Research Paper

Physicochemical and sensory properties of commercial chicken nuggets

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Abstract

Proximate composition, colour, toughness and sensory properties five brands of commercial chicken nuggets were evaluated. The proximate composition of commercial chicken nugget showed significant difference ($p<0.05$) between samples. The range of moisture, protein, fat, ash and carbohydrate content were 34.71-56.51%, 12.52-16.62%, 18.14-25.00%, 1.20-1.58% and 7.52-26.49%. The L, a and b values of cooked chicken nuggets ranged between 64.38 – 68.41, 0.51 – 3.51 and 16.46 - 19.35, respectively. The toughness values of chicken nuggets ranged from 12.66 – 18.00 and water holding capacity ranged from 34.54 – 51.57%. The weight of chicken nuggets ranged from 18.28 - 29.77g and cooking loss value ranged from 3.37 – 13.05%. The hardness, cohesiveness, springiness, gumminess and chewiness ranged between 33.36 – 77.45, 0.61 – 0.80, 1.00 – 1.23, 21.26 – 61.66 and 23.02 – 66.13, respectively. From sensory evaluation, it was shown that generally all samples were acceptable to the panellists. This result showed that Malaysian chicken nuggets produced by different manufacturers, were significantly different in chemical composition, colour, textural properties and sensory evaluation.

Keywords: fast food, chicken nuggets, physicochemical properties, sensory evaluation, Malaysia.

Introduction

Fried food is very common and generally acceptable worldwide, one popular product being chicken nuggets. Nuggets are a restructured meat product with batter and coater to retain the

quality. The main composition of nugget is meat, usually from chicken, fish or combination with vegetable protein and gum. The composition of all batter is flour. In Malaysia, chicken nuggets are an important food served at almost all fast food restaurant chains. Proximate composition and physicochemical characteristics of chicken nuggets are the most significant factors for consumer acceptability.

According to the Malaysian Food Regulation [1], restructured meat products must contain not less than 60% meat in any formulation. USDA [2] suggested the coat of the nugget should be less than the weight of product. The quality of nugget can be significantly affected by processing, raw material and ingredient factors, either from nutritional value or overall acceptability by consumers. Only those nuggets with high nutritional value, low cholesterol, good textural properties, nice flavour and taste profile will become the favourite choice of consumers.

Nuggets are a ready to cook and ready to eat product with simple preparation makes it a popular choice with consumers for a quick meal. Many factories have developed in Malaysia in order to increase output and fulfil the increasing demands of consumers. Due to the high competition between manufactures, investment in advanced technologies has been necessary in order to produce high quality products. This study was carried out to determine the quality characteristics associated with chicken nuggets available in Malaysian markets currently.

Materials and Methods

Sample preparation
Five frozen commercial chicken nuggets from different brands or manufacturers were collected from supermarkets located in Malaysia. The nuggets of each brand were picked randomly and brought to the laboratory for analysis.

Proximate composition analysis
The proximate composition (moisture, fat, protein and ash content) was determined according to standard procedures of AOAC [3]. Carbohydrate content was calculated by difference.

Colour analysis
Lightness L^*, redness a^* and yellowness b^* (CIE, 1978) internal colours of cooked nugget samples were evaluated on a Minolta spectrophotometer CM 3500d, Japan, the equipment was standardized with a white colour standard [4].

Cooking loss
Chicken nuggets were weighed before and after cooking. The percentage cooking loss was evaluated by establishing what percentage of the weight was lost during the cooking process.

Water Holding Capacity (WHC)
Five grams of sample were weighed into centrifugation tubes and there after centrifuged at 5°C at low speed (1000g for 15 min). The WHC was determined as liquid loss and expressed as percentage of weight of liquid release.
%WHC = (before centrifuge weight - after centrifuge weight)/(before centrifuge weight) x 100.

Texture Profile Analysis (TPA)

The textural properties of nuggets were evaluated using a texture analyzer model TA-XT2 (Stable Microsystems Ltd. Surrey, England, UK). Texture profile analysis [5] was performed using central cores of five pieces of each sample (1.5 cm x 1.5 cm x 1.5 cm), which were compressed twice to 80% of the original height [6] by a compression probe (P 75). A crosshead speed of 2 mm/s was used. The following parameters were determined: hardness (N) = maximum force required to compress the sample (*H*); springiness (mm) = ability of sample to recover its original form after a deforming force was removed (*S*); cohesiveness = extent to which sample could be deformed prior to rupture (A_2/A_1, A_1 being the total energy required for first compression and A_2 the total energy required for the second compression); adhesiveness (Ns) = work necessary to pull the compressing plunger away from sample; gumminess (N/mm^2) = force necessary to disintegrate a semisolid sample for swallowing (*H* x cohesiveness); chewiness (N/mm) = work to masticate the sample for swallowing (*S* x gumminess). 5-bladed Kramer Shear Cell was used to compress the nugget to 35% of its original height. The test speed was 3.0 mm/s. The average of the ten samples is reported as toughness.

