Physicochemical and sensory characteristics of chicken nugget with curcuma (Curcuma zanthorrhiza) flour fortification

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Abstract. Loss of weight and appetite are significant concerns for many parents with toddlers and preschoolers as poor or ‘picky’ eaters. The combination of healthy yet delicious food for kids is greatly needed to cope this problem. One of them is providing chicken nugget with nutritional content such as curcumin which is able to boost the children appetite. This experiment was conducted to find out the effect of curcuma flour fortification on physicochemical and sensory characteristics of chicken nugget. Five formulations were developed: 0, 0.5, 1, 1.5, and 2% (w/w) of filler. The chicken nugget was characterized for their physical, chemical, and sensory characteristics. Curcuma flour fortification did not affect the water holding capacity, tenderness, protein, and fat contents of chicken nugget (P>0.05), but increased the vitamin E and curcumin contents of chicken nugget (P<0.05). Sensory characteristic test results showed that the fortification of curcuma flour did not affect acceptability in the sensory characteristic of chicken nugget. In conclusion, chicken nugget with curcuma flour fortification at the level of 2.0% showed the best characteristic of the chicken nugget.

1. Introduction
One of the biggest challenges for parents with kids between one and five years of age is loss of appetite. This issue leads to the growth and development problem of children, since their energy to grow is coming from food. A proper nutritional value and interesting meal to attract toddlers and preschoolers in eating needs to be improved. Chicken nuggets, a restructured processed meat product, favored by consumers especially children may become a solution to serve ready to eat meat product which has a high nutritional value and delicious taste at once. In order to boost the children appetite, the chicken nugget can be fortified by an appetite-booster compound such as curcuma (Curcuma zanthorrhiza).

Curcuma, or in Indonesia called as Temulawak, is vegetable containing vitamin E (tocopherol) and curcumin [1]. Vitamin E functions as a natural antioxidant which can counteract the free radicals, help to slower the aging process, increase fertility and prevent the spread of cancer cells. Besides that, curcuma has also been shown to reduce the cholesterol levels in blood and liver cells [2]. These properties are resulted from the content of curcumin, a substance that is useful to maintain and nourish the liver (hepatoprotector). Although it is important for health, consumption of curcuma, especially in
children, is very lack. Therefore, the innovation in the development of processed meat products combined with vegetables need to improve in order to solve the problem of less appetite in kids’ stage.

2. Material and methods

2.1. Material

The ingredients used for making chicken nuggets were chicken breast fillet, white egg, tapioca flour, wheat flour, curcuma flour, garlic powder, pepper powder, salt, flavoring, block broth, and bread flour from a local market in Yogyakarta, Indonesia. For the physical, chemical and sensory characteristics observation, H2SO4, H3BO3, HCl, petroleum benzine, and distilled water were used.

2.2. Methods

2.2.1. Processing of chicken nuggets. Chicken meat was cut into small pieces, then grinded with a grinder machine. Minced meat, tapioca flour, wheat flour, spices, and remaining ingredients were put in a bowl chopper for 10 minutes. The finished nugget dough was divided into five levels of curcuma flour with the fortification formula were 0 (T0), 0.5 (T1), 1.0 (T2), 1.5 (T3) and 2.0% (T4) of filler. Then the mixture was homogenized for 2 minutes, then steamed at 80°C for 30 minutes. The cooked batter was cut into 4 cm long, 2 cm wide, and 1.5 cm thick, dipped in a batter solution made of egg white and egg yolk which has been mixed and then coated with bread flour. The chicken nuggets were then fried in a deep fat frying method at a temperature of 160 ± 5°C for 5 minutes.

| Table 1. Formulation of control chicken nugget (T0) and with various levels (T1, T2, T3, and T4) of fortification with curcuma flour |
|---------------------------------|---|---|---|---|---|
| Ingredients (%)                | T0 | T1 | T2 | T3 | T4 |
| Chicken breast fillet          | 75 | 75 | 75 | 75 | 75 |
| Wheat flour                    | 6  | 5.97| 5.94| 5.91| 5.88|
| Tapioca flour                  | 6  | 5.97| 5.94| 5.91| 5.88|
| Curcuma flour                  | 0  | 0.06| 0.12| 0.18| 0.24|
| White egg                      | 6  | 6  | 6  | 6  | 6  |
| Salt                           | 2.5| 2.5| 2.5| 2.5| 2.5|
| Garlic powder                  | 2.5| 2.5| 2.5| 2.5| 2.5|
| Pepper powder                  | 0.5| 0.5| 0.5| 0.5| 0.5|
| Flavoring                      | 1.5| 1.5| 1.5| 1.5| 1.5|
| Total                          | 100| 100| 100| 100| 100|

T0: Without fortification of curcuma flour; T1: 0.5% fortification of curcuma flour; T2: 1% fortification of curcuma flour; T3: 1.5% fortification of curcuma flour, and T4: 2% fortification of curcuma flour.

