredients was limited to 2% for soy protein and 3.5% for soy and cereal flour in the United States of America. However, there were no such restrictions stated in the Malaysian Food Regulation 1985. The adding of spices in beef frankfurters is essential due to the pungent odour of beef. All the samples that were added with spices, which was referred to as natural source, while flavouring was referred to as extracts such as protein hydrolysate in the formulation of sample B. The chicken stock added in sample E, together with its spice blend, was believed to produce the barbecue flavour. Salt was added in all the samples to act as a preservative. Sugars were added in sample B and D. They were primarily used in counteracting the salt flavour intensity and contributed towards the browning of the meat.

*Proximate composition*

Proximate composition for beef frankfurter is shown in Table 2. The beef frankfurters showed significant differences ($P<0.05$) in all the proximate composition among the samples. The proximate composition was in the range of 63.0-73.9% for moisture, 10.63-16.43% for protein, 1.10-12.22% for fat, 2.28-3.29% for ash and 6.79-13.92% for carbohydrate. The wide

**Table 3.** Colour coordinates (L , a and b values) of raw and cooked Malaysian commercial beef frankfurters

| Sample | L (Lightness) | a (redness) | b (Yellowness) |
|---|---|---|---|
| | | Raw | |
| A | 47.02±0.65[c] | 21.97±0.37[a] | 20.97±0.24[b] |
| B | 51.54±0.08[a] | 14.32±0.35[c] | 19.90±0.44[c] |
| C | 50.03± 0.44[b] | 8.04±0.29[d] | 19.98±0.46[c] |
| D | 52.23±0.22[a] | 17.31±0.29[b] | 23.10±0.13[a] |
| E | 52.28±1.53[a] | 17.99±0.64[b] | 19.33±0.78[c] |
| | | Cooked | |
| A | 39.72±0.78[c] | 18.97±0.11[a] | 19.45±0.37[b] |
| B | 46.20±0.69[a] | 10.45±0.25[d] | 22.13±0.40[a] |
| C | 44.29±1.02[b] | 9.63±0.74[e] | 22.04±0.75[a] |
| D | 45.07±0.89[ab] | 15.66±0.20[b] | 22.43±0.43[a] |
| E | 45.92±0.54[b] | 12.03±0.45[c] | 19.65±0.16[b] |

*Values are means of 10 replications.

[a-e]Mean with the same letter within the same column are not significantly different ($p<0.05$)

range of proximate compositions among the samples correlated to different sources of raw materials and the formulations used. According to the Malaysian Food Regulation 1985, meat in restructured foods such as frankfurters should not be less than 65%. As a major ingredient in frankfurters, the percentages of meat in the samples were unidentified because such information was unavailable. However, the regulation states that frankfurters should contain more than 1.7% of nitrogen in organic combination. The results obtained were A (2.6%), B (2.3%), C (1.7%), D (1.8%), E (2.5%); it is possible that all the samples had meat content which was more than 65%. However, this statement may not be accurate since nitrogen can be contributed by other protein sources except from the meat. The lower protein content might be due to a lower meat content which has been substituted by starch in order to produce a lower cost frankfurter while still maintaining the texture and water holding capacity (Romans *et al.,* 1985). Another protein source found in many of the sample formulations is soy protein which functions both as a binder and an emulsifier. It is the only soy product that functions similarly to meat in forming emulsions. Similar results were also reported by Gonzales-Vinaz *et al*. (2004) about commercial frankfurters in Spain which contained approximately 11.13 to 16.06 % of protein; this represented about 1.78 to 2.57 % of nitrogen content. Commercial beef sausages in Brazil also showed similar protein contents with averages of 15.2% (Pereira *et al.,* 2000).

Overall, the fat content of the samples was quite low while the most, which is sample E, was just 12.22% when compared with the maximum fat content in meat products allowed by the Malaysian Food Regulation 1985, which is 30%. The results suggest the trend of Malaysian consumers' perception on the bad effect of cholesterol on health. Some formulations had included vegetable oil or fats in order to reduce cholesterol by replacing fat and lean meat as vegetable materials which contained no cholesterol (Jimenez-Colmenero *et al.,* 2000). The fat content in commercial beef frankfurters in Malaysia is seemingly lower when compared with the fat content in commercial frankfurters produced in Spain. Gonzales-Vinaz *et al*. (2004) reported that the fat content among commercial frankfurters in Spain, which were made from a mix of beef, turkey, pork, and chicken, was about 10.83% to 21.92%. A higher fat content in beef sausages was also reported in commercial beef sausages in Brazil with the average fat content of about 17.0% (Pereira *et al.,* 2000).

