Physical quality of coated and uncoated breadcrumbs of *Moringa oleifera* leaf-fish nugget with various fillers

D P Putri1*, W Setiaboma1, D Kristanti1

1 Research Center for Appropriate Technology, BRIN
KS Tubun Street No. 5 Subang 41213

E-mail: devry26@gmail.com

**Abstract.** Nugget is a restructured meat product made by adding various spices and flour as filling and coating materials. Flour as a filler plays an important role in the physical quality of nuggets. The nuggets are coated with breadcrumbs that have a function to improve appearance and increase acceptability of product. This study aims to determine effect of various fillers on physical properties of coated and uncoated breadcrumbs of Moringa leaf fish nuggets. The factors were different ratio of fillers (comparison of corn starch and sago flour) and breadcrumbs coating (coated and uncoated). Nuggets with 100% wheat flour filler were used as a control. The results showed that the use of sago and corn starch flour as a filler increased the ability of WHC, hardness, gumminess, and chewiness but reduced the cooking loss of nuggets. The used of 100% sago flour was the highest of WHC (139.36%). The coating breadcrumbs had lower WHC (111.87%) ability. The cooking loss value ranged from 8.65–17.66%. The cooking loss was more visible in the samples without breadcrumb coating. The different ratio of filler significantly affected increasing the hardness, the springiness, and the cohesiveness while coated of breadcrumb reduced the hardness.

1. Introduction

Nugget is fried food meat product that is popular frozen food in Indonesia. The nuggets are restructured meat commonly made from chicken meat, but now days the nugget is made by white, red or mix of both them[1]. Now days, consumers concern to healthy food however convenient food is still trended due to busy live style. *Moringa oleifera* leaf contains functional properties that can be applied in food product[2]. The development of nugget with addition moringa leaf have been investigated such as chicken nugget[3], nugget goat meat[4], and giant catfish [5].

Batter of nugget was combination of meat, flour or starch, and seasoning forms. The batter formulation affects to quality of the nuggets. Wheat flour is original flour that used as filler in the batter, but Indonesia must import it. The study of filler no wheat flour or mix flour have been done. Corn starch is local flour that potential applied in restructure meat product. Application of corn starch in restructure product have investigated i.e corn starch of meat patties [6], corn starch as fat replacer in buffalo sausage[7], and various different corn in nugget[8]. Corn starch could act water binding among meat particles even though added corn starch impact on performance texture, appearance and sensory[6,7]. Another local flour that potential as filler is sago flour. Sago flour have been used in restructured product such as sausage[9] and chicken nugget[10].

Generally, nuggets are coated with breadcrumbs/tempura that contained protein and starch which are important components as coating materials. Interaction between both can affect the level of
adhesion of nugget system. The coating commonly used in deep frying product due to increasing appearance and texture, moreover it behavior as barrier resis to loss of moisture[11,12].

The different filler effect on adheres of the batter to breadcrumbs. However, preparation of nugget addition Moringa with different filler (corn starch and sago flour) moreover effect of coated and uncoated breadcrumbs has not been performed. This study aims to determine effect of various fillers on physical properties of coated and uncoated breadcrumbs of Moringa leaf-fish nuggets.

2. Materials and Methods

2.1. Materials

Fresh of giant catfish (*Arius thalassinus*) fillet were purchased from a local farmer from Subang, West Java, Indonesia. The meat pieces were washed and then mashed with meat grinder. The fish was stored in a freezer at -18°C until used. Fresh *Moringa oleifera* leaves were collected from Dawuan District, Subang, West Java Province, Indonesia. Corn starch, sago flour, wheat flour, garlic, onion, shallot, salt, sugar, pepper powder, nutmeg powder, eggs, and breadcrumbs were obtained from market in Subang, West Java, Indonesia.