Sensory evaluation test

Thirty members of the panel were trained in product and terminology. The sensory evaluation test was performed on a seven point scale [7]. For the sensory evaluation test the chicken nuggets were shallow pan fried in cooking oil until golden brown and served warm to an experienced panel of scientists and postgraduate students in the discipline of food technology to determine their sensory characteristics. The sensory attributes evaluated were: colour, appearance, odour, taste, gumminess, hardness, juiciness and overall acceptability were evaluated using 7 hedonic scale, where 7=like extremely and 1=dislike extremely.

Statistical methods

Data obtained from all the analyses were analysed by using One-Way Analysis of Variance (ANOVA) and followed by DUNCAN Multiple range test of statistical package for social science version 15.0 (SPSS Inc., Chicago, Illinois, U.S.A). Statistical significance was indicated at 95% confidence level.

Results and Discussion

According to Table 1, the proximate composition for chicken nuggets were significantly different (P<0.05). Sample CN 3 had the lowest moisture content that is 34.71%, while sample CN 4 has the highest moisture content that is 56.51%. Three of the samples had almost similar protein content. The protein value ranged 12.52% to 16.62%. The difference in protein content depends on the raw meat that is used in the manufacturing of chicken nuggets. In short, protein content in chicken nuggets comes mainly from raw meat so a higher amount of raw meat used in the formulation will result in higher protein content. According to Selgas *et al.*, [8], chicken proteins have a high biological value due to their quantity and quality, containing types and ratio of amino acids very similar to those required for maintenance and growth of human tissue. Fat content was highest in CN 3 (25.00%) and lowest in CN 4 (18.14%).

Reduction in fat can significantly affect the acceptability of a product and increase the toughness of meat product [9]. It is of such importance that several studies have attempted to maintain sensory and texture attributes through the use of fat replacers [10]. From a physiological standpoint, fat is a source of energy in the diet (9 Kcal/g). However, fat intake is associated with increased risk of obesity, some types of cancer, high blood cholesterol and coronary heart disease. For these reasons, several health-related organizations (American Heart Association, American Cancer Society and World Health Organization) have proposed limiting total fat intake to no more than 30% of total calories [10]. The fat content of chicken nuggets analyzed were in accordance with the Malaysian Food Act 1983, which stipulates below 30% [1].

Table 1. **Proximate Composition of Commercial Chicken Nuggets (%wb).**

Sample	moisture	fat	protein	ash	carbohydrate
CN1	40.83b±0.24	18.64a±0.23	12.52a±0.32	1.52c±0.04	2 .49c±0.37
CN2	47.16c±0.55	19.27b±0.18	12.79a±0.49	1.35b±0.06	19.43b±0.73
CN3	34.71a±0.37	25.00d±0.36	12.66a±0.41	1.58c±0.05	26.05c±0.39
CN4	56.51e±0.46	18.14a±0.67	16.62c±0.46	1.20a±0.08	7.52a±0.80
CN5	54.42d±0.42	20.75c±0.68	15.18b±0.41	1.40b±0.06	7.74a±0.87

* Means within a column with different letters are significantly different ($p < 0.05$) n = 6.

Carbohydrate content in chicken nuggets ranged from 7.52% - 26.49%. The increase of carbohydrate content in modern chicken nuggets could be due to an increase of starch content (acts as extender) to substitute for raw meat in the manufacturing of chicken nuggets. The main reason behind this is the manufacturer plans to reduce processing cost to increase the marginal profit. The ash content in chicken nuggets varied from 1.20-1.58%. According to Field [11], the ash content for mechanically deboned chicken meat is higher compared to traditional deboned chicken meat (chicken meat deboned by hand). This is because during the process of mechanical deboning, the bones of the meat were crushed and mixed into the mince causing higher ash content.

