

## Characteristic of Chicken Liver Nuggets Using Different Types of Flour as Fillers

**Dedes Amertaningtyas**

Department of Animal Science, Faculty of Animal Science, Brawijaya University

**Januar Fajrul Ramadhan**

Department of Animal Science, Faculty of Animal Science, Brawijaya University

**Herly Evanuarini**

Department of Animal Science, Faculty of Animal Science, Brawijaya University

**Ria Dewi Andriani**

Department of Animal Science, Faculty of Animal Science, Brawijaya University

Address: Jl. Veteran, Lowokwaru, Malang 65145, East Java, Indonesia

Corresponding author: [dedesfptub@ub.ac.id](mailto:dedesfptub@ub.ac.id)

**Abstract.** *Chicken liver is rich in protein and iron, which can help prevent anemia and stunting. One innovation is processing chicken liver into nuggets, a popular ready-to-eat food product. This study aims to explore the effects of various flours (cornstarch, soybean, pumpkin, and carrot) on the characteristics of chicken liver nuggets, including yield, texture, water activity, moisture content, and color. By utilizing nutrient-dense flours, it is hoped that chicken liver nuggets can become more nutritious, healthier, and meet quality standards, while also holding the potential for commercialization on both household and large-scale industries, supporting community food security. This research employed a Completely Randomized Design (CRD) with four treatments and three replications. The tested variables included yield, water activity (Aw), water content, texture, and color. The analysis results indicated that the treatments had a highly significant effect ( $P > 0.1$ ) on yield and color, a significant effect on moisture content, and no significant effect on texture and water activity. The findings revealed that chicken liver nuggets had average yield values of 96.38%-103.27%, texture of 4.094 N-5.236 N, Aw of 0.857-0.870, moisture content of 33.70%-42.04%, and color values of  $L^*$  (lightness) 36.90-43.27,  $a^*$  (redness) 12.67-16.77, and  $b^*$  (yellowness) 19.17-22.23. This study demonstrates that the use of cornstarch, soybean, pumpkin, and carrot flours can improve the quality of chicken liver nuggets, making them suitable for consumption as a menu variation with quality that complies with the Indonesian National Standard (SNI) for chicken nuggets with additives.*

**Keywords:** *Carrot flour, Chicken liver, Cornstrach, Nugget, Soybean flour, Pumpkin flour*

## INTRODUCTION

A healthy and nutritious diet significantly influences both short and long term health. Beyond fulfilling nutritional needs, food should also be economical, easy to prepare, and long lasting. One of nutritious food source is livestock products, which play a crucial role in agricultural sustainability, especially in developing countries. Livestock products include primary outputs such as meat, milk, and eggs, as well as by-products like liver, gizzard and intestines. Although often considered of low economic value, these by-products have the potential to be processed into value added food. One example is chicken liver, commonly used in traditional Indonesian cuisine (Harsita et al., 2022). Chicken liver is a rich source of nutrients, particularly in iron content. According to research, chicken liver contains approximately 8.99 mg of iron per 100 gram, which is more easily absorbed by the body due to its lower content of mineral binding compounds (Santosa et al., 2016). Additionally, chicken liver has a significant protein content of about 19.7%, which plays a crucial role in growth and tissue repair. The fat content in chicken liver is relatively low, around 3.2%, making it a good option for low fat diets (Purwadhani et al., 2024). According to BSN SNI 6683 (2014), chicken nugget products with combinations must contain a minimum of 9% protein and a maximum of 20% fat.

Nuggets are typically made from meat with the addition of supporting ingredients. The utilization of chicken liver as an alternative raw materials is very popular due to its high nutritional content, especially its protein and iron levels which surpass other animal protein sources (Fauziah et al., 2019). One approach is processing chicken liver into nuggets using various types of flour. As by-product of poultry processing, chicken liver can be processed into nuggets, a popular ready-to-eat frozen food (Aisyah et al., 2024). Research of various flour in the making of chicken liver nuggets is important to understand their effect on characteristics such as yield, texture, water activity, water content and color. According to Permatasari et al., (2020), 100 grams of chicken liver contains 27.4 grams of protein and 15.8 miligram of iron. Although chicken liver can be served as animal-based food source, it requires processing technologies that appeal to consumers (Syahadah, 2016). Currently, the processing of chicken liver remains limited, and its cholesterol and purine content (345 mg of cholesterol and 312.2 mg of purine every 100 g chicken liver) must be considered as it may increase uric acid levels in the blood (Sadiyah et al., 2022). By processing chicken liver to nuggets, the value can be

elevated. Moreover, practicality and availability of fast food make the production of chicken liver nuggets with various flour (corn, soy bean, pumpkin and carrot) highly relevant (Susanti et al., 2021).