2.2.2. Physical characteristics. The pH was measured by mixing Ten grams of sample with 10 ml distilled water. The pH value was measured by pH meter based on Bouton et al. [3]. The water holding capacity was tested by the Hamm method [4]. A total of 300 mg of meat samples were placed on a water free filter paper, then a weight of 35 kg was applied for 5 minutes. The water released during pressing was a free water. The water holding capacity was the total water content minus the water released during pressing. Total water content was obtained from the reduction in sample weight after the heating process at 105°C for 12 hours.

The tenderness value was tested by penetrometer according to the method of Kartika et al. [5] A 1.5 cm thick chicken nugget sample was placed under the KIC penetrometer needle with a weight of 50 g. When the ballast load was released the needle will enter the chicken nugget sample. The depth of the piercing needle into the sample multiplied by 0.1 ml was the tenderness value of the chicken.
nugget sample. Tenderness measurements were made at 3 different places and the results were averaged (mm/50 g).

2.2.3. Chemical characteristics. Protein and fat contents of the chicken nugget were determined according to the standard procedures of AOAC [6]. Protein content was tested using the Kjeldahl method [6]. The tests included destruction of the sample with concentrated sulfuric acid, followed by distillation using boric acid, and titration using HCl. For fat content, the samples were extracted using a solution of Petroleum benzine for 16 hours. Differences in sample weight between the sample before extraction and after extraction called as a fat content. Vitamin E content of chicken nugget samples was determined according to Eitenmiller et al. [7]. Curcumin content of chicken nugget was observed according to Pozharitskaya et al. [8].

2.2.4. Sensory characteristics. Sensory characteristic of chicken nugget samples was determined according to Keeton et al. [9] with the 15 panelist members. Judging scale for each factor as follows: very good (5), good (4), fair (3), poor (2), and very poor or rejected (1). The panelists judged the samples for color, aroma, flavor, texture, juiciness, and acceptability.

2.2.5. Statistical analysis. The data from the physical and chemical characteristics observation were analyzed by analysis of variance (ANOVA) and mean differences were tested by Duncan's New Multiple Range Test. Sensory characteristic data were analyzed by non-parametric analysis through the Kruskal-Wallis Hedonic Test [10].

3. Results and discussion

3.1. Physical characteristics

Based on the results of the analysis, the treatment of the fortification with curcuma flour had a significant effect (P<0.05) on the pH of chicken nugget. The addition of curcuma flour lead to the decrease in pH value of chicken nugget. It may be due to the low pH of curcuma, therefore the higher level of curcuma flour, resulted in decreasing the pH of chicken nugget. A pH value has important role since it relates to the bacterial growth which optimally grow at a pH around 6.79 [11]. The final chicken nugget pH with curcuma flour fortification has lower pH compared to the control treatment.

### Table 2. Physical characteristic of chicken nugget fortified with curcuma flour

| Parameter                     | Treatment       |
|-------------------------------|-----------------|
|                               | T0             | T1             | T2             | T3             | T4             |
| pH value                      | 6.92±0.10d     | 6.64±0.05c     | 6.60±0.07bc    | 6.55±0.02ab    | 6.51±0.01a     |
| Water folding capacity (%)    | 51.80±1.02     | 37.52±0.82     | 36.86±1.21     | 34.66±0.95     | 45.2±2.35      |
| Tenderness (mm/50 g)          | 9.92±0.32      | 9.58±0.14      | 9.60±0.21      | 9.53±0.28      | 9.42±0.29      |

a, b, c, d Superscripts letters indicate significant differences among the group in the same row at P<0.05.

T0: Without fortification of curcuma flour; T1: 0.5% fortification of curcuma flour; T2: 1% fortification of curcuma flour; T3: 1.5% fortification of curcuma flour, and T4: 2% fortification of curcuma flour.

Fortification with curcuma flour had no significant effect (P>0.05) on the water holding capacity and tenderness of chicken nugget. Water holding capacity of chicken nugget was not affected by the treatment of curcuma flour fortification. This might be related to protein content of the curcuma flour fortification which was not different among the treatments in this experiment. Protein holds the water in the meat product which lead to increase the water holding capacity. Water holding capacity tends to decrease because the pH of the chicken nuggets decreases. This is in accordance with Prinyawiwatkul et al. [12], if the pH decreases then water holding capacity also decreases. The decreasing of pH value would be followed by the drop of chicken nugget tenderness.
3.2. Chemical characteristics

Table 3 showed that the fortification of curcuma flour had no effect (P>0.05) on the protein and fat contents of chicken nugget. Previous study showed that turmeric (Curcuma sp.) powder contains crude protein content about 9.40% and 6.85% of fat content [13]. Due to a small amounts of curcuma which was added into the chicken nuggets, both compounds have not affected by the fortification of curcuma flour.

Table 4 shows that the curcuma flour fortification have no effect (P>0.05) on the color, juiciness, and protein content about 9.40% and 6.85% of fat content [13]. Due to a small amounts of curcuma flour which was added into the chicken nuggets, both compounds have not affected by the fortification of curcuma flour.

