International Food Research Journal 18(4): 1349-1357 (2011)

Physicochemical characteristics and sensory properties of selected Malaysian commercial chicken burgers

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Abstract: Ten selected brands of commercial chicken burgers were analysed for their proximate composition, texture profiles, colour and sensory properties. Results show commercial chicken burgers consisted of moisture, proteins, fat and ash in the range of 46.72-69.37%, 11.08-18.77%, 9.08-20.54%, and 1.50-2.96%, respectively. Meanwhile, texture profiles comprised of hardness ranging from 8003.25-19038.15 g, while chewiness had the value ranging from 650.78-1275.78 g. On the other hands, cohesiveness had the value ranging from 0.223-0.371, while springiness recorded the value in the range from 0.141-0.443. Colour analysis of cooked burgers resulted in lightness (L^*) ranging from 48.21-73.59, redness (a^*) from 0.75-9.08, and yellowness (b^*) from 21.56-31.24. In sensory evaluation, the most acceptable colour of chicken burger was the one which had the medium lightness (L^*) with the value of 63.96), medium redness (a^*) with the value of 7.00) and the highest yellowness (b^*) intensity value at 31.24. In addition, the most acceptable texture was the one with medium hardness value of 12590 g, high chewiness value of 1195.42 g, high cohesiveness value of 0.371, and medium springiness value of 0.254. It can be concluded that the Malaysian commercial chicken burgers complied with the Food Act of Malaysia and contained different levels of chemical compositions, textural characteristics and colour properties.

Keywords: Chicken burgers, commercial burgers, physicochemical characteristics, sensory properties

Introduction

Presently, Malaysia has a large population of consumers who eating chicken and has been sufficient with self-supplies. Chicken meat is among the most popular meat protein source consumed by Malaysians. It may possibly due to the facts that, there are no cultural or religious constraints to the consumption of poultry. Increased in chicken meat popularity has been noted by the fact that it can be processed into ready to eat meals (Barbut, 2002). In addition, processed chicken based products such as burgers have been distributed through wholesalers and restaurants, and also widely consumed by the people. Furthermore, local industries have grown up to accomplish the demands from these products (Chang, 2005; Guerrero-Legarreta and Hui, 2010).

The term "burgers" was taken originally from the word "hamburger" which presumably is a product that originated from Hamburg. Most of European countries regulated that burgers should contain at least 80% meat and 20-30% of fat content. In other circumstances, burgers are also recognized as patties (Al-Mrazeeq *et al*., 2008; Ranken, 2000). In Malaysia, the government has set a minimum requirement of meat content in manufacturing of any processed meats including burgers, to be not less than 65% (Food Act 1983 and Food Regulations, 1985).

Various brands of burgers are available in the market with different prices and qualities. The quality of burger may be varied due to the different raw materials and ingredients used and not forgetting the processing methods complied. Presently, the trends among the consumers to eat low-fat products have been a concerned to processed meat manufacturers (Weiss *et al*., 2010). Substitution of some ingredients with other non-meat ingredients has been practiced among processed meat industries. This replacement is done due to the several reasons such as for quality, health or economic purposes. As an example, the replacement of ingredients from animal origin with that of plants has been applied in food industries (Egbert and Payne, 2009).

Previously, Babji *et al*. (2000) have reported about the quality assessment of six local brands chicken burgers available in Malaysia without evaluation in texture profile and sensory analysis. Therefore, this study was conducted to assess the quality of commercial chicken burgers currently available in Malaysia by evaluating its quality attributes such as texture and colour, and consumers' acceptation through sensory evaluation.

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Materials and Method

Sample preparation

Ten commercial brands of chicken burgers were obtained from the local Hypermarket. Uncooked burgers were kept frozen while waiting for further analyses. Each burger was cooked (griddled) on a hot plate (Tefal® Plancha, Groupe SEB, France) for 10 minutes at medium heat. Both sides of burger were kept flipped for few minutes until a well done cooked burger is obtained (Dreeling *et al*., 2000).

Proximate analysis

The moisture, protein, fat and ash contents were analysed according to AOAC method (AOAC, 2000). Moisture content was determined by using the air oven drying method. The Protein content was analyzed by the Kjeldahl method, while the Fat content was determined by the Soxhlet method. Carbohydrates content were then calculated by subtracting the total of other components (moisture, protein, fat, and ash) from the total value (100%).

