Food ScienTech Journal Vol. 7 (1) 2025 ISSN : 2685-4279 DOI:10.33512/fsj.v7i1.30982

Effect of Wheat Flour Concentration on Physicochemical and Sensory Properties of Cilembu Yam Chicken Nugget

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Submitted: 20.01.2025; Revised: 05.05.2025; Accepted: 16.05.2025

ABSTRACT

Cilembu yam is a yellow or orange yam that is abundantly available and is still minimally utilized in Indonesia. One alternative to diversify the utilization of cilembu yam is processing it into cilembu yam chicken nuggets. The 50% substitution of chicken meat with cilembu yam produces nuggets with a more attractive colour, and the taste of chicken is still felt, and the sweetness is not prominent. Still, the texture of the nuggets becomes too soft, so wheat flour is added as a filler and binder. The objective of this study was to determine the effect of wheat flour concentration on the physicochemical and sensory characteristics of cilembu yam-chicken nuggets. The research design used a single-factor randomized group design with four replications. The concentration of wheat flour added was 5%, 10%, 15%, 20%, 25%, and 30%. Data were analyzed with Analysis of Variance with α=5% then, followed by Duncan's Multiple Range Test with α=5%. The results showed that as the concentration of wheat flour increased, the water-holding capacity of the nugget batter as well as the hardness and toughness of the fried cilembu yam chicken nugget, increased while the moisture content and juiciness decreased. The preference for bite ability increased to 15% in wheat flour concentration and was not significantly different from 20%. The use of wheat flour concentration up to 20% increased the preference for springiness but decreased the preference for juiciness to an acceptable level.

Keywords: Cilembu yam chicken nugget, wheat flour, physicochemical properties, sensory properties

INTRODUCTION

Cilembu yam is a typical sweet potato of Cilembu Village that is abundantly available, the yearly productivity of cilembu yam in Indonesia reaches 1.914 ton (Fianda, 2023). Cilembu yam have high levels of beta-carotene. The signature of cilembu yam is its yellow or orange-colored flesh and its high sugar content so it is sweeter when compared to other sweet potatoes. The abundant availability of cilembu yam is not supported by maximum utilization. In Indonesia, cilembu yam are generally only processed into steamed or roasted sweet potatoes, making them less attractive. This reason makes cilembu yam an appropriate commodity to be used as a food diversification ingredient in mixed nuggets.

The choice of diversification of cilembu yam utilization into cilembu yam

chicken nugget is based on several factors such as the increasingly dense activities and mobility of the community causing a shift in people's lifestyles to like ready-to-eat and ready-to-cook food. One example of practical food that is a favorite choice of the community is nuggets. Another factor is the shift in people's preferences from local food to modern food from abroad such as nuggets. This opinion aligns with data from the Sekretariat Jenderal Kementerian Pertanian (2022), that there is an increase in nugget consumption from 27.027kg/capita/year in 2018 to 31.532kg/capita/year in 2019.

Nugget is a restructured meat product in which small or irregularly sized meat is reunited into a single unit of larger size in the presence of binders and fillers. Filler is generally a starchy material that can be gelatinized and fill the space between protein threads to support the cohesiveness of the nugget. The binder is usually material rich in proteins that can unite the protein between the small or irregularly sized meat. Nuggets can be made from various types of meat such as beef, and fish, but are generally made from chicken. Until now there have also been many innovations in mixed chicken nuggets such as corn chicken nuggets (Fahrullah et al., 2023), spinach chicken nuggets (Lestari et al., 2023), carrot chicken nuggets, tomato chicken nuggets, and broccoli chicken nuggets (Ariwibowo & Ayuningtyas, 2023).

In making cilembu yam chicken nuggets, chicken meat was substituted with steamed cilembu yam as much as 50%. The substitution of chicken meat with steamed cilembu yam by 50% can support the diversification of cilembu yam utilization more optimally. It can produce nuggets with a yellower and more attractive color, the chicken flavor that is still felt with a sweet taste that does not dominate so it is still acceptable. Unfortunately, the substitution of chicken meat with 50% steamed cielmbu yam and 5% wheat flour produced nuggets with a texture that was too soft. The texture that is too soft indicates a lack of binding or unification between the dominant starch components in cilembu yam and protein in chicken meat, so it requires an additional amount of filler and binder that can bind components between nuggets. According to Hairunnissa et al. (2021), wheat flour was commonly added into nugget formulation to act as a binder and filler.

The wheat flour used is medium protein flour with a protein content of 9-11% and a starch content of 65-70% (Pramono et al., 2020). Wheat contains the main proteins, namely gliadin which causes the dough to become elastic, and glutenin which causes the dough to become stronger. The protein in wheat flour can act as a binder while the starch can act as a filler that gives sturdiness and cohesiveness to the texture of the nuggets.