2.2. Sample preparation

Sample formula is presented in Table 1. Garlic, onion, shallot, ground pepper, nutmeg powder, and salt as a seasoning were pounded using a cobek. Fillet of giant catfish, spices and *M. oleifera* leaves were added to the chopper and mixed. Pour the flour and mixed well. The batter placed on the bowl added the scallion and mixed well. The batter was placed on an aluminum pan and steamed for 30 minutes. The mixture was cooled at room temperature then cut to size 1 x 4 cm. The next process was coated (BC) and uncoated (NBC) nugget. The nugget coated using flour, egg whites, and breadcrumbs. The nuggets were pre frying for 15 second and then kept in the freezer. The factors were different ratio of fillers (comparison of corn starch and sago flour) and breadcrumbs coating (coated and uncoated). Nuggets with 100% wheat flour filler were used as a control.

| Ingredients         | 1   | 2     | 3   | 4   | 5   | 6   |
|---------------------|-----|-------|-----|-----|-----|-----|
| Corn starch         |     |       | 11.25 | 22.5 | 33.75 | 45  |
| Sago flour          | 45  | 33.75 | 22.5 | 11.25 | 45  | 45  |
| Wheat Flour         |     |       |     |     | 45  | 45  |
| Fish                | 100 | 100   | 100 | 100 | 100 | 100 |
| Moringa leaves      | 20  | 20    | 20  | 20  | 20  | 20  |
| Leek                | 15  | 15    | 15  | 15  | 15  | 15  |
| Seasoning           | 44.025 | 44.025 | 44.025 | 44.025 | 44.025 | 44.025 |
| Ice cube            | 10  | 10    | 10  | 10  | 10  | 10  |

2.3. Water Holding Capacity (WHC)[13]

The WHC was measured based on the Excess-Water method with modification. Five grams of sample were weighed into centrifugation tubes and then 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.

2.4. Cooking yield [14]

Fish nuggets (initial weight) are fried at 180±2°C for 5 minutes. The sample was lowered for 1 hour, then weighed (the weight of the frying pan), and the percentage of cooking yield was calculated from the weight with formula (1).

Cooking yield (%) = (frying weight / initial weight) × 100  

(1)
2.5. Texture Profile [15]

The textural properties of nuggets were evaluated using a texture analyzer model TA-XT2 (Stable Microsystems Ltd. Surrey, England, UK). Texture profile analysis 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 (A2/A1, A1 being the total energy required for first compression and A2 the total energy required for the second compression); adhesiveness (Ns) = work necessary to pull the compressing plunger away from sample; gumminess (N/mm²) = 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.

2.6. Statistical analysis

The data analysis in this study are statistically tested using analysis of variance ANOVA using SPSS. If there is a difference, then it uses the Duncan Multiple Range Test at the level of accuracy of 5%.

3. Result and Discussion

3.1. Water holding capacity and cooking loss nugget coated and uncoated with breadcrumb

The WHC analysis showed the ability of the meat protein in the nuggets to bind the added water during the influence of external forces. The ability of WHC of nuggets was influenced by the use of flour as filler. The results of the analysis of WHC and cooking loss of nuggets with coated and uncoated treatments were in Table 2.

|        | F1     | F2     | F3     | F4     | F5     | F6     |
|--------|--------|--------|--------|--------|--------|--------|
| WHC (%)|        |        |        |        |        |        |
| BC     | 111.87 ±2.94A | 120.24 ±3.59A | 120.25 ±2.98B | 109.80 ±0.44A | 101.22 ±6.12A | 81.69 ±1.48A |
| NBC    | 139.36 ±4.47B | 136.33 ±1.53B | 108.72 ±3.07B | 125.14 ±1.94B | 110.63 ±3.67B | 103.59 ±2.19B |
| Cooking loss (%)|        |        |        |        |        |        |
| BC     | 12.93 ±0.23B | 11.21 ±0.55A | 11.12 ±0.70A | 12.48 ±0.70B | 12.71 ±0.58B | 12.95 ±0.77B |
| NBC    | 10.91 ±0.42B | 11.05 ±0.42A | 17.12 ±0.42B | 8.65 ±0.42A | 10.22 ±0.58A | 17.66 ±0.81B |