Weight loss and diameter shrinkage

Weight loss and diameter shrinkage were determined using the procedure described by Dreeling *et al*. (2000). Weight loss was calculated by the differences in weight between uncooked and cooked burgers, divided by the weight of uncooked burger. Diameter shrinkage was calculated by the differences in diameter between uncooked and cooked burgers, divided by the diameter of uncooked burger.

Texture profile analysis (TPA)

Texture profiles such as hardness, chewiness, cohesiveness and springiness were measured using TA-HDi (Stable Micro Systems, Ltd., UK). Cooked chicken burgers were tempered to 20°C prior to TPA measurement and then cut into 2 cm x 2 cm wide. The cuts were compressed twice using compression platen. The thickness of burgers were varied and measured on its original thickness to give equivalent condition caused by cooking process and comparable measurement in sensory analysis.

Colour analysis

The colour of both cooked and uncooked burgers were measured using Hunter L a b method. Colour properties such as L^* (lightness), a^* (redness), and b^* (yellowness) were measured using Minolta CM-3500d spectrophotometer.

Cholesterol determination

The cholesterol determination was done using the spectrophotometric procedure described by Turhan *et al*. (2009). Fat from 5 grams of homogenized chicken burgers were extracted with petroleum ether. Solvent was evaporated in water bath at 50°C. Fat residue was saponified by heating with 8 ml of 15% potassium hydroxide in 90% ethanol and 2 ml of 3% propylgallate 90% in a water bath at 88°C for 10 minutes. The solution was allowed to cool until reaching room temperature (25°C), before adding 10 ml of petroleum ether and then vortexed for another 30 seconds. After separation, 2 ml of the ether layer was pipetted into a clean test tube and evaporated in water bath at 50°C. After evaporation, 3 ml of acetic acid saturated with ferrous sulphate and 1 ml of concentrated H_2SO_4 were added to develop the chromospheres for colorimetric analysis of cholesterol. The absorbance was measured with a spectrophotometer at 490 nm against a reagent blank.

Myoglobin and meat content estimation

Myoglobin content was analysed using the method described by Jin *et al*. (2007) with slight modification. Two grams of sample was homogenized with 20 ml of 0.04 M phosphate buffer pH 6.8 at 13,500 rpm for 20 s. Then 10 g of homogenate was placed into centrifugation tube and centrifuged at 4000 g for 30 min. The supernatant was filtered with Whatman No.1 filter paper and added with 0.2 ml of 1% (w/v) sodium dithionite. Myoglobin was measured using spectrophotometer at 555 nm, intended from the millimolar extinction coefficient of 7.6 and a molecular weight of 16,111. Meat content was estimated using the method described by Babji *et al*. (2000). Skinless breast chicken meat was mixed with soy protein in certain concentration. Standardize mixtures were made with the following concentration: meat: soy, 0:100, 20:80, 40:60, 60:40, 80:20, and 100:0. The meat content estimation of burgers was calculated from standard curve using their myoglobin contents.

Sensory analysis

Sensory analysis was done with hedonic test as described by Trindade *et al*. (2009). Forty untrained panellists were served with a quarter parts of burgers just after cooking. Hedonic scores ranging from 1 to 9 which represented dislike extremely to the like extremely. The sensory attributes evaluated were colour, hardness, chewiness, juiciness, and overall acceptability.

Statistical analysis

Two different packs of each brand were analysed. One sample was taken from each pack. All chemical and physical analyses were performed on each pack thrice and in duplicate. Data were subjected to analysis of variance (ANOVA). Comparison of means was carried out by Duncan's multiple-range test. Pearson's correlation method was performed to analyse correlation between several data. Analysis was performed using SPSS software (SPSS 16.0 for Windows, SPSS Inc, Chicago, IL, USA).