The use of various types of flour as fillers in nugget production plays a significant role in improving the physical, chemical, and organoleptic characteristics of the final product. Cornstarch, for example, can enhance the chewiness and improve the texture of the nuggets due to its high starch content and excellent gelatinization properties (Ratnasari et al., 2021). Soy flour, according to Ratulangi et al., (2018), serves as a source of plant based protein that can increase the protein content in nuggets while also improving water and fat binding capacity, resulting in a denser texture that is less likely to crumble. Furthermore, substituting fillers with pumpkin flour in the production of spent layer chicken nuggets can decrease water content and impart a natural orange color to the product. A study by Syafie & Djumadil (2023) found that the use of pumpkin flour as a filler enhances water binding capacity and significantly influences organoleptic characteristics such as color, taste, texture, aroma, and appearance of the nuggets. Then, the addition of carrot flour contributes to increasing the fiber and  $\beta$ -carotene content in nuggets. A study by Paldiari & Rahmayuni (2023) showed that the incorporation of carrot flour in the production of mackerel nuggets resulted in mackerel nuggets with higher protein and crude fiber content.

The right formulation in selecting the best ingredients can produce nutritious, efficient, and high value chicken liver nuggets. This product has potential to compete in market, both at the household level and large scale industries, as a healthy, nutrient rich and meets the standard quality of nuggets. Creative and innovative formulation of chicken liver nuggets is expected to replace the use of wheat flour with nutrient rich ingredients while maintaining quality that appeals to consumers.

## **LITERATURE REVIEW**

Nuggets are one of the ready to eat frozen processed products made through a grinding process, seasoned, and mixed with binding agents before being shaped as desired and coated with breadcrumbs (Hetikisworotringtyas and Runik, 2019). The nugget-making process requires emulsifying agents to maintain dough stability, as these emulsifiers function as binders for fat and water within an emulsion system. One of the ingredients used in nugget production is flour. Amertaningtyas et al., (2022) explained

that nuggets are processed products made using reconstructed meat technology, which utilizes relatively small and irregular meat pieces, then reassembles them into a larger size with the help of fillers and binders. The nugget making process requires several ingredients, one of which is a binding agent. According to Safitri and Aggrayni (2019), the addition of binding agents not only functions to retain water within the meat but also helps enhance color, create a firm texture in the meat, and reduce shrinkage during cooking. Amertaningtyas et al., (2021) stated that the formulation of additional ingredients for making chicken liver nuggets includes 1 kg of steamed chicken liver, with other ingredients used based on a percentage of the liver's weight, namely 20% tapioca flour, 15% salt, 15% garlic, 3% ground pepper, 10% chicken eggs, and 2% water.

Chicken liver is highly nutritious food that serves as a valuable source of essential nutrients, particularly high quality protein, vitamin A, iron and fat. According to previous studies, chicken liver contains a significant amount of vitamin A, which plays a crucial role in maintaining vision, immune function, and cellular growth (Amertaningtyas et al., 2021). Additionally, chicken liver is rich in B complex vitamins, including vitamin B12, folic acid, and riboflavin, which are essential for energy metabolism and red blood cell production. However, despite its nutritional benefits, chicken liver also contains a relatively high amount of cholesterol, which may pose health concerns for certain populations, such as individuals with cardiovascular diseases (Amertaningtyas et al., 2022). To optimize its nutritional value while minimizing potential drawbacks, the incorporation of various flour types as functional ingredients in nugget formulations has been explored.