The concentration of wheat flour to be studied is 5%; 10%; 15%; 20%; 25%; and 30%. The usage of wheat flour of less than 5% produces a nugget texture that is too soft while the addition of wheat flour of more than 30% produces nuggets that are too chewy with a meat percentage of less than 30% so that it cannot be categorized as a processed meat product. Isolated soy protein also needed to be added in all treatments to help shape the texture of the nuggets to remain firm and springy but not chewy. Differences in the amount of wheat flour added can affect the characteristics of cilembu yam chicken nuggets. There is a need to study how the amount of wheat flour addition affects the physicochemical and sensory characteristics of cilembu yam chicken nuggets such as water holding capacity of the nugget batter, moisture content, juiciness, and texture (hardness and toughness), as well as the preference of bite ability, springiness, and juiciness of the nuggets after frying.

The objective of this study was to determine the effect of wheat flour

concentration on the physicochemical and sensory characteristics of cilembu yam-chicken nuggets.

MATERIALS AND METHODS

Tools and Materials

a. Cilembu yam, chicken breast, medium protein wheat flour, isolated soy protein, white pepper, table salt, garlic, bread crumb, tapioca flour, water, and cooking oil are all obtained from local distributors

b. Materials used for the analysis include water and Whatman paper no 40 (GE Healthcare, United Kingdom).

c. The equipment used are digital balance (Denver Instrument XL-3100, Germany), meat chopper and motor (Phillips HR 2071, Netherlands), gas stove (Rinnai RI E522E, Japan), deep fryer (Fritel Professional FT5371, Belgium), freezer (GEA AB-318R, Germany), 100mL and 5 mL measuring cup (Pyrex, America), steamer (diameter 42 cm), aluminum baking pan (size 20 x 20 x 1 cm), thermometer, spoon, knife, mortar, sieve, cutting board, plate, brush, ruler, and gloves.

d. Equipment for the analysis are centrifuge (Hettich EBA 200, Germany), vortex (Barnstead Thermolyte Maxi Mix II, America), oven (Memmert ULE 400, Germany), pH meter (Ohaus AV33PH-F, America), analytical balance (Ohaus PX244E, America), Texture Analyzer (Stable Micro System TA-XT Plus, United Kingdom), 250 mL beaker glass (Pyrex, America), 15 mL centrifuge tube, dropper pipette, weighing bottle, spoon, exiccator, questionnaire, and tray.

Cilembu Yam Chicken Nugget Making Process

Cilembu yam were first washed, then cut into uniform thicknesses of 2 cm and steamed at a water vapor temperature of 80±1°C for 15 minutes. The cilembu yam was then peeled off the skin, crushed and strained using a sieve to remove the fibrous part of the yam. The chicken breast was washed and cut into 2 x 2 x 2 cm pieces. Cilembu yam were then mixed with chicken breast, cold water, flour, isolated soy protein, white pepper, salt & garlic to be grinded for 25 seconds. Nugget batter was then molded in a 20 x 20 x 1 cm pan and steamed at 80±1°C for 30 minutes. The nuggets were then cooled at room temperature for 15 minutes and cut into 4 x 2 x 1 cm pieces then coated with batter mix and bread crumbs. The coated nuggets were then pre-fried at 170°C for 30 seconds and vacuum-packed. The packaged nuggets were then stored at -18°C for 15 hours and fried at 170°C for 2 minutes 30 seconds to be used for the test.

Water Holding Capacity (WHC)

1 gram of nugget batter was added with 9 grams of water and was vortexed for 15 seconds. The sample was incubated at room temperature for 10 minutes and then centrifuged at 3000 rpm for 20 minutes. The supernatant is then separated and weighed.

$$\text{WHC (\%)} = \frac{initial\ water\ (g) - final\ water\ (g)}{sample\ weight\ (g)} \times 100\%$$

Moisture Content

Moisture content analysis is carried out using the thermogravimetric method where 1 gram of the fried nugget sample was mashed and put into a weighing bottle with a known constant weight. The sample was then heated in an oven (105°C) until a constant weight was reached.

$$\text{Water Content (\%)} = \frac{Initial\ sample\ weight\ (g) - constant\ sample\ weight\ (g)}{sample\ weight\ (g)} \times 100\%$$

Juiciness

Separate the fried nugget from the coating layer and weigh the sample. Place the sample between constant Whatman paper and press using a texture analyzer with a 75 mm cylindrical probe and a force of 10 grams. Weigh Whatman paper then heat Whatman

paper in the oven (105°C, 15 minutes). Then, weigh Whatman paper after heating.