Results

Labelling information

Table 1 shows the ingredient information stated on the labels of chicken burgers used in this study. Meat as the main ingredient should not less than 65% according to the Malaysian Food Act Regulation's, although the percentages of meat were not stated on the labels. Plant based proteins such as soy protein and hydrolysed or texturized vegetable protein are commonly used in many brands. Food additives such as food conditioner, flavourings, colouring substances, and flavour enhancer (including) are permitted to be used as ingredients in manufactured meat with particular levels (Food Act 1983 and Food Regulations, 1985). Flour and starches were widely used as filler, although only few brands had labels which showed the flour and starches were used. For the fat contents, one brand used chicken fat, two brands used vegetable oil and the rest did not provide labelling information for the fat used in their burgers.

Proximate compositions

Proximate compositions of chicken burgers are presented in Table 2. Moisture content were varies from 46.72-69.37%. Fats content were ranged from 9.08-20.54%. Food Regulation of Malaysia states that the fat content in processed meat products should not exceed 30% (Food Act 1983 and Food Regulations, 1985). The function of Fat is mainly influencing the sensory quality of burgers, particularly its flavour (Suman and Sharma, 2003). Among the commercial chicken burgers, all the brands evaluated have been complying with the regulation in terms of fat content. Low-fat burgers usually consist of fat contents at 10% or below (Dreeling *et al*., 2000; Suman and Sharma, 2003; Troy *et al*., 1999; Turhan *et al*., 2009). Some of the brands are considered to have low fat burgers such as CCB1, CCB3 and CCB4 which are significantly different from others ($p<0.05$). Low fat can be achieved as more water is added in meat batter and this will increase the moisture content (Jiménez-Colmenero, 1996). Pearson's correlation between moisture and fat was negative and significant at the 0.01 level (R^2= -0.751).

Protein contents of burgers analyzed in this study were ranged from 11.08-18.77%. Food Regulation of Malaysia requires a minimum limit of nitrogen content in organic form for processed meat products to be less than 1.7%, which is equal to 10.625% protein content (Food Act 1983 and Food Regulations 1985). Therefore, all commercial chicken burgers have adequate protein content and complied with the Malaysian Food Regulations 1985. This data is comparable with the previous work reported by Babji *et al*. (2000), where protein content of local brands chicken burgers ranged from 12.67-15.66%, whereas franchised chicken burgers were from 18.20-22.74%. However, many of the protein sources used in commercial burger's ingredients used presently are partially substituted with non-meat protein source. Besides the pricing reason which is less costly, non-meat protein sources such as egg, whey protein, and texturized soy protein, are able to improve the flavour and texture of burgers by increasing the fat and moisture binding ability (Gujral *et al*., 2002; Rentfrow *et al*., 2004; Kassem and Emara, 2010). The nutritional information of commercial chicken burgers shown in Table 1 indicated that most of the manufacturers use soy protein as non-meat protein ingredients to partially replace meat.

Carbohydrates content determined in the present study were ranged from 2.56-21.27%. Pearson's correlation between moisture and carbohydrate is significant at the 0.01 level (R^2= -0.739). These values are considered higher than the previous work reported by Babji *et al*. (2000), who reported that carbohydrate content of Malaysian chicken burgers ranged from 1.97-12.53%. Carbohydrates in burgers are mainly from the use of starches as ingredients. Starches, such as maize, tapioca, rice, potato, and wheat, have been used in processed meat products as meat filler and water binder (Joly and Anderstein, 2009). The other ingredients that may contribute to carbohydrates nutrient in burgers are non-starch hydrocolloids. Carrageenan, konjac, alginate, and xanthan gum are such a good sources of non-starch hydrocolloids which are able to work with proteins to help in retaining moisture content and thus modifying the texture of meat products (Lamkey, 2009). Another good source of carbohydrates that can be incorporated in burgers is dietary fiber. The usage of dietary fiber in processed meat formulation is especially practiced when concerning the economical, nutritive, and technological issues. Some of dietary fibers that have commonly been used are cellulose, oat fiber, wheat fiber, potato fiber, carrot fiber, sugar beet fiber, soy and pea fiber (Bodner and Sieg, 2009).