Values are expressed as mean ± standard deviation. Means in the same column (uppercase letters) and row (lowercase letters) with different letters were significantly different at p < 0.05. F1 = moringa leaf fish nugget with 100% of sago flour as a filler; F2 = moringa leaf fish nugget with 75% of sago flour and 25% of corn starch as a filler; F3 = moringa leaf fish nugget with 50% of sago flour and 50% of corn starch as a filler; F4 = moringa leaf fish nugget with 25% of sago flour and 75% of corn starch as a filler; F5 = moringa leaf fish nugget with 100% of corn starch as a filler; and F6 = moringa leaf fish nugget with 100% of wheat flour as a filler (control).

The results of the analysis showed that the control nuggets had the smallest WHC, which was 81.69% for coated nuggets and 103.59% for uncoated nuggets. The use of sago flour and corn starch produced nuggets with higher WHC than control, namely 101.22%-120.25% on coated nuggets and 108.72-139.36% on uncoated nuggets. The results consistent with previous study which showed that there was no difference in cooking loss and WHC on chicken nuggets made with 4 different types of
fillers, namely sago flour, corn starch, glutinous rice flour and tapioca [16]. Nugget made from sago flour filler has the highest WHC value, which is 139.36% in uncoated breadcrumb nuggets.

In this study, it was suspected that the ability of WHC nuggets was influenced by the type of filler used. Sago flour has starch containing 27% amylose and 73% amylopectin. Corn starch contains 74-76% amylopectin and 24-26% amylose. Sago flour has higher amylose content than corn starch. This causes the interaction between protein from fish and sago starch to produce a matrix that can trap more water, resulting in the highest WHC value [17]. This was supported by [18] which states that corn can be soluble in water but less able to hold water. The water absorption capacity determines the amount of water available for the process gelatinization of starch during cooking. If the amount of water was less than the gel formation does not reach the optimum condition. The water absorption capacity also affects the ease of homogenizing the flour mixture when mixed with water. Flour with high water absorption tends to be homogenized faster. The high amylose content in sago makes the starch not too wet, not too sticky, and easy to absorb water [19]. The high water binding capacity of products containing tapioca flour and sago flour was due to the size of the granules and the very high amylose content because it contains a lot of hydroxyl groups in starch molecules so that it allows more bound water. Fillers can increase water binding capacity because of their ability to hold water during processing and cooking [16].

Breadcrumb dough adhesive provides an excellent barrier to mass transfer from the food matrix. They increase the level of adhesion and yield value, and reduce the frying loss value [6]. However, in this study the coating treatment with breadcrumb didn’t showed a trend towards cooking loss This is presumably due to the less than optimal breadcrumb attachment. So that breadcrumb as a barrier is not optimal. On the other hand, the double frying process causes a decrease in yield and an increase in frying loss due to the decomposition of coating materials and meat. So that there was increasing mass transfer from the nugget to the outside during frying.

3.2. Texture Profile

The results of texture profile analysis of nuggets with coated and uncoated treatments are in Table 3. The results showed that the hardness, gumminess, and chewiness values of control nuggets were 1417.36 (N/cm²) 1043.76 (N/cm²) and 795.79 (Ncm), respectively. This value was significantly smaller than nuggets with corn flour and sago flour fillers.