$$\text{Juiciness (\%)} = \frac{\text{paper weight after pressing–heating (g)}}{\text{sample weight (g)}} \times 100\%$$

Texture

Install the 2 mm cylindrical probe, place a 4 × 2 × 1 cm of fried nugget sample on the texture analyzer table, and select the chicken nugget program. Click calibrate height with turning distance: 15 mm, turning speed: 20 mm/sec, contact force: 10 g. Fill in the TA settings with the pre-test speed setting: 1.00 mm/sec, test speed: 3.00 mm/sec, post-test speed: 10.00 mm/sec, target mode: 70% strain, trigger type: Automatic (forced), trigger force: 10 g, pause mode: off, stop plot at: Home position, tare mode: Automatic, advanced options: On, Graph Preferences: y=force (g) & x=time (sec).

Sensory Evaluation

The sensory evaluation (hedonic preference test) was done by 60 untrained panels. The parameters analyzed using the sensory evaluation include bite ability, springiness, and juiciness. The analysis was conducted by serving six samples of cilembu yam chicken nuggets 10 minutes after frying with a random three-number code. The test was carried out with a scoring method with a numerical scale starting from 1 to 7 with the following conditions:

1 = Strongly dislike
2 = Dislike
3 = Somewhat dislike
4 = Neutral
5 = Somewhat like
6 = Like
7 = Really like

Statistical analysis

The experimental design used was a randomized group design with one factor, wheat flour concentration. The wheat flour concentration consisted of six levels (5%, 10%, 15%, 20%, 25%, and 30%), each level was repeated four times. In each replication, samples will be taken randomly to be tested. The data were analyzed with Analysis of Variance (ANOVA) with α = 5% and followed by the Duncan Multiple Range Test (DMRT) with α = 5%.

RESULTS AND DISCUSSION

Water Holding Capacity (WHC)

Water Holding Capacity (WHC) of meat is the ability of meat to hold water from within and water added during external pressure (Szmańko et al., 2021). The WHC of nugget batter is an indicator of the possible amount of water that can be held during processing. The WHC of cilembu yam chicken nugget dough with the addition of various wheat flour concentrations ranged from 30.16% to 52.72%.

Figure 1. shows that an increase in wheat flour concentration causes an increase in the WHC of the nugget batter. This is because wheat flour contains as much as 65-70% starch and 9-11% protein so increasing the amount of wheat flour will increase the amount of starch and protein in the dough. During milling, wheat protein will bind water by forming hydrogen bonds and forming a gluten protein matrix while wheat starch will trap water even in limited amounts. Therefore, an increase in the amount of starch and protein from the wheat flour led to more water being retained by the dough. The results in this study align with Soegijono (2019), where increasing the concentration of wheat flour in young jackfruit chicken nugget batter results in higher WHC of the nugget batter.

A low WHC is not desirable because it indicates that less water can be retained during processing, which can cause cooking loss and high nutritional loss (Warner, 2023). Cilembu yam chicken nuggets have a higher WHC than chicken nuggets with plantain banana peel flour. The WHC of chicken nuggets with plantain banana peel flour ranged from 26.2-32.8% (Kasumi et al., 2023).

Lower WHC of plantain banana peel flour chicken nugget may be due to the lower protein content in banana peel flour than in wheat flour. The protein content of plantain banana peel flour only reached 0.32% (Kasumi et al., 2023) while the protein content of medium protein flour reached 9-11% (Punia et al., 2019). WHC of food is influenced by its protein content since protein has a high water-binding ability. This theory is in line with the opinion of Teruel et al. (2015) that the protein content in food ingredients will affect the ability of food ingredients to bind water.

According to Lukman et al. (2019), commercial chicken nuggets have a water holding capacity ranging from 34.54-51.57%. Therefore, the use of wheat flour in mixed chicken nuggets such as cilembu yam chicken nuggets is more capable of producing nuggets with a high WHC, closer to the WHC of commercial chicken nuggets.

Moisture Content

In the moisture content analysis, the sample is heated until it reaches a constant weight that assumes all the free water and weakly bound water have evaporated. Figure 2. shows that increasing the concentration of wheat flour resulted in a decrease in the water content of fried cilembu yam chicken nuggets. This is due to an increase in starch and protein caused by an increase in wheat flour concentration.

Steaming leads to protein gelation and starch gelatinization forming a starch-protein gel matrix that can bind and trap water, thereby reducing the amount of free water and weakly bound water. Heating leads to protein denaturation where its structure becomes more open. Protein denaturation is then followed by a dissociation stage where the hydrophobic and sulfhydryl groups of the protein will be located on the outside while the hydrophilic groups that bind water are on the inside. The sulfhydryl groups on the protein then form disulfide cross-links with other sulfhydryl groups and form a gel system so that water bound by hydrophilic groups will be trapped in the gel (Wang et al., 2025).