The selection of flour as an additional ingredient in the making of chicken liver nuggets significantly influences their nutritional composition, textural properties, and overall acceptability. The following subsections outline the characteristics of different types of flour used in nugget production. Cornstarch is a product derived from post-harvest corn processing. It consists of two fractions that can be separated in hot water: the soluble fraction, known as amylose, and the insoluble fraction, known as amylopectin (Apriliani et al., 2019). It contains 24-26% amylose and 76% amylopectin (Safitri et al., 2021). Therefore, cornstarch can be used as an alternative binding agent to replace wheat flour. Soybean flour is a plant-based protein source that is rich in protein content. According to Lestari et al. (2018), soybean flour contains 34.9% protein, and its high

protein content significantly influences the final product. Based on Mahmud et al., (2018), the nutritional composition of 100 g of soybeans consists of 9 g of water, 35.9 g of protein, 5.8 g of fiber, 20.6 g of fat, and 29.9 g of carbohydrates. Given this potential, soybean flour can be used to enhance the protein and fiber content in nugget production. Pumpkin flour is a product made from drying and grinding cooked or pre-processed pumpkin flesh. The use of pumpkin flour in nugget production can influence the flavor of the nuggets, thereby increasing consumer preference. According to Alza et al., (2023), pumpkin flour contains 6.39% moisture, 16.19% protein, 0.63% fat, and 63.59% carbohydrates. Carrot flour is a product made by drying and grinding fresh carrots into a fine powder. Carrots have a relatively high moisture content, approximately 89.9%, which makes them highly perishable and prone to quality deterioration (Kementerian Kesehatan, 2021). To address this issue, various carrot-based processed products, such as carrot flour, have been developed. The utilization of carrots in the form of carrot flour aims to extend their shelf life and facilitate processing (Arza and Tirtavani, 2017).

## RESEARCH METHODS

This research was conducted over a month in Livestock Product Technology Laboratorium, Animal Science Faculty, Brawijaya University for the production of nuggets and testing of yield, texture, water activity, water content and color.

### Materials

The main materials used in this research include fresh chicken liver, tapioca flour, cornstarch, soybean flour, pumpkin flour and carrot flour. Supporting ingredients are garlic, salt, white pepper, eggs, breadcrumps and cooking oil. The equipment utilized include digital scale (Ohaus), knife, chopper, steamer, molds, stove and othe frying tools. The formulation of chicken liver nuggets is presented in Table 1.

Table 1. Modified formula of chicken liver nuggets according to Amertaningtyas et al., (2021)

Numb.	Materials	Percentage (%)	M (g)	K (g)	L (g)	W (g)
1	Steamed chicken liver (g)	59.2	200	200	200	200
2	Tapioca flour (g)	11.8	40	40	40	40
3	Treatment flour (g)	2.9	10	10	10	10
4	Salt (g)	1.8	6	6	6	6
5	White pepper (g)	1.2	4	4	4	4
6	Garlic (g)	2.4	8	8	8	8
7	Egg (g)	8.9	30	30	30	30
8	Water (g)	11.8	40	40	40	40



### **Texture (N)**

Texture testing was conducted according to Ernaningtyas et al., (2020) using Tensile Strength Instrument. The tensile strength instrument was turned on and left stabilized for five minutes. The sample placed exactly beneath the instrument's needle. The load was released and the scale reading was noted once the instrument stopped. The value displayed on the monitor represented the hardness, expressed in Newtons (N).

### **Water Activity (Aw)**

Water activity (Aw) testing was conducted according to Christie et al., (2016). The chrused sample was placed into the sample container of Aw meter. The Aw meter was turned on. The container was tighly sealed and lefted until it sound twice. The value displayed on the monitor expressed the water activity value.

### **Water Content**

Water content testing was conducted according to Ernaningtyas et al., (2020). The petri dish was dried in oven at 105°C for an hour. The petri dish was placed into desiccator for 15 minutes and then weighed. The measured sample was placed into the petri dish and then dried in the oven at 105°C for 5 hours. After the drying, the petri dish and sample was put back into desiccator to cool down the temperature as room temperature. The dish filled with the sample weighed again and water content was calculated with the following formula:

$$\text{Water content (\%)} = \frac{B-C}{B-A} \times 100\%$$

Descriptions:

A = the weight of the empty dish (g)

B = the weight of the dish filled with the sample (g)

C = the weight of the dried dish filled with the sample (g)

### **Color L\*a\*b\***

Color testing (L\*a\*b\*) was conducted according to Kaemba et al., (2017) by calibrating the chromameter with the white color standard available on the device, using white as the reference color. The device the provided an analysis of the whiteness degree in the form of L\*a\*b\* values.