Table 1. Labelling information taken from the packaging

Sample	Ingredients information printed on the label
CCB1	Chicken meat, soy protein, salt, food conditioner, flavouring, monosodium glutamate (MSG).
CCB2	Chicken meat, soy protein, spices, salt, flavouring, food conditioner.
CCB3	Chicken meat, vegetable oil, spices, sugar, salt, starch, flour, food conditioner.
CCB4	Chicken meat, flour, vegetable protein, starch, spices, sugar, salt, food conditioner, MSG.
CCB5	Chicken meat, soy protein, spices, sugar, salt, food conditioner, MSG, sodium nitrite.
CCB6	Chicken meat, flour, vegetable protein, starch, spices, sugar, salt, food conditioner, MSG.
CCB7	Chicken meat, vegetable oil, vegetable protein, seasoning, salt, flour, dietary fiber, sugar, food conditioner.
CCB8	Chicken meat, chicken fat, soy protein, food conditioner, spices, sugar, salt, flavour enhancer.
CCB9	Chicken meat, soy protein, hydrolysed vegetable protein, salt, food conditioner, flavouring, MSG.
CCB10	Chicken meat, soy protein, hydrolysed vegetable protein, salt, food conditioner, flavouring, colouring, MSG.

Table 2. Proximate composition of uncooked commercial chicken burgers

Sample	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Carbohydrate (%)
CCB1	54.50 ±0.13^{e}	9.08 ±0.21^{a}	12.71 ±1.24^{b}	2.45 ±0.03^{ef}	21.27 ±1.29^{i}
CCB2	49.43 ±0.28^{c}	19.47 ±0.11^{f}	18.77 ±0.19^{f}	1.92 ±0.02^{c}	10.42 ± 0.00^{c}
CCB3	57.89 ±0.22^{g}	9.60 ±0.03^{a}	17.25 ±0.21^{e}	2.56 ±0.03^{f}	12.71 ± 0.42^{de}
CCB4	69.37 ±0.04^{i}	10.35 ±0.04^{b}	15.22 ±0.04^{d}	2.49 ±0.00^{ef}	2.56 ±0.14^{a}
CCB5	52.76 ±0.21^{d}	17.53 ±0.64^{e}	13.16 ±0.05^{bc}	2.49 ±0.02^{ef}	14.08 ±0.93^{ef}
CCB6	46.72 ±0.64^{a}	20.54 ±0.45^{g}	13.54 ±0.40^{bc}	2.96 ±0.06^{g}	16.26 ±0.75^{gh}
CCB7	65.18 ±0.04^{h}	11.11 ±0.09^{c}	13.01 ±0.79^{bc}	2.41 ±0.06^{e}	8.30 ± 0.78^{b}
CCB8	55.13 ±0.57^{e}	17.04 ±0.39^{e}	11.08 ±0.36^{a}	2.14 ±0.14^{d}	14.62 ± 0.74^{fg}
CCB9	56.27 ±0.13^{f}	14.58 ±0.15^{d}	15.50 ±0.46^{d}	1.50 ±0.00^{a}	12.16 ± 0.74^{d}
CCB10	48.59 ±0.16^{b}	17.49 ±0.28^{e}	14.38 ±1.05^{cd}	1.78 ±0.03^{b}	17.77 ± 0.90^{h}

Different superscripts letter in the same column showed significant differences among samples.

Apart from that, ash content analyzed were varies from 1.50-2.96%. Ashes are sum of the total minerals presented in food such as sodium, phosphorus and iron, that can be contributed by the meat as raw material, salt and spices added (Fernández-López *et al*., 2006).

Diameter shrinkages and weight loss

Diameter shrinkages and weight losses of cooked burgers are presented in Figure 1. The degrees of shrinkages were ranged from about 2-10%. This is an important parameter because the patties are mainly served with the burger buns and it should comparable with the buns size. The burgers shrank during cooking due to the meat protein denaturation and fluid (moisture and fat) loss. The addition of fibers and non-meat protein ingredients may reduce diameter shrinkage and weight loss (Gujral *et al*., 2002; Turhan *et al*., 2009).