Steaming also causes starch to gelatinize. According to Li et al. (2022) and Arruda et al. (2025), heating can break the hydrogen bonds connecting amylose and amylopectin so that the amylose in starch begins to diffuse out of the granules and free water with large kinetic energy will enter the starch granules and form hydrogen bonds with hydroxyl groups of amylopectin and amylose so that the amount of free water decreases and the starch granules swell. The hydroxyl groups in starch are then able to form hydrogen bonds with amine groups in proteins to form a starch-protein gel matrix (Brigita, 2021). Water trapped in the starch-protein gel matrix will be difficult to release.

Moisture content is also influenced by the presence of starch in cilembu yam. The incompletely gelatinized starch in steamed cilembu yam (Figure 3.) plays a role in retaining water during steaming. The results of this study are in line with the research of Soegijono (2019) where the moisture content of young jackfruit chicken nuggets decreased with increasing concentration of wheat flour added.

Cilembu yam chicken nuggets have a lower moisture content compared to those made with sago flour. The moisture content of nuggets containing sago flour can reach up to 60.35% (Talebe et al., 2020). This is due to

the lower protein content in sago flour compared to wheat flour. Higher protein levels contribute to stronger gel formation, which effectively binds water, thereby reducing the amount of free and loosely bound water.

Ideally, the moisture content of chicken nuggets should be balanced, not too high or too low. According to the Indonesian National Standard (BSN, 2002), the maximum allowable moisture content is 60%. Excessively high moisture content indicates a greater presence of free water, which can promote microbial growth and shorten shelf life (Tarlak, 2023). On the other hand, moisture content that is too low is also undesirable, as it leads to a loss of juiciness due to less releasable water during chewing.

Therefore, the use of wheat flour in cilembu yam chicken nuggets is more capable of producing nuggets that are under the maximum standard moisture content of chicken nuggets and are close to the moisture content of commercial chicken nuggets, which is 34.71-56.51% (Husain & Huda-Faujan, 2020).

Juiciness

Juiciness is the degree of liquid released during mastication (Rudge et al., 2025). The analyzed samples were separated from the coating layer before being used. The juiciness of cilembu yam chicken nuggets with the addition of various concentrations of wheat flour ranged from 0.89% to 1.62%. Figure 4. shows that an increase in wheat flour concentration resulted in a decrease in the juiciness of fried cilembu yam chicken nuggets.

An increase in wheat flour concentration causes more starch-protein gel matrix causing the amount of free water and weakly bound water to decrease. Water that is bound and trapped in the starch-protein gel matrix is also difficult to release by mechanical pressure applied by the cylindrical probe in the juiciness test. These results are in line with Jamaly et al. (2017), where beef meatballs with more wheat flour addition have a lower juiciness value.

Hardness

Hardness is the maximum force required for the material to deform (Nwosisi et al., 2019). A higher hardness value marked by a higher peak on the texture analyzer graph indicates that a greater force is needed to press the product until it reaches deformation. The hardness of cilembu yam chicken nuggets ranged from 103.33 g to 181.67 g.

Figure 5. shows that increasing the concentration of wheat flour resulted in an increase in the hardness of fried cilembu yam chicken nuggets. An increase in wheat flour concentration causes an increase in starch and protein content so that more starch-protein gel matrix is formed. The more starch-protein gel matrix formed, the tighter the nugget structure. Therefore, a greater force is needed to deform the nuggets. The results of this study are in line with Soegijono (2019), increasing the concentration of wheat flour increased the hardness value of young jackfruit chicken nuggets.

Cilembu yam chicken nuggets have a lower hardness compared to commercial chicken nuggets, which typically range from 333.6 to 745 g in firmness (Utomo et al., 2024). This reduced hardness is primarily due to the lower protein content in Cilembu yam nuggets, as 50% of the chicken meat is replaced with Cilembu sweet potato, a starch-rich ingredient. While both protein and starch can form gel matrices, their gel properties differ significantly.

Protein gels often exhibit stronger networks due to their ability to form more interactions, while starch gels are less firm due to their structure and the type of interactions they can form. in the process of starch gelatinization, amylose will form

hydrogen bonds between constituent glucose molecules to form a three-dimensional network. According to Tolano-Villaverde et al. (2015), in protein gelation, more bonds are formed such as disulfide bonds, hydrogen bonds, hydrophobic interactions, and electrostatic interactions so protein gels are more robust than starch gels.

The hardness of Cilembu yam chicken nuggets is also lower than that of chicken nuggets made with beneng taro flour, which has a hardness between 395 and 756 g (Utomo et al., 2024). This difference arises because beneng taro flour nuggets, although using flour with lower protein content than wheat, are still made entirely from chicken meat, maintaining a higher overall protein level and thus a firmer texture.