*Colour*

Table 3 shows the colour of the beef frankfurters. The range of the colour values in the raw frankfurters are: L 47.02-52.28, a 8.04-21.97 and b 19.33-23.1. After cooking, beef frankfurters tended to become darker and showed less redness. Changes in L values after cooking were: -15.53% (A), 13.71% (D), -12.17% (E), -11.47 % (C) and -10.37% (B). The changes in a values in beef frankfurters after cooking were: -33.13% (E), -27.0% (B), -13.65% (A), -9.5% (D) and 19.78% (C). The effect of cooking towards b values varied among the samples with no clear trend. The range of b values in the cooked frankfurters was in the range of 19.45-22.43.

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 frankfurters when L values were between 62.3 and 68.5. The results showed that many of the samples did not reach the desirable L values, even becoming darker after cooking. There are several factors which contribute to the colour of the sausages: increasing fat content, endpoint temperature, and the post-cooking time before evaluation will decrease the a values of cooked ground beef patties (Berry and Bigner-George, 2000). The sources of the meat might have had different effects on colour. Fresh beef sausages made from unsalted pre-rigor mince are lighter, less red and more yellow than sausages made from other minces (Boles *et al.,* 1998). As comparisons made by Boles *et al.* (1998), sausages made from pre-rigor mince were less red but maintained their colour longer than sausages made from either post-rigor or salted pre-rigor mince. In addition, fat content might have contributed to a higher value of lightness. According to Jo e*t al.* (1999), pork sausages with high fat produced a lighter colour than low-fat sausages. Based on this statement, the low fat content of beef sausage samples may correlate to the low L value.

Another factor that determines the colour changes of sausages is the method of processing the frankfurter-type sausage. Washing of meat may produce a lighter and lower redness in meat (Nowsad *et al.,* 2000). Garcıa-Segovia *et al.* (2007) found that cooking from 60ºC to 80ºC means a reduction of DeoxyMyoglobin and OxyMyoglobin (reddish loss) peak intensity and an increase of MetMyoglobin (brownish-red) and SulfMyoglobin (greenish) in beef muscle. The results obtained through the colour analysis of frankfurters agreed with this statement which showed a trend of a decrease in the a value in many of the samples. However, thermal processing may contribute to the L values due to water loss which forms opacity on the surface and reflects light. Boles *et al.* (1998) said that chopping time also influenced the initial colour but had no effect on the colour stability of the fresh sausages. Sausages made from batter that had been chopped for 40 bowl revolutions were lighter (higher L value), less red (lower a value) and more yellow (higher b value) than those made from batter that had been chopped for only 20 or 30 bowl revolutions. It was expected that more air would be incorporated into the batter with increased chopping time; this would reduce colour stability.

**Table 4.** Folding test scores for Malaysian commercial beef frankfurters

| Sample | Scores |
|---|---|
| A | 5.00±0.00[a] |
| B | 4.40±0.55[a] |
| C | 4.80±0.45[a] |
| D | 4.40±0.55[a] |
| E | 4.40±0.55[a] |

*Value is means of 10 replications.
[a]Mean with the same letter within the same column are not significantly different (p<0.05)

As a curing agent, nitrites may contribute to a pinkish colour in sausages. Muscles cured with 100 mg nitrite/kg meat formed products with significantly higher a values than those cured with a lower (25 mg/kg meat) nitrite level (Dineen *et al.,* 2000). Light can catalyze the dissociation of nitric oxide from cured meat pigments and can cause colour fading especially when oxygen is present (Varnam and Sutherland, 1995). In addition, starch which is found in some of the samples may contribute to the redness. According to Annor-Frempong *et al.* (1999), meat products with 5.4% of cassava flour had significantly better internal colour due to the fine white colour of cassava flour which tended to enhance the desirable red colour of meat products.