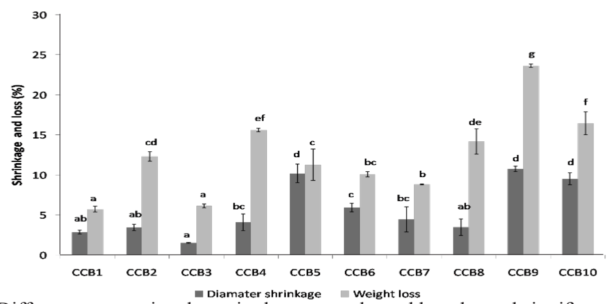

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Figure 1. Diameter shrinkage and weight loss of cooked chicken burgers

Weight losses range from about 5-25%. Loss of weight occurred during cooking mainly due to moisture evaporation and drip of melted fat (Mansour and Khalil, 1997; Alakali *et al*., 2010). CCB1 and CCB3 have the lowest weight loss among samples. It may be because less fluid was lost during cooking due to its lower fat content; this result was confirmed that of Suman and Sharma (2003). On the other hand, CCB4 which is also considered as low fat burger has a high value of weight loss due to its higher moisture content. This study indicated that Pearson's correlation value between diameter shrinkage and weight loss is significant at the 0.01 level (R^2= 0.654).

Texture profile analysis (TPA)

Textural profiles of burgers are shown in Figures 2 to 5. Hardness (Figure 2) and chewiness (figure 3) values were ranged from 8003.25-19308.15 g and 771.68-1275.78 g, respectively; whereas springiness (Figure 4) and cohesiveness (Figure 5) values were ranged from 0.141-0.443 and 0.235-0.323. Almost oll of the textural profiles of the burgers tested were differed significantly omong them. These values are lower than what Ganhão *et al*. (2010) has reported on beef burgers, which showed hardness range from 23280-42140 g, chewiness 14580-27650 g, springiness 0.95-1.02 and cohesiveness 0.64-0.67. Another source of fowl meat that is processed into burger is ostrich, as reported by Fernández-López *et al*. (2006) that ostrich burger had lower range on hardness values which is 3207.46-11364.49 g. On the other side, fish burgers as reported by Coelho *et al*. (2007) had less hardness, but it was more cohesive, chewy and springy.

Based on the present data, the hardness attribute had a significant positive correlation at 0.05 significant level with cohesiveness attribute (R^2= 0.512) and negative correlation at the 0.01 significant level with springiness attribute (R^2= -0.813). The cohesiveness attribute is significantly negative correlated with springiness at the 0.05 level (R^2= -0.616). Besides the quality of meat used as raw material, the addition of several ingredients also influence texture of burgers.

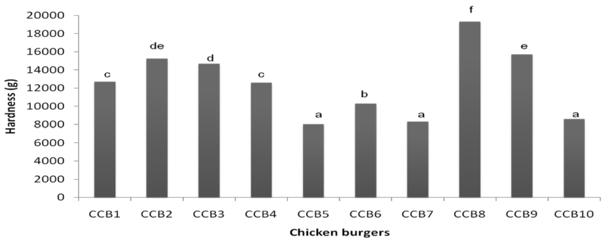

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Figure 2. Hardness of cooked chicken burgers

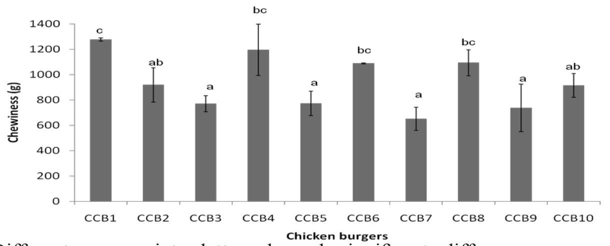

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Figure 3. Chewiness of cooked chicken burgers

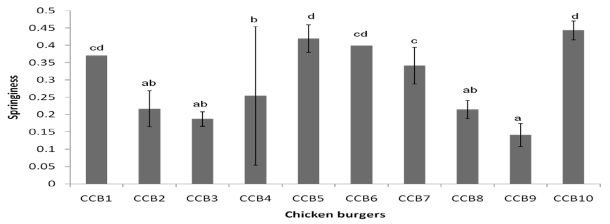

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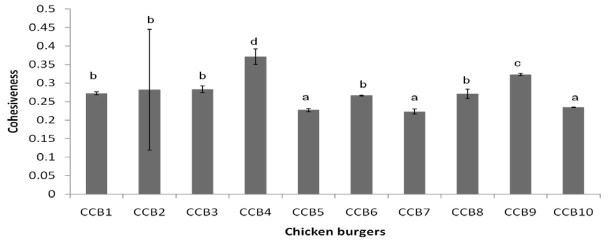
Figure 4. Springiness of cooked chicken burgers



Different superscripts letter showed significant differences among samples.