| Table 3. Texture profile of nuggets with various fillers and breadcrumbs. |
|---------------------------------|------|------|------|------|------|------|------|
|                                | F1   | F2   | F3   | F4   | F5   | F6   |
| Hardness (N/cm²)               |      |      |      |      |      |      |
| BC                             | 2680.51 ± 29.96<sup>A</sup> | 2232.51 ± 80.21<sup>B</sup> | 2304.23 ± 66.50<sup>A</sup> | 2249.50 ± 42.36<sup>B</sup> | 2317.88 ± 138.68<sup>A</sup> | 1417.36 ± 39.93<sup>A</sup> |
| NBC                            | 2917.22 ± 29.32<sup>B</sup> | 3110.81 ± 8.92<sup>B</sup> | 2430.48 ± 15.16<sup>B</sup> | 2533.66 ± 85.52<sup>B</sup> | 2383.32 ± 60.22<sup>A</sup> | 1949.41 ± 58.71<sup>B</sup> |
| Springiness (cm)               |      |      |      |      |      |      |
| BC                             | 0.77 ± 0.05<sup>AB</sup> | 0.81 ± 0.07<sup.AC</sup> | 0.81 ± 0.03<sup>AC</sup> | 0.76 ± 0.04<sup>AC</sup> | 0.78 ± 0.01<sup>AC</sup> | 0.76 ± 0.01<sup>AC</sup> |
| NBC                            | 0.93 ± 0.05<sup>CD</sup> | 0.95 ± 0.01<sup>CD</sup> | 0.88 ± 0.04<sup>CD</sup> | 0.87 ± 0.06<sup>CD</sup> | 0.88 ± 0.05<sup>CD</sup> | 0.92 ± 0.02<sup>CD</sup> |
| Cohesiveness (ratio)           |      |      |      |      |      |      |
| BC                             | 0.74 ± 0.01<sup>AB</sup> | 0.73 ± 0.03<sup>B</sup> | 0.72 ± 0.02<sup>AB</sup> | 0.72 ± 0.02<sup>AB</sup> | 0.72 ± 0.02<sup>B</sup> | 0.74 ± 0.01<sup>AB</sup> |
| NBC                            | 0.77 ± 0.04<sup>AC</sup> | 0.76 ± 0.05<sup>AC</sup> | 0.76 ± 0.04<sup>AC</sup> | 0.73 ± 0.03<sup>AC</sup> | 0.74 ± 0.02<sup>AC</sup> | 0.72 ± 0.03<sup>AC</sup> |
| Gumminess (N/cm²)              |      |      |      |      |      |      |
| BC                             | 1973.68 ± 30.14<sup>A</sup> | 1638.05 ± 68.31<sup>AB</sup> | 1670.44 ± 94.31<sup>AB</sup> | 1629.87 ± 47.97<sup>AB</sup> | 1665.31 ± 119.62<sup>AB</sup> | 1043.76 ± 38.11<sup>AB</sup> |
| NBC                            | 2250.33 ± 111.12<sup>B</sup> | 2377.29 ± 163.89<sup>B</sup> | 1839.02 ± 91.18<sup>B</sup> | 1860.57 ± 141.92<sup>AB</sup> | 1759.07 ± 78.13<sup>AB</sup> | 1397.15 ± 84.54<sup>AB</sup> |
| Chewiness (Ncm)                |      |      |      |      |      |      |
| BC                             | 1527.05 ± 101.32<sup>A</sup> | 1333.95 ± 157.37<sup>B</sup> | 1347.44 ± 92.03<sup>AB</sup> | 1242.90 ± 81.90<sup>B</sup> | 1302.19 ± 114.55<sup>AB</sup> | 795.79 ± 38.18<sup>AB</sup> |
| NBC                            | 2080.42 ± 50.07<sup>B</sup> | 2247.68 ± 177.04<sup>B</sup> | 1621.75 ± 111.40<sup>AB</sup> | 1611.76 ± 164.99<sup>AB</sup> | 1547.23 ± 54.65<sup>AB</sup> | 1282.99 ± 77.46<sup>AB</sup> |
Values are expressed as mean ± standard deviation. Means in the same column (uppercase letters) and row (lowercase letters) with different letters were significantly different at p < 0.05. F1 = moringa leaf fish nugget with 100% of sago flour as filler; F2 = moringa leaf fish nugget with 75% of sago flour and 25% of corn starch as a filler; F3 = moringa leaf fish nugget with 50% of sago flour and 50% of corn starch as a filler; F4 = moringa leaf fish nugget with 25% of sago flour and 75% of corn starch as a filler; F5 = moringa leaf fish nugget with 100% of corn starch as a filler; and F6 = moringa leaf fish nugget with 100% of wheat flour as a filler (control).