## RESULTS AND DISCUSSION

The analysis of variance showed that the substitution treatments using cornstarch, soybean, pumpkin and carrot flours in chicken liver nuggets had a highly significant effect ( $P > 0.01$ ) on yield and a significant effect ( $P > 0.05$ ) on water content. However, there are no significant effect ( $P < 0.05$ ) was observed on the texture and water activity ( $A_w$ ) of the chicken liver nuggets. The data can be seen in Table 3.

Table 3. The average values of yield, texture,  $A_w$  and water content

Treatments	Yield (%)	Texture (N)	$A_w$	Water Content (%)
M	96.38±1.57 <sup>a</sup>	4.094±0.190	0.870±0.014	33.70±3.77 <sup>a</sup>
K	100.68±0.18 <sup>b</sup>	5.228±0.978	0.857±0.003	39.61±1.64 <sup>b</sup>
L	99.26±1.54 <sup>ab</sup>	4.834±0.166	0.870±0.010	39.07±1.63 <sup>b</sup>
W	103.27±0.57 <sup>b</sup>	5.236±0.349	0.869±0.011	42.04±0.79 <sup>b</sup>

Description: Superscript notation that are different in the same column indicate highly significant different ( $P > 0.01$ ) in yield and a significant different ( $P < 0.05$ ) in water content.

### Yield

Table 3 shows that the addition of cornstarch, soybean flour, pumpkin flour and carrot flour had a highly significant effect ( $P > 0.01$ ) on the yield of chicken liver nuggets. The highest yield was observed in nuggets with carrot flour (103.27%), while the lowest was found in nuggets with cornstarch (96.38%). The yields of nuggets with soybean flour and pumpkin flour were 100.68% and 99.26%. The analysis of variance revealed a highly significant difference between nuggets with cornstarch and other treatment, whereas nuggets with soybean flour, pumpkin flour and carrot flour did not show a highly significant difference.

Yield values reflect the production success rate, the higher the yield, the better the production quality. Kurnia (2015) stated that higher yield values indicate more effective treatments. Several factors can influence yield, such as the heating duration, as explained by Saleh and Yusniani (2022). In this case, ensuring uniform frying duration is crucial for effectiveness of flour addition treatments. Another factor affecting yield is the water content in the nuggets. Cempena et al., (2024) reported that higher water content increases yield. This research's results show a direct relationship between yield and water content, consistent with the research of Saleh and Yusniani (2022). This relationship is likely due to the starch content in cornstarch, soybean flour, pumpkin flour and carrot flour. Dahiya

et al., (2015) noted that legume-based flours have lower starch content compared to tuber-based flours. This aligns with the results showing that chicken liver nuggets with carrot flour treatments have highest yield values, and make it the best treatment.

### **Texture**

The analysis of variance in Table 3 shows that the addition of cornstarch, soybean flour, pumpkin flour and carrot flour did not have a significant effect ( $P < 0.05$ ) on the texture of chicken liver nuggets, with the lowest texture value observed in cornstarch (4.094 N) and the highest in carrot flour (5.236 N). According to Bakoil (2022), the starch and gluten content in carrot flours, particularly its amylose (20%) and amylopectin (80%) components. Meanwhile, cornstarch contains 24-26% amylose and 74-76 amylopectine (Indrawati et al, 2019). This may slightly enhance texture, even though without significant differences. This is likely due to the high starch content in tapioca flour, used as a binder, which contains up to 85.46% starch (Sari and Widjanarko, 2015) influencing texture stability across treatments.

A balanced ratio between amylose and amylopectin in flours tends to maintain uniform texture. Chan et al., (2023) explained, that the structure of amylose and amylopectin in starch highly affects the texture of products, while Nisah (2017) said that high amylose content can make the texture of products less elastic. In their research, Rosnah and Zulhija (2018) show the same effect in fish-based nuggets, where the amylose content has the ability to binds water and leading to more elastic texture.