Figure 5. Cohesiveness of cooked chicken burgers

El-Magoli *et al*. (1996) reported that the addition of whey protein concentrate at certain concentration was able to increase the hardness and chewiness values of low-fat burger. Furthermore, Kassama *et al*. (2003) showed that the addition of texturized soy protein increased hardness and cohesiveness attributes of burger patties.

Colour properties

Colour properties of uncooked and cooked burgers are shown in Figures 6 to 8. All burgers tended to decrease in lightness (L) and increase in redness (a) and yellowness (b) after cooking. L values (Figure 6) of uncooked burgers range from 69.04-77.40 and obviously dropped after cooking to a range of 48.21-66.11, except for CCB4 sample which remained at 72.59. The values of redness (Figure 7) increased from 0.97-5.89 before cooking to 2.55-9.07 after cooking, except for CCB9 which decreased in redness from 1.46 to 0.75. The yellowness values (Figure 8) increased from 15.90-25.10 before cooking to 21.56-31.24. These data indicated that the colour of commercial burgers has been contributed by the type of meat used and colouring agent added in industries. Burgers made from breast meat have less redness intensity compared with burgers made from thigh or mechanically deboned meat (Babji *et al*., 2000). During burger preparation, colour alteration occurs in meat, while heme protein is denatured simultaneously with the oxidization of iron into ferric and the heme pigment remains intact (Ganhão *et al*., 2010). Based on the present data, there was a significant correlation between L^* and b^* (R^2= -0.698), and a^* and b^* (R^2= 0.681) at the 0.01 level.

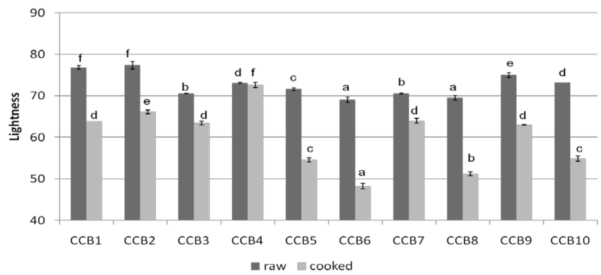


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Figure 6. Lightness of uncooked (raw) and cooked chicken burgers

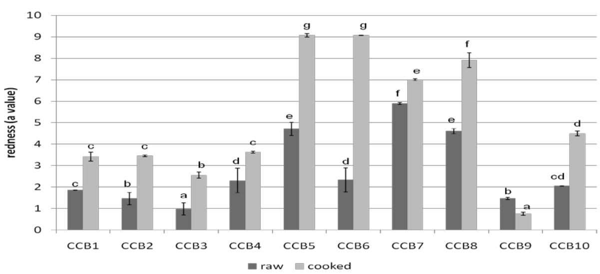

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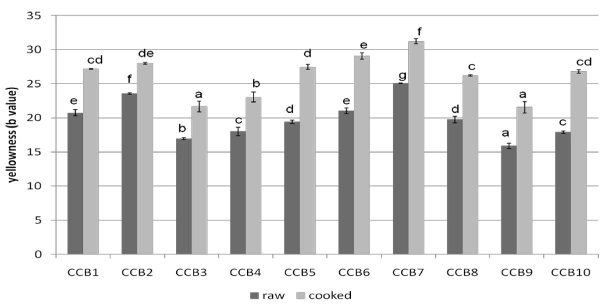
Figure 7. Redness (a value) of uncooked (raw) and cooked chicken burgers



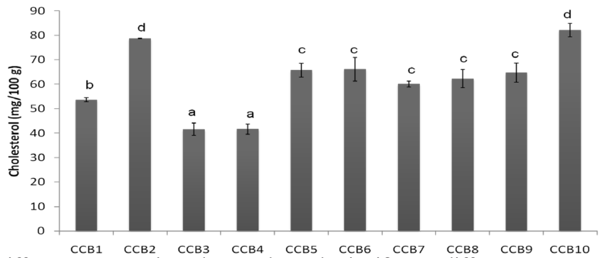
Different superscripts letter in the same coloured bar showed significant differences among samples.