In Table 2, CN 1 shows the highest L* value at 68.41, a* value at 3.51 and b* value at 19.35 compared to other brands. The lowest L* value is found in CN 4 at 64.38, a* value at 1.42 and b* value at 16.46. The difference in colour properties of chicken nuggets may be attributed to the effect of oil temperature and sample thickness during frying. The colour change phenomenon gets more intense at higher temperatures and smaller sample thickness [12]. These changes include discolouration of the meat, due to the oxidization of pigment heme groups [13]. According to Cross *et al*. [14], heat applied on meat was responsible for converting myoglobin and haemoglobin to metmyoglobin, which is brown in colour.

Table 2. **Colour Properties of Commercial Chicken Nuggets**.

Sample	L*	a	b
CN1	68.41d±0.57	3.51d±0.23	19.35e±0.33
CN2	65.32b±0.22	1.38c±0.14	17.06b±0.16
CN3	65.74b±0.36	0.51a±0.16	18.75d±0.16
CN4	64.38a±0.28	1.42c±0.39	16.46a±0.39
CN5	65.50c±0.29	0.96b±0.29	17.54c±0.29

*Means within a column with different letters are significantly different ($p<0.05$) n = 6

Toughness index for chicken nuggets is shown in Figure 1. Nuggets showed similar results in toughness (ranging from 12.66 – 18.55). Factors responsible for textural properties in comminuted meat proteins are degree of myofibril proteins extracted, stormed protein content, degree of comminution and type and level of non-meat ingredient. The amount of protein content, types and amount of extenders such as starch will play a decisive role on hardness of chicken nuggets as well. As an example, addition of legume flour can slightly increase toughness of chicken nuggets.
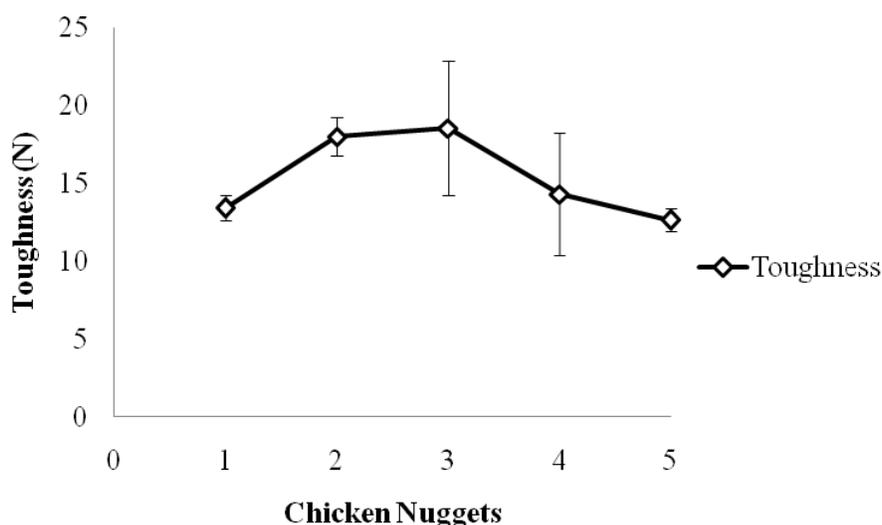
Figure 1. **Toughness Values Of Fried Chicken Nuggets.**
Each value is the mean ± standard error (*n*=20), (1): CN1, (2): CN2, (3): CN3, (4): CN4, (5): CN5

According to Ngadi *et al*. [15], the changes in the textural properties of chicken nuggets could be attributed to the physical and chemical changes taking place during the frying process, particularly in the batter or breading portion. There is a cut-off point above which the texture of chicken nuggets would be unacceptable. Therefore, determination of good textural qualities of chicken nuggets should be done together with sensory tests in order to find out the most suitable range preferred by consumers.