### **Water Activity ( $A_w$ )**

The analysis of variance in Table 3 shows that the addition of cornstarch, soybean flour, pumpkin flour and carrot flour did not have a significant effect ( $P < 0.05$ ) on the water activity ( $A_w$ ) of chicken liver nuggets, with  $A_w$  value ranging from 0.857 to 0.870. The lowest  $A_w$  value was observed in the soybean flour treatment (0.857), while the highest was in the pumpkin flour and cornstarch (0.870). Based on Mutia et al., (2022) about chicken nuggets with skim milk powder, the best  $A_w$  was on 0.943 and compared to that, this research is considered of better quality since its lower  $A_w$  value.

Water activity ( $A_w$ ) is a measure of the moisture content in food products that affects quality, including stability and shelf life (Barbosa-Canovas et al., 2020). The lack of the significant effect from flour treatments is likely due to the chicken liver nuggets formulation and composition. The addition of 5% flour in the nugget formulation did not

influence  $A_w$  significantly. For instance, cornstarch has good water retention properties as a binder, but its effectiveness in nugget product is influenced by formulation and cooking processes (Carcelli et al., 2020).

### Water Content

The analysis of variance in Table 3 indicates that the addition of cornstarch, soybean flour, pumpkin flour and carrot flour significantly ( $P>0.05$ ) affected the moisture content of chicken liver nuggets. The average water content ranged from 33.70% to 42.04%, with the lowest found in nuggets with cornstarch (M) and the highest in nuggets with carrot flour (W). These result highlight a significant difference between cornstarch and other flours, while the differences among soybean, pumpkin flour and carrot flour were not significant.

The water content of the nuggets remained below 60%, complying with SNI 01-6683-2014 for chicken nuggets, indicating that the chicken liver nuggets were processed effectively. Meeting the SNI standard for water content is crucial for maintaining nugget quality, as higher water content can encourage microbial growth and accelerate product spoilage (Taus et al., 2022). The significant difference observed in nuggets with cornstarch might be caused by its high amylose content (24-26%), which reduces water binding capacity (Safitri et al., 2021; Rosnah and Zulhija, 2018). Meanwhile, the highest water content in carrot flour nuggets could be due to the high water content of carrots, which is around 80% (Nurkistin, 2014), that may accelerate microorganism growth and shorten shelf life of nuggets with carrot flour compared to the other flours.

### Color

The analysis of variance in Table 4 shows that adding various flour significantly ( $P<0.1$ ) affects the color of chicken liver nuggets. The result data of color testing is shown in Table 4.

Table 4. Color testing data result ( $L^*$ ,  $a^*$ ,  $b^*$ )

Numb.	Treatments	Color		
		$L^*$	$a^*$	$b^*$
1.	M	37.73±0.93 <sup>ab</sup>	16.77±1.00 <sup>b</sup>	20.33±0.93 <sup>a</sup>
2.	K	43.27±1.08 <sup>c</sup>	14.53±0.84 <sup>ab</sup>	22.23±0.84 <sup>a</sup>
3.	L	40.57±0.75 <sup>bc</sup>	14.83±0.93 <sup>ab</sup>	21.73±1.04 <sup>a</sup>
4.	W	36.90±1.04 <sup>a</sup>	12.67±0.76 <sup>a</sup>	19.17±0.81 <sup>a</sup>

Description:

- Different notations/superscripts in the column indicate the highly significant difference ( $P < 0,01$ )
- $L^*$ (brightness),  $a^*$ (redness), and  $b^*$ (yellowness)