Figure 8. Yellowness (b value) of uncooked (raw) and cooked chicken burgers

Cholesterol contents

Cholesterol contents of burgers are shown in figure 9. The cholesterol values detected were ranging from 41.62-82.16 mg/100 g. The burgers which are considered as low-fat i.e. CCB1, CCB3, and CCB4, have lower cholesterol content ranging from 41.62 to 41.66 mg/100 g. This values were lower than other low fat beef burgers reported from previous workers which ranged from 61.97- 72.13% (Piñero *et al*., 2008; Turhan *et al*., 2009). This might be due to the fact that burgers were made form skinless chicken breast which contains 43.4 mg cholesterol per 100 g meat whereas other parts of chicken contain as high as 95.3 mg/100 g (Chizzolini *et al*., 1999). Jiménez-Colmenero *et al*. (2001) reported that the cholesterol contents of meat products are generally less than 75 mg/100 g. Pearson's correlation between fat and cholesterol content is significantly positive at a significant level of 0.01 (R^2= 0.786).

Several health-related organisations have issued recommendation regarding cholesterol intake which should be 300 mg or below per day (Jiménez-Colmenero *et al*., 2001). Cholesterol content of meat products are closely linked to fat levels and it changes during cooking. Cooking processes particularly roasting and grilling lead to lose of fat due to fat melting and dripping, otherwise the cholesterol tend to be more concentrated. Some researchers reported increments in cholesterol content after cooking which ranges from 13-45% (Piñero *et al*., 2008; Turhan *et al*., 2009). Alina *et al*. (2009) reported that palm fat can be used as animal fat replacer in processed meat products and it can reduce 28-41 mg cholesterol/100 g. Martinez *et al*. (2009) reported that a mixture of pre-emulsified corn, olive, and deodorized fish oil in a hamburger can reduce cholesterol levels to 16.1 mg/100 g.

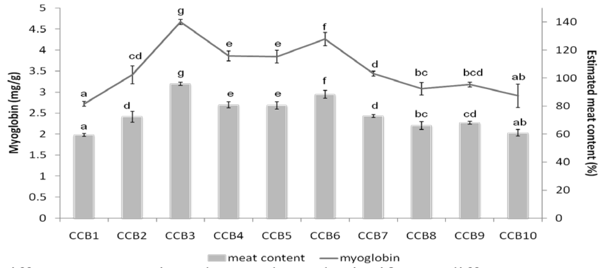


Different superscripts letter showed significant differences among samples.

Figure 9. Cholesterol content of chicken burgers

Myoglobin and estimated meat content

Myoglobin and estimated meat content of burgers are presented in figure 10. The lowest myoglobin content was detected in CCB1 2.72 mg/g, whereas the highest was in CCB4 i.e. 4.67 mg/g. Myoglobin contributes to reddish colour in burgers unless colouring and curing ingredients are added (Babji *et al*., 2000). However, myoglobin contents vary according to meat type, i.e. lean chicken breast contains less myoglobin compared to thigh meat and mechanically deboned meat (Kranen *et al*., 1999; Mielnik *et al*., 2002; Vallejo-Cordoba *et al*., 2010). Based on the present data, myoglobin content has significant negative correlation with lightness at the 0.05 significant level (R^2= -0.516). More myoglobin content comes out with less lightness value.



Different superscripts letter showed significant differences among samples.