Weight of chicken nuggets, as shown in Figure 2, ranged in value from 18.28 – 29. Based on Figure 3, better cooking scores were shown by CN2, that is 4.48% and CN4, that is 3.37%, whereby lower percentages of cooking loss were obtained. Cooking loss is synonymous with emulsion stability. It is an important parameter for assessing the quality of meat products. Breakdown of emulsion occurs with increasing comminution temperature and will increase cooking losses [16].
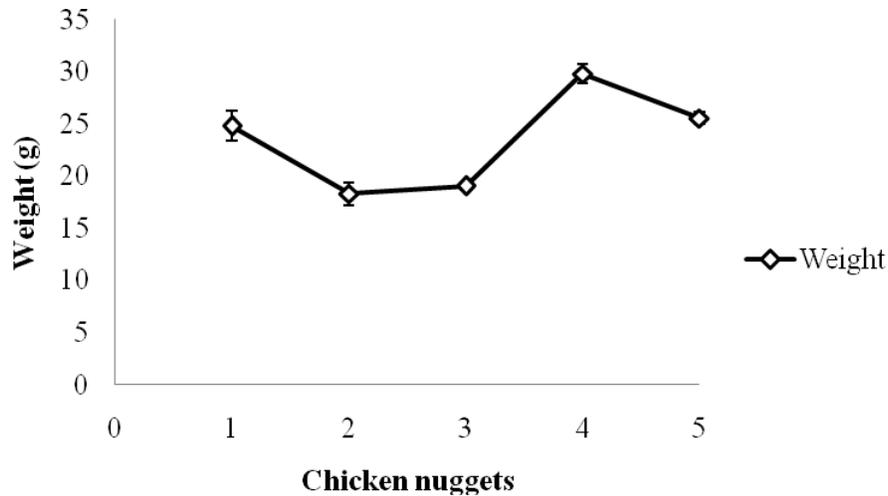
Figure 2. Weight Values of Fried Chicken Nuggets.
Each value is the mean ± standard error (*n*=20), (1): CN1, (2): CN2, (3): CN3, (4): CN4, (5): CN5
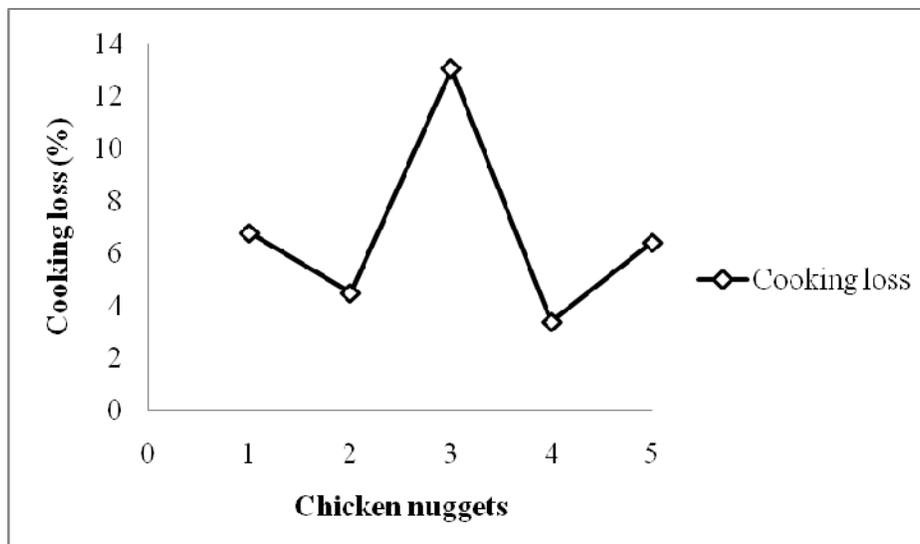
Water holding capacity results for fried chicken nuggets is shown in Figure 4. Based on these figures, water holding capacity of nuggets ranged from 34.54 – 51.57%. Water holding capacity determines how far beef products are able to hold water when pressure is imposed in a centrifuge [17]. At isoelectric point in meat protein, protein networks contract electrostatic push force resulting in lesser, reduced space present in that network for water holding capacity [18]. Mittal and Barbut [19], found water holding capacity values proportional with early content of products, where water holding capacity values were low in products high in fat. The water holding capacity functionality nature was influenced by how far effective protein matrix binding scattered excess fat and water in products [20].

Texture analysis results for chicken nuggets frying were determined as hardness, cohesiveness, springiness, gumminess and chewiness values, respectively (Table 3). There was a significant difference (P<0.05) in texture properties values among all samples. Hardness of fried nuggets showed significant difference (P<0.05). Based on the table, sample CN2 was softer compared to other samples. During the frying process, the physical, chemical and sensory characteristics of the food are modified [16]. There is a cut-off point above which the texture of nuggets would be unacceptable. Therefore, determination of good textural qualities of nuggets should be done together with a sensory test in order to find out the most suitable range preferred by consumers.