*Folding test*

The folding test is a simple and fast method to measure the quality of gel springiness in frankfurters. As shown in Table 4, the folding test scores of beef frankfurters were in the range of 4.40 to 5.0. There were no significant difference (P>0.05) in the scores among the beef frankfurters. According to Nowsad *et al.* (2000), washing (regardless of the type of meats) improves the gel quality of meat by removing all the gel inhibitory substances while concentrating the myofibrillar proteins. This observation is in line with Niwa (1992) who reported that actin and myosin in myofibrillar proteins are the main parts that contribute to better gel strength and good folding test. In general, the scores of the folding test are indicative of the meat species, sources of starch, storage method and ingredients used for frankfurter formulation.

**Table 5.** Textural characteristics of Malaysian commercial beef frankfurters

| Sample | Hardness (kg) | Elasticity (mm) | Cohesiveness | Gumminess (kg) | Chewiness (kgmm) | Shear Force (kg) |
|---|---|---|---|---|---|---|
| A | 10.30±1.42[a] | 14.79±0.33[a] | 0.34±0.02[a] | 3.49±0.57[a] | 51.72±3.90[a] | 5.38±0.51[b] |
| B | 8.89±1.11[ab] | 14.68±0.36[a] | 0.29±0.02[b] | 2.60±0.53[b] | 38.15±3.08[b] | 7.08±0.88[a] |
| C | 6.12±1.25[c] | 13.52±0.54[c] | 0.31±0.03[b] | 1.89±0.45[c] | 25.50 ±5.92[c] | 4.67±0.42[b] |
| D | 4.59±0.68[d] | 13.83±0.51[c] | 0.26±0.02[c] | 1.17±0.15[d] | 16.15±2.05[d] | 2.12±0.22[c] |
| E | 8.70±1.22[b] | 12.73±0.43[b] | 0.35±0.02[a] | 3.03±0.55[ab] | 38.61±7.70[b] | 1.67±0.26[c] |

*Values are means of 10 replications.
[a-e]Mean with the same letter within the same column are not significantly different ($p<0.05$)

*Texture profile*

Table 5 shows the texture profile and shear force of beef frankfurters. Hardness is the force necessary to attain a given deformation or penetration by the teeth. The hardness of the beef frankfurters ranged from 4.59-10.30 kg. Through analysis, the beef frankfurters showed greater hardness while sample A was the hardest amongst all the samples. This may be due to the higher content of protein as well as the effect of the higher amount of connective tissues among the samples. In contrast to the higher content of protein is the lower content of fat or moisture. Samples with a higher content of moisture and fat will give a lower hardness value. The results are similar with the report of Gonzales-Vinaz *et al*. (2004) which stated that fat may have provided some lubrication effect and the higher fat content which gave a lower breaking value of commercial frankfurters in Spain. The researchers also reported that increasing dry matter or the lowering of moisture content corresponded with the greater cutting resistance of the frankfurters.

Caceres *et al.* (2006) found that gumminess and chewiness behave similarly to hardness. According to the results obtained, chewiness had a great value which ranged at 16.15-51.72 kgmm and a high shear force range between 1.67-7.08kg. These were also due to the amount of connective tissues in beef, which required longer mastication and greater shearing needed to make it fit for swallowing. A low cohesiveness (0.26-0.35) in beef frankfurters showed a good correlation with its low fat content which is supported by Andres *et al.* (2006). The range of elasticity and gumminess are 12.73-14.79 mm and 1.17-3.49 kg. Gumminess was referred to as energy required to disintegrate a semisolid food so that it is ready for swallowing. High gumminess was due to better gel quality which might be formed by adding binders in the frankfurter formulation.

Among texture attributes, hardness is the most important to the consumer as it decides the commercial value of a meat (Chambers and Bowers 1993). According to Dingstad *et al.* (2005), frankfurters with hardness of 4.73kg and above will have at least 60% of consumers willing to buy it. As a result, the hardness of all the frankfurters in the local market is found to be desirable. Hsu and Chung (1998) also indicated a positive correlation between hardness and overall acceptance which means that consumers generally prefer a harder texture. However, higher values for the parameters measured in the texture profile do not necessarily mean better quality. There is a cut-off point above which the texture of comminuted meat products would be unacceptable (Yu and Yeang, 1993). Therefore, the determination of good textural qualities of comminuted meat products should be done together with a sensory test in order to find the most suitable range preferred by consumers.

## Conclusions

Based on the results of the analysis, proximate composition, colour, cooking yield and textural properties are generally different among different brands of Malaysian commercial beef frankfurters. The differences in the physicochemical properties of Malaysian commercial beef frankfurters are may be due to the type and amount of ingredients added and the different processing methods.

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