Toughness

The toughness value is the mechanical energy required to break the bond between components and cause fracture, calculated from the area under the curve (Peleg, 2019). Based on the analysis, the toughness of cilembu yam chicken nuggets with various wheat flour concentrations ranged from 142.50 g.sec to 238.34 g.sec. Figure 6. shows that an increase in wheat flour concentration increased the toughness of fried cilembu yam chicken nuggets. This is due to the more starch-protein gel matrix formed along with the increase in wheat flour concentration. The more starch-protein gel matrix that is formed, the more bonds between components so that toughness increases.

The increase in toughness along with the increase in wheat flour concentration is more due to the increasing amount of starch and protein rather than the higher level of gelatinization and gelation. This opinion is supported by the results of texture testing with a texture analyzer presented in Figure 7. and Figure 8. After the nuggets with 5% wheat flour reached the maximum force, the decrease in the amount of resistance force occurred more slowly than the nuggets with 30% wheat flour. At lower wheat flour concentrations with the same amount of water, the level of starch gelatinization and protein gelation is higher than at high wheat flour concentrations. Higher levels of starch gelatinization and protein gelation facilitate the formation of strong inter-component bonds.

Sensory Evaluation on Bite Ability

The sensory evaluation on bite ability was assessed the first time the panelists bit into the cilembu yam chicken nuggets. Based on the results of the study, it is known that the average likeness score on bite ability of cilembu yam chicken nuggets ranges from 4.77 (neutral) to 6.05 (like). Figure 9. shows that the likeness score on bite ability increased up to 15-20% wheat flour concentration.

An increase in wheat flour concentration causes an increase in the amount of starch and protein capable of forming a starch-protein gel matrix. The use of wheat flour with concentrations up to 15-20% produces nuggets that are compact but still easy to bite. The use of wheat flour concentration less than 15% produces nuggets that are too soft while wheat flour concentration above 20% produces nuggets with a texture that is too hard due to the increasingly dense starch-protein gel matrix formed, making it difficult to bite.

Sensory Evaluation on Springiness

The sensory evaluation on springiness was assessed after panelists chewed the nugget samples twice. Based on the results of the study, it was found that the average likeness score of springiness of cilembu yam chicken nuggets ranged from 4.12 (neutral) to 6.18 (like). Figure 10 shows that the likeness score of the springiness increased up to 20% wheat flour

concentration. An increase in wheat concentration causes an increase in the amount of starch-protein gel matrix. The use of less than 20% wheat flour concentration resulted in less springy nuggets while the use of wheat flour more than 20% resulted in nuggets with too springy texture.

The likeness score on springiness of cilembu yam chicken nuggets with wheat flour is higher than chicken nuggets with plantain banana peel flour which only ranges from 3.03-4 (Kasumi et al., 2023). Nuggets that are generally preferred are nuggets with a medium level of springiness. The lower likeness score on springiness in banana peel flour nuggets may indicate that the springiness of the nugget needs to be improved. This is because banana peel flour lacks gliadin and glutenin, the key proteins found only in wheat flour. In wheat flour, gliadin makes up about 30% and glutenin about 50% of the protein content (Urade et al., 2018). When hydrated and kneaded, these proteins interact to form a gluten network, which gives the dough its elastic and springy texture (Ma et al., 2019).

In addition, Cilembu yam chicken nuggets have a higher starch content compared to those made with plantain banana peel flour, as part of the chicken meat is replaced with Cilembu yam. Cilembu yam is rich in carbohydrates, with starch being its main component. According to Jiang et al. (2024), high starch, especially amylopectin, causes an increase in product springiness.

Sensory Evaluation on Juiciness

Juiciness is an impression of moisture that appears when the product is chewed (Zhang, 2024). The sensory evaluation on juiciness was assessed after panelists chewed the nugget samples twice. Based on the results of the study, it was found that the average likeness score of fried cilembu yam chicken nuggets' juiciness ranged from 3.33 (somewhat dislike) to 6.22 (like). Figure 11 shows that an increase in wheat flour concentration resulted in a decrease in the likeness score of the juiciness.

An increase in wheat flour concentration causes an increase in the amount of starch-protein gel matrix so that the amount of weakly bound water and free water decreases according to the results of the water content and juiciness. Panelists liked the cilembu yam chicken nuggets with 5% wheat flour concentration the most with an average score of 6.22 because it produces the highest juiciness value so that more free water can be released during chewing, causing a more juicy impression. Nuggets with high juiciness are easier to swallow so the panelists liked it more. The use of more than 5% wheat flour concentration resulted in drier nuggets.