**Table 3**. **Changes in Texture Profile Analysis of Chicken Nuggets**.

Sample	Hardness (N)	Cohesiveness (Ns)	Springiness (mm)	Gumminess (N)	Chewiness (N mm)
CN1	77.45a±1.20	0.80a±0.02	1.07bc±0.02	61.66a±1.85	66.13a±1.96
CN2	33.36e±1.18	0.64c±0.01	1.08b±0.02	21.26e±1.25	23.02e±1.13
CN3	75.00b±1.00	0.67b±0.01	1.23a±0.03	50.38b±1.36	61.95b±1.05
CN4	55.23c±1.32	0.68b±0.01	1.03cd±0.02	37.81c±0.57	38.82c±1.28
CN5	48.57d±1.25	0.61d±0.02	1.00d±0.04	29.45d±1.30	29.29d±0.07

*Means within a column with different letters are significantly different ($p<0.05$) n = 6

Figure 3. Cooking Values of Fried Chicken Nuggets.
Each value is the mean ± standard error (*n*=20), (1): CN1, (2): CN2, (3): CN3, (4): CN4, (5): CN5
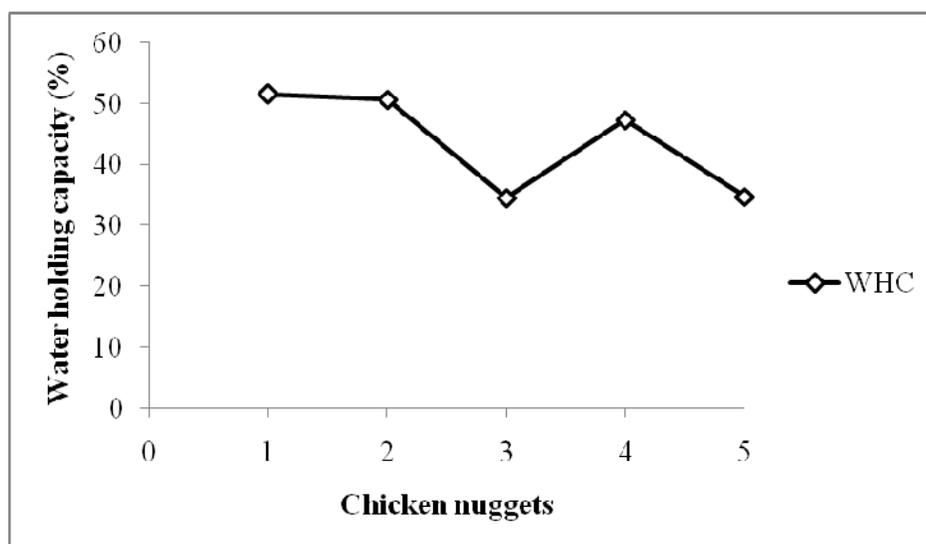
Figure 4. Water Holding Capacity Values of Fried Chicken Nuggets.
Each value is the mean ± standard error (*n*=20), (1): CN1, (2): CN2, (3): CN3, (4): CN4, (5): CN5

Based on 7-hedonic scale (1=dislike extremely, 7=like extremely) sensory scores (Table 4) showed that the acceptability of chicken nuggets were not significantly different ($p<0.05$). Panellists had significantly higher preference for the colour of chicken nuggets found in CN5 at 6.40 and lower preference for the colour in CN 1 at 4.08 and CN 3 at 4.04. This indicated that panellists preferred chicken nuggets with light colour.

Table 4. Sensory Evaluation of Commercial Chicken Nuggets.

Sample	CN1	CN2	CN3	CN4	CN5
Colour	4.08a±1.53	4.32a±1.60	4.04a±1.59	5.40b±1.12	6.40c±0.82
Odor	6.00b±1.12	4.68a±1.55	5.60b±1.00	5.32ab±1.18	5.56b±1.08
Taste	4.88ab±1.62	4.12a±1.83	5.60b±1.12	5.60b±1.12	5.60a±1.12
Gumminess	4.72a±1.59	5.60b±1.26	5.52b±1.16	5.92b±0.70	5.80b±0.96
Hardness	4.92a±1.71	5.24ab±1.54	5.36ab±1.35	5.92b±0.76	5.40ab±1.47
Juiciness	4.40a±1.78	5.40b±1.15	5.28b±1.31	5.64b±0.95	5.44b±1.73
All acceptable	4.56a±1.64	4.52a±1.39	5.40b±1.29	5.84b±0.85	5.44b±1.47

*Means within a column with different letters are significantly different ($p<0.05$) n = 30

Conclusions

Based on the analysis results, proximate composition, colour, textural properties and sensory evaluation tests, several brands of chicken nuggets were significantly quite different. The differences in nuggets were mainly due to the type and amount of ingredients added, different formulation and different processing methods. The analysis results obtained in this study shows that manufacturers of chicken nugget products in Malaysia produce with different

formulations. Therefore, it should be reasonable to carry out a study to produce general guidelines for better quality chicken nuggets.

Acknowledgment

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