The curcumin analysis showed a significant effect (P<0.05) on the curcumin content of chicken nugget due to variation on the curcuma flour fortification levels. The higher the curcuma flour fortification on the chicken nuggets, the higher level of curcumin in the chicken nugget. Tayyem et al. [14] stated that the curcumin content on the turmeric (Curcuma sp.) powder are vary among samples, from 5 ppm to 31 ppm. Therefore, the addition of curcuma flour enables to increase the curcumin content of chicken nugget ranged from 1 ppm to 14 ppm gradually with the increasing of curcuma flour levels. Vitamin E content of chicken nugget also has been influenced by the fortification of curcuma flour. USDA stated that in a 100-gram turmeric will content 4.4 mg vitamin E [14]. The increasing vitamin E level on this experiment ranged about 0.009% to 0.076% as the increasing of curcuma flour fortification levels. The higher level of curcumin in the chicken nugget due to variation on the curcuma flour fortification levels. The higher the curcuma flour fortification, the lower the aroma and acceptability of chicken nugget. Whereas aroma, flavor, and texture were significantly influenced by the presence of fortification. The higher level of curcuma flour fortification, the lower the aroma and flavor. This may be the smell of curcuma has the unique aroma and flavor which influence the judges when they tasted the chicken nugget.

3.3. Sensory characteristics

Table 4 shows that the curcuma flour fortification have no effect (P>0.05) on the color, juiciness, and acceptability of chicken nugget. Whereas aroma, flavor, and texture were significantly influenced by the presence of fortification. The higher level of curcuma flour fortification, the lower the aroma and flavor. This may be the smell of curcuma has the unique aroma and flavor which influence the judges when they tasted the chicken nugget.

### Table 3. Chemical characteristics of chicken nugget fortified with curcuma flour

| Parameter      | Treatment   |
|----------------|-------------|
|                | T0          | T1          | T2          | T3          | T4          |
| Protein (%)    | 17.36±1.02  | 17.66±0.98  | 17.51±1.10  | 17.51±9.02  | 16.78±1.12  |
| Fat (%)        | 7.53±0.92   | 6.75±0.72   | 6.72±1.00   | 6.08±0.85   | 6.06±1.02   |
| Curcumin (ppm) | 31.26±0.47a | 32.00±0.23b | 37.01±0.22c | 41.14±0.23d | 45.85±0.20e |
| Vitamin E (%)  | 0.170±0.003 | 0.179±0.003 | 0.206±0.005 | 0.220±0.004 | 0.246±0.006 |

| Parameter | T0          | T1          | T2          | T3          | T4          |
|-----------|-------------|-------------|-------------|-------------|-------------|
| Color     | 4.47±0.83   | 4.40±0.50   | 4.33±0.48   | 4.13±0.35   | 4.07±0.25   |
| Aroma     | 4.00±0.00b  | 3.80±0.67bc | 3.67±0.39bc | 3.53±0.63b  | 3.33±0.72e  |
| Flavor    | 4.47±0.52a  | 4.20±0.41ab | 3.93±0.79ab | 3.87±0.91a  | 3.73±0.96c  |
| Texture   | 3.40±0.63a  | 3.47±0.91ab | 3.53±0.91ab | 3.60±0.50ab | 4.00±0.00b  |
| Juiciness | 3.07±0.45   | 3.13±0.91   | 3.20±0.86   | 3.27±0.45   | 3.60±0.50   |
| Acceptability | 4.26±0.45 | 4.13±0.35   | 4.06±0.88   | 4.00±0.53   | 3.86±0.35   |

### Table 4. Sensory characteristics of chicken nugget fortified with curcuma flour

| Parameter | T0          | T1          | T2          | T3          | T4          |
|-----------|-------------|-------------|-------------|-------------|-------------|
| Color     | 4.47±0.83   | 4.40±0.50   | 4.33±0.48   | 4.13±0.35   | 4.07±0.25   |
| Aroma     | 4.00±0.00b  | 3.80±0.67bc | 3.67±0.39bc | 3.53±0.63b  | 3.33±0.72e  |
| Flavor    | 4.47±0.52a  | 4.20±0.41ab | 3.93±0.79ab | 3.87±0.91a  | 3.73±0.96c  |
| Texture   | 3.40±0.63a  | 3.47±0.91ab | 3.53±0.91ab | 3.60±0.50ab | 4.00±0.00b  |
| Juiciness | 3.07±0.45   | 3.13±0.91   | 3.20±0.86   | 3.27±0.45   | 3.60±0.50   |
| Acceptability | 4.26±0.45 | 4.13±0.35   | 4.06±0.88   | 4.00±0.53   | 3.86±0.35   |

Superscripts letters indicate significant differences among the group in the same row at P<0.05.
4. Conclusion
Increasing the fortification levels of curcuma flour increased the content of curcumin and Vitamin E on chicken nuggets. Sensory characteristics, such as color, juiciness, and acceptability were not influenced by fortification of curcuma flour. This is a good innovation for nugget production with curcuma flour fortification, because with this treatment, the acceptability of chicken nuggets is not changed. Chicken nugget with fortification of curcuma flour at the level of 2.0% showed the best characteristic of chicken nugget.

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