The likeness score on the juiciness of cilembu yam chicken nuggets is higher than that of young jackfruit chicken nuggets which only ranges from 3.67-5.41 (Soegijono, 2019). Consumers tend to prefer juicy nuggets. The higher likeness score on the juiciness of Cilembu yam chicken nuggets is due to the higher amount of fiber present in young jackfruit than cilembu yam. Young jackfruit contains about 10.43% fiber (Soegijono, 2019), while Cilembu yam contains only 3.4% (Direktorat Jenderal Kesehatan Masyarakat, 2018). Fiber is unable to form a gel so the water bound by the fiber is easily released when there is mechanical pressure or heating so the water in young jackfruit chicken nuggets is more easily lost during processing such as frying and causes it to be less juicy. According to Putri et al. (2021), water bound by fiber is water that is only physically bound.

CONCLUSION

Different concentrations of wheat flour significantly affect the physicochemical characteristics, including the water-holding

capacity of cilembu yam chicken nugget batter, as well as the water content, texture (hardness and toughness), juiciness, and sensory characteristics (bite ability, springiness, and juiciness) of fried cilembu yam chicken nuggets. The water-holding capacity of the nugget batter, as well as the hardness and toughness of the fried cilembu yam chicken nuggets, increased as the concentration of wheat flour increased. Moisture content, juiciness, and sensory evaluation score on the juiciness of fried cilembu yam chicken nuggets decreased as the concentration of wheat flour increased. The sensory evaluation score for bite ability increased to 15-20% wheat flour concentration and decreased from 25% to 30% wheat flour concentration. The sensory evaluation score for springiness increased up to 20% wheat flour concentration and decreased starting from 25-30% wheat flour concentration.

ACKNOWLEDGEMENT

The research was funded by Widya Mandala Catholic University Surabaya through "Penelitian Dana Fakultas Tahun 2024" with contract number 309A/WM01.5/N/2024.

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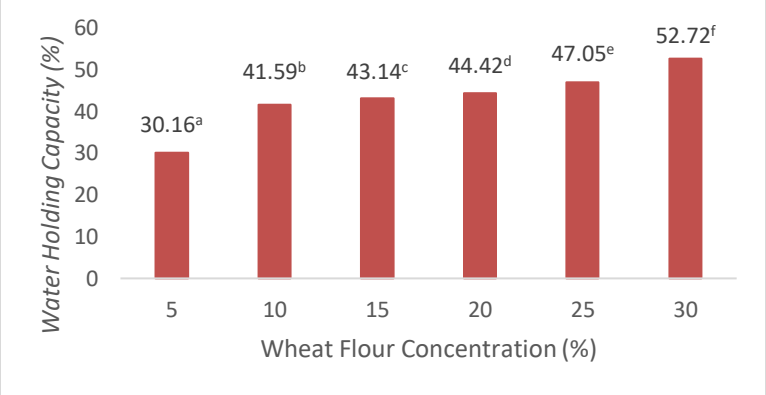
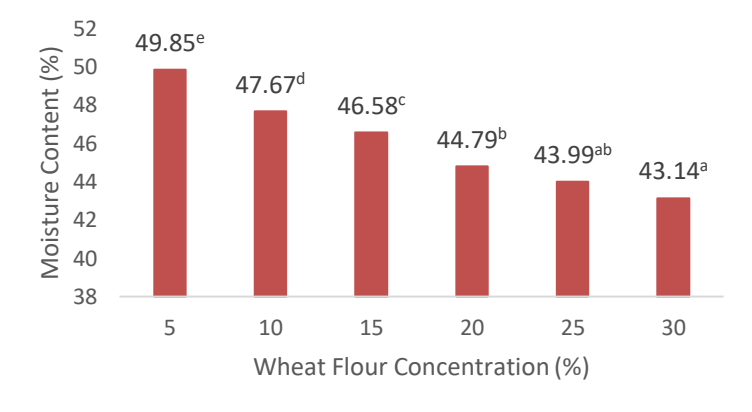


Note: Value with different notation has a significant differences at 5% (DMRT test)

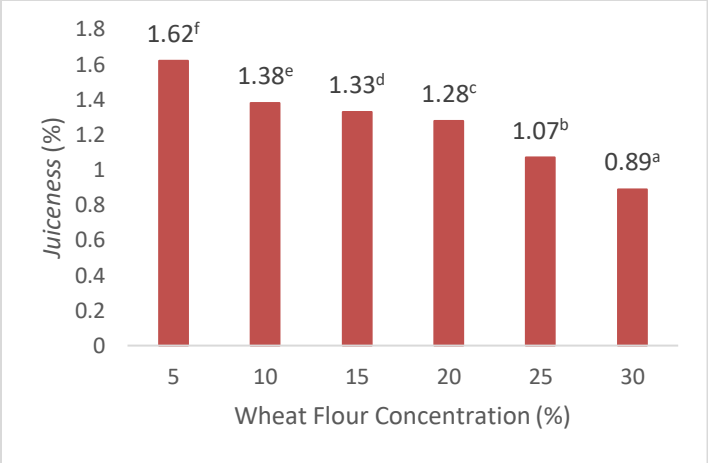
Figure 1. Water Holding Capacity of Cilembu yam Chicken Nugget Dough with Various Wheat Concentration