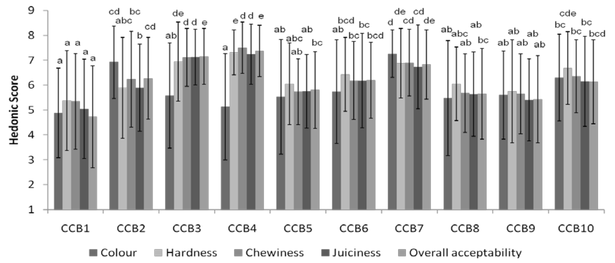
Figure 10. Myoglobin and estimated meat content of chicken burgers

Estimated meat contents of burgers ranged from 59.34-95.91%. According to Food Regulation in Malaysia, processed meat products must contain at least 65% of meat (Food Act 1983 and Food Regulations, 1985). Based on the calculation there are two brands that is CCB1 and CCB10 did not meet the regulation. However, the method used to estimate meat content in this study has some limitation. The method is fully dependant to myoglobin content of chicken breast used as standard which contains less myoglobin than other parts of chicken (Kranen *et al*., 1999). In the other words, the built-assumption is all chicken burgers were made from chicken breast rather than other parts used as their raw materials.

According to previous work, Babji *et al*. (2000) reported that local manufacturers of six brands chicken burger in Malaysia use 58-80.63% meat content for their products. In other countries such as, Australia and New Zealand higher limits for minimum meat content of manufactured meat that is 66% has been set (Food Standards Australia New Zealand, 2010). England established a more specific standard for burgers made from bird species including chickens-its meat content shall not be less than 55% (Statutory Instruments, 2003). A different standard has been set in Canada. A minimum meat protein level was applied rather than its meat content, whereas a minimum meat protein level for uncooked burger is 11.5% (Department of Justice Canada, 2010). A study in United States of America reported that 6 out of 8 hamburger brands contained meat protein level between 10.2-14.8%. They also found hamburgers with the lowest meat protein level as low as 2.1% (Prayson *et al*., 2008).

Sensory evaluation

Sensory evaluation of cooked chicken burgers is shown in figure 11. Panellists gave the highest score for colour properties to CCB7 which is considered as like moderately. It has high lightness (L= 63.96), high redness (a= 7.00) and very high yellowness (b= 31.24). Pearson's correlation shows significant level at 0.05 between colour assessment from sensory evaluation and yellowness value (b^*) from instrumental colour analysis (R^2= 0.558). Therefore yellowish colour of burgers is preferable by consumers.



Different superscripts letter showed significant differences among samples.

Figure 11. Sensory analysis (hedonic test) of chicken burger

Based on textural properties i.e. hardness, chewiness, juiciness and overall acceptability, CCB3 and CCB4 are the most preferred burger, which are rated in the range between like slightly and like moderately. Those burgers consist of hardness values of 12590 g and 14652.35 g, chewiness 771 and 1195.42 g, respectively. These low fat burgers were also assessed with highest score of juiciness. However, this finding is different with previous studies which report a tendency that, low fat burgers are less acceptable juiciness compared to control burgers with higher fat content (Troy *et al*., 1999; Turhan *et al*., 2009). Panellists' assessment on overall acceptability of burgers is strongly influenced by its juiciness (R^2= 0.778) and chewiness (R^2= 0.749) which are significant at the 0.01 level. Chewiness is positively correlated with juiciness (R^2= 0.706, significant at the 0.01 level). Nonetheless, correlation between overall acceptability and hardness is also significant (R^2= 0.601 at the 0.01 level).

A correlation between textural properties of sensory evaluation and TPA by instruments was found. Based on the present data, hardness of sensory analysis has a low negative significant correlation with hardness attribute of TPA at the 0.05 level (R^2= -0.108). This low correlation might be due to wide range in degrees of likeness judged by the panellists, caused by stimulus or contrast effects during sensory evaluation.

Generally, the R^2 values in this study were low. Correlations between two analysed attributes mostly were not completely linear. It might be due to the variation of raw material and additional ingredients used in chicken burgers gave diverse influences.

Conclusion

All of the commercial chicken burgers produced locally in Malaysia are significantly different on several quality attributes such as chemical composition, textural and colour properties due to variation in formulation. Some brands are contained lower fat and lesser concentration of cholesterol. Majority of the chicken burger brands complied with the Food Regulations of Malaysia in several aspects such as meat percentage, fat and protein contents. Sensory evaluation showed that chicken burger with yellowish colour, moderate hardness and chewiness are more preferred by the panellists.

Acknowledgments

Authors acknowledge with gratitude the support given by Universiti Sains Malaysia (USM). This research was carried out with aid of a research grant from MALAYAN SUGAR MANUFACTURING COMPANY BERHAD.

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