Treatment of uncoated breadcrumb on nuggets significantly increased the value of the texture profile which included hardness, springiness, cohesiveness, gumminess, and chewiness. Comparison of filler types significantly affected the texture of nugget. Nugget made with 100% sago flour filler had the hardest texture. The use of a combination of filler between corn starch and sago flour can reduce the hardness of the nugget, even though the resulting nugget texture is not as soft as that made from 100% wheat. The hardness is force that needed to deformation of sample. The gumminess is the density that persists during chewing. The chewiness is energy that needed to chew the sample until ready to swallow. The higher of hardness, gumminess, and chewiness, the harder to bite and chew. The hardness, gumminess, and chewiness of F6 nugget were lower than other, while F1 nugget higher. The hardness, gumminess, and chewiness of Moringa fish nuggets were not significantly different. The hardness, gumminess, and chewiness of F1, F2, F3, F4, and F5 nuggets were higher than F6 nugget. The result indicated that sago and cornstarch caused the harder texture of nugget than wheat flour.

The results were consistent with the previous study results. [20] Devadason et al., 2010 reported that score of gumminess, and chewiness of buffalo meat nuggets with corn starch as filler higher than wheat flour. The use of sago as a filler caused an increase in hardness and elasticity of duck sausages [9]. The non wheat flour as a filler lead an increase in hardness, gumminess, and chewiness of mushroom chicken nuggets due to the lower of amylose content [12]. The amylose content of corn starch and sago are 24-26% and 27%, respectively. The amylose content of corn starch and sago are lower than wheat flour, 38.6% [21].

Springiness is ability of sample to recover its original form after deforming force removed. Cohesiveness is ratio of energy for second and first compression. The springiness and cohesiveness of moringa fish nuggets were not significantly different. The results were similar with the previous study. The use of cornstarch in buffalo meat nuggets and sago in duck sausages did not affect the springiness and cohesiveness [20][9].

The breadcrumbs coating affected the texture profile of moringa leaf fish nuggets. The hardness, springiness, cohesiveness, gumminess, and chewiness of coated moringa leaf fish nuggets were lower than uncoated. [12] Kristanti and Setiaboma (2021) reported similar result, the texture properties of breadcrumbs coated mushroom chicken nuggets were significantly lower than non-coated. The breadcrumbs have been shown to improve the texture profile of nuggets.

4. Conclusion
The use of sago flour and cornstarch as a filler increased the ability of WHC, hardness, gumminess, and chewiness but reduced the cooking loss of nuggets. The coated of breadcrumbs reduced the profile texture of Moringa leaf-fish nugget. Furthermore, it needs to sensory evaluation on Moringa leaf-fish nugget to determine the effect of the filler and physical properties changes on customer acceptance.

Reference
[1] Lukman I, Huda N and Ismail N 2009 Physicochemical and Sensory Properties of Commercial Chicken Nuggets J. Food Ag-Ind 2 171–80
[2] Devisetti R, Srerama Y N and Bhattacharya S 2016 Processing effects on bioactive components and functional properties of moringa leaves: development of a snack and quality evaluation J. Food Sci. Technol. 53 649–57
[3] Madane P, Das A K, Pateiro M, Nanda P K, Bandyopadhyay S, Jagtap P, Barba F J,
Shewalkar A, Maity B and Lorenzo J M 2019 Drumstick (Moringa oleifera) flower as an antioxidant dietary fibre in chicken meat nuggets *Foods* **8** 1–19

[4] Verma A K, Rajkumar V, Kumar M S and Jayant S K 2019 Antioxidative effect of drumstick (Moringa oleifera L.) flower on the quality and stability of goat meat nuggets *Nutr. Food Sci.* **50** 84–95