Note: Value with different notation has a significant differences at 5% (DMRT test)

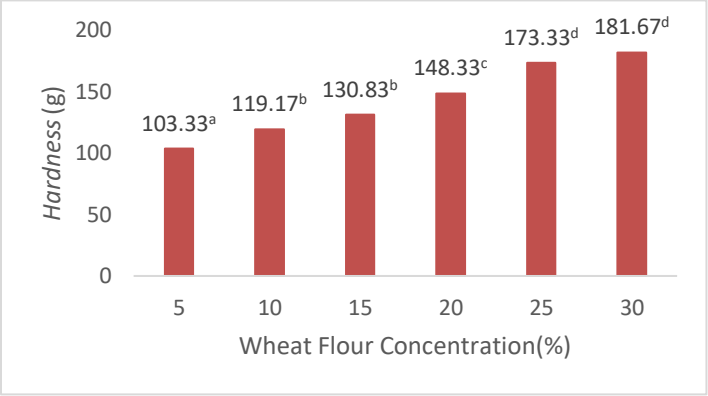
Figure 2. Moisture Content of Cilembu yam Chicken Nugget with Various Wheat Concentration

Figure 3. Partially Gelatinized Steamed Cilembu yam



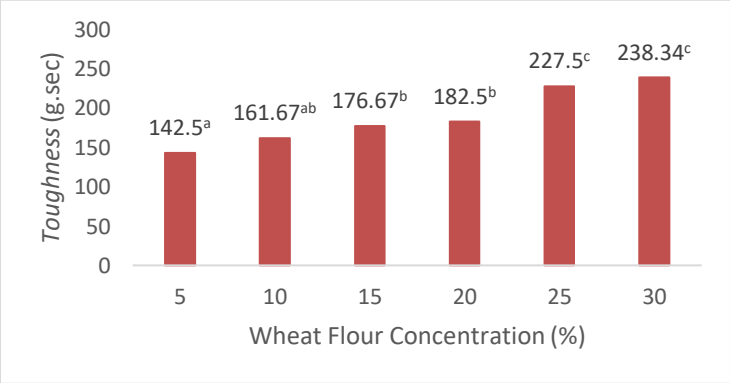
Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 4. Juiciness of Cilembu yam Chicken Nugget with Various Wheat Concentration



Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 5. Hardness of Cilembu yam Chicken Nugget with Various Wheat Concentration



Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 6. Toughness of Cilembu yam Chicken Nugget with Various Wheat Concentration

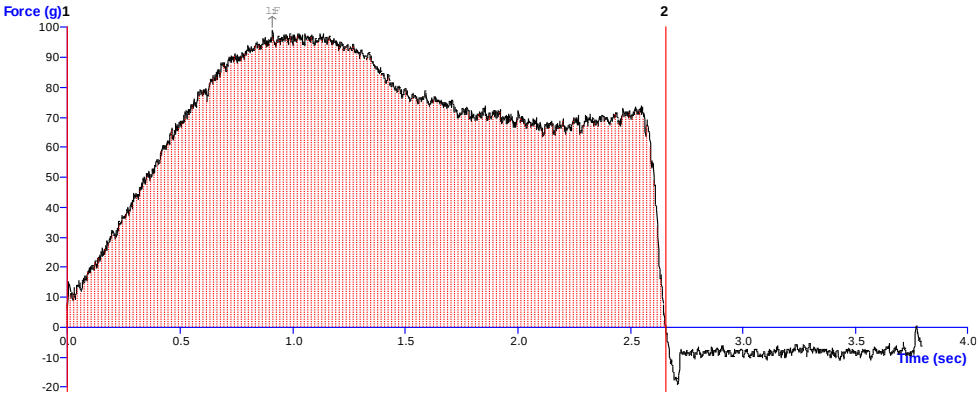


Figure 7. Graph of Texture on Cilembu yam Chicken Nugget with 5% Wheat Concentration

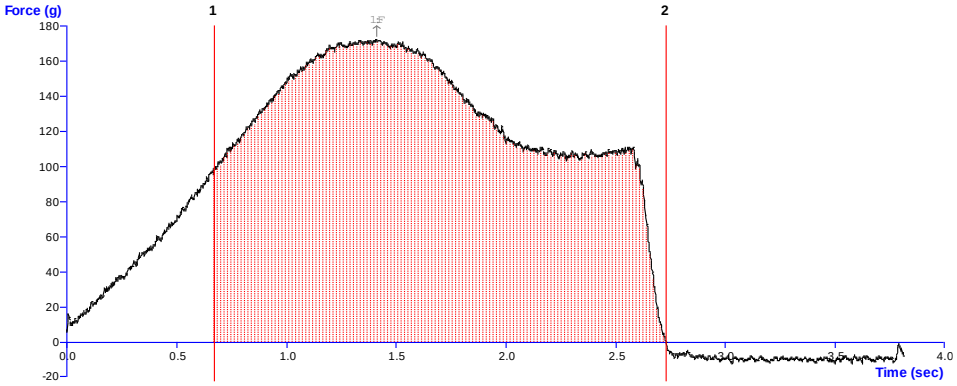
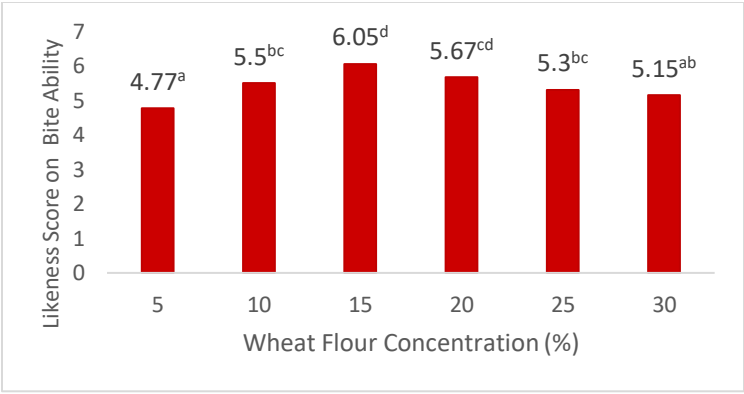
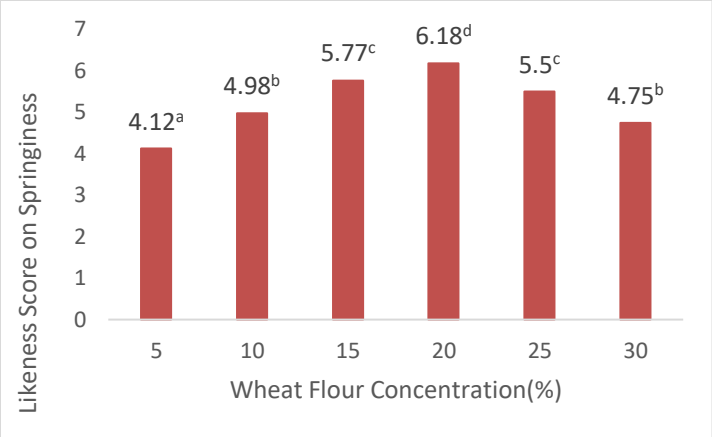


Figure 8. Graph of Texture on Cilembu yam Chicken Nugget with 30% Wheat Concentration



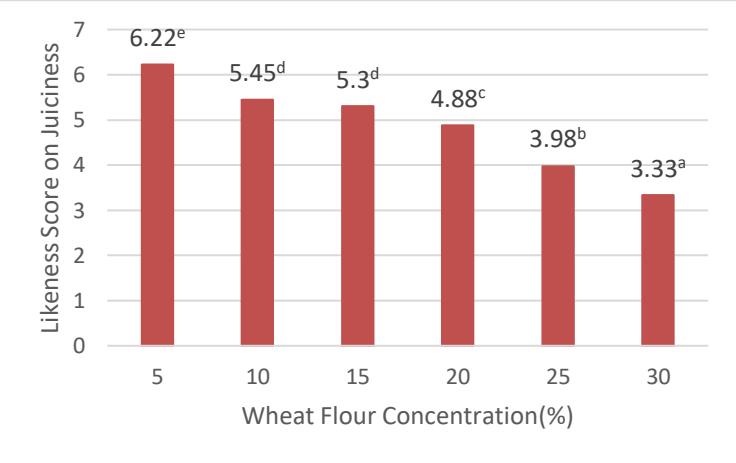
Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 9. Sensory Evaluation on Bite Ability of Cilembu yam Chicken Nugget with Various Wheat Concentration



Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 10. Sensory Evaluation on Springiness of Cilembu yam Chicken Nugget with Various Wheat Concentration



Note: Value with different notation has a significant differences at 5% (DMRT test)

Figure 11. Sensory Evaluation on Juiciness of Cilembu yam Chicken Nugget with Various Wheat Concentration