[5] Solichah E, Iwansyah A C, Pramesh D and Desnilasari D 2021 Evaluation of physicochemical, nutritional, and organoleptic properties of nuggets based on moringa (Moringa oleifera) leaves and giant catfish (Arius thalassinus) *Food Sci. Technol. A head of* **1–6**

[6] Kilincecker O 2018 Effects of different starches on some of the frying and storage properties of meat patties *Adv. Food Sci.* **40** 35–41

[7] Jairath G, Sharma D P, Dabur R S, Singh P K and Bishnoi S 2018 Standardization of corn starch as a fat replacer in buffalo calf meat sausages and its effect on the quality attributes *Indian J. Anim. Res.* **52** 1521–5

[8] Ma’ruf W, Rosyidi D, Radiati L E and Purwadi P 2019 Physical and Organoleptic Properties of Chicken Nugget from Domestic Chicken (Gallus domesticus) Meat with Different Corn Flours as Filler *Res. J. Life Sci.* **6** 162–71

[9] Muthia D, Nurul H and Noryati I 2010 The effects of tapioca, wheat, sago and potato flours on the physicochemical and sensory properties of duck sausage *Int. Food Res. J.* **17** 877–84

[10] Nurlela S, Hastuti H and Suparman S 2018 The Quality of Nugget of Broiler Chicken Meat with Addition of Sago Flour (Metroxylon Sp.) *Chalaza J. Anim. Husb.* **3** 67–72

[11] Sarteshnizi A and Khaneghah M 2015 Mini Review A review on application of hydrocolloids in meat and poultry products *Int. Food Researc J.* **22** 872–87

[12] Kristanti D and Setiaboma W 2021 The colour and texture properties of mushroom chicken nugget with various flour as a filler *IOP Conf. Ser. Earth Environ. Sci.* **672**

[13] Verbeken D, Neirinck N, Van Der Meeren P and Dewettinck K 2005 Influence of κ-carrageenan on the thermal gelation of salt-soluble meat proteins *Meat Sci.* **70** 161–6

[14] Kim H Y, Kim K J, Lee J W, Kim G W, Choe J H, Kim H W, Yoon Y and Kim C J 2015 Quality evaluation of chicken nugget formulated with various contents of chicken skin and wheat fiber mixture *Korean J. Food Sci. Anim. Resour.* **35** 19–26

[15] Mittala G S, Nadulskib R, Barbut’ S and Negi S C 1992 Textural profile analysis test conditions for meat products *vol 25*

[16] Komansilan S 2015 Pengaruh Penggunaan Beberapa Jenis Filler Terhadap Sifat Fisik Chicken Nugget Ayam Petelur Afkir *Zootec* **35** 106

[17] Utami E Y, Rosyidi D and Widyastuti E S 2015 Pengaruh substitusi daging ayam broiler dengan jamur salju (Tremella fuciformis) pada kualitas nugget ayam *J. Ilmu dan Teknol. Has. Ternak* **10** 63–75

[18] Aini N, Wijonarko G and Sustriawan B 2016 SIFAT FISIK, KIMIA, DAN FUNGSIONAL TEPUNG JAGUNG YANG DIPROSES MELALUI FERMENTASI (Physical, Chemical, and Functional Properties of Corn Flour Processed by Fermentation) *J. Agriitech* **36** 160

[19] Patricia Caesy C, Kathleen Sitania C, Gunawan S and Aparamarta H W 2018 Pengolahan Tepung Sagu dengan Fermentasi Aerobik menggunakan Rhizopus sp. *J. Tek. ITS* **7** 7–9
[20] Devadason I P, Anjaneyulu A S R and Babji Y 2010 Effect of different binders on the physico-chemical, textural, histological, and sensory qualities of retort pouched buffalo meat nuggets *J. Food Sci.* **75** 31–5

[21] Blazek J and Copeland L 2008 Pasting and swelling properties of wheat flour and starch in relation to amylose content *Carbohydr. Polym.* **71** 380–7