The analysis of variance in Table 4 shows that the lowest brightness level ( $L^*$ ) was observed in cornstarch treatment (M), with an average value of 37.73, while the highest brightness level was found in the treatment with soybean flour (K), with an average value of 43.27. This indicates that the highest brightness was achieved in chicken liver nuggets with the addition of soybean flour, whereas nuggets with cornstarch had the least brightness. In terms of redness ( $a^*$ ), the highest value was observed in chicken liver nuggets with cornstarch (M), with an average value of 16.77. This might be due to the white color of cornstarch, which has minimal influence on the original reddish color of chicken liver, resulting in the highest redness value for this treatment. In terms of yellowness ( $b^*$ ), the highest value was recorded in chicken liver nuggets with the addition of soybean flour (K), with a value of 22.23. Color plays a crucial role in the acceptance of nugget products and serves as an indicator of chemical changes in food (Lekahena, 2016). The color variation of the added cornstarch (white), soybean (yellowish-white), pumpkin (light yellow), and carrot (orange) leads to significant differences in the  $L^*$ ,  $a^*$ , and  $b^*$  color parameters of the nugget products (Arifianto et al., 2017). According to Sinaga (2019), the  $L^*$  value describes brightness (0 for black, 100 for white),  $a^*$  indicates the green-red spectrum (negative for green, positive for red), and  $b^*$  represents the blue-yellow spectrum (negative for blue, positive for yellow).

## CONCLUSION

The addition of cornstarch, soybean flours, pumpkin flours and carrot flours at 5% significantly affects the quality of chicken liver nuggets, particularly in terms of yield and color, and also affects water content. However, this treatment does not significantly impact texture or water activity ( $A_w$ ) of the nuggets. From a producer's perspective, the best nugget is obtained with treatment W (carrot flour addition), yielding a production value of 103.27. From a consumer's perspective, the best nugget is obtained with treatment K (soybean flour addition), with a texture value of 5.228,  $A_w$  of 0.857, and moisture content of 39.61.

## ACKNOWLEDGMENT

This research was funded by Dana Penerimaan Negara Bukan Pajak (PNBP) with serial number DIPA Brawijaya University: DIPA: 974.36/UN10.C10/PN/2022 in the Hibah Penelitian Pemula (HPP) schema.

## REFERENCES

- Aisyah, I. S., Hidayanti, L., & Ghaffar, M. (2024). Pelatihan Pengolahan Nugget Ikan Lele untuk Mencegah *Stunting* pada Balita. *Jurnal Amba Negeri*, 5(1), 115-124. <https://doi.org/10.36590/jagri.v5i1.905>
- Alza, Y., Novita, L., & Zahtamal, Z. (2023). Identifikasi Nilai Gizi Makro dan Mikro Tepung Labu Kuning Khas Riau. *Sang Pencerah: Jurnal Ilmiah Universitas Muhammadiyah Buton*, 9(1). <https://doi.org/10.35326/pencerah.v9i1.2822>
- Amertaningtyas, D., Evanuarini, H., & Apriliyani, M.W. (2022). Chemical Quality and Amino Acid Profile of Liver Nuggets Using Different Flours. *Earth dan Environment Science*, 1-7. [doi.org/10.1088/1755-1315/1020/1/012025](https://doi.org/10.1088/1755-1315/1020/1/012025)
- Amertaningtyas, D., Gusmaryani, S., Fasha, N. N., Evanuarini, H., & Apriliyani, M. W. (2021). Penggunaan Tepung Terigu dan Tepung Tapioka pada Nugget Hati Ayam dan Nugget Hati Sapi. *Jurnal Ilmu Ternak Universitas Padjadjaran*, 21(2), 143-151. <https://doi.org/10.24198/jit.v21i2.36613>
- Apriliani, P., Haryati, S., & Suudjatinah. (2019). Berbagai Konsentrasi Tepung Maizena Terhadap Sifat Fisikokimia dan Organoleptik Petis Udang. *Jurnal Teknologi Pertanian*, 1-9. Doi: [D.111.15.0048](https://doi.org/10.1111.15.0048)
- Arifianto, M. (2017). *Pengaruh Substitusi Tepung Tapioka Dengan Tepung Labu Kuning (Cucurbita Moschata) Terhadap Warna, Tekstur Dan Mutu Organoleptik Nugget Itik*. Doctoral dissertation, Universitas Brawijaya. <http://repository.ub.ac.id/id/eprint/138154> (Accessed on 2 September 2024)
- Arza, P. A., & Tirtavani, M. (2018). PENGEMBANGAN CRACKERS DENGAN PENAMBAHAN TEPUNG IKAN PATIN [*Pangasius hypophthalmus*] DAN TEPUNG WORTEL [*Daucus carota L.*]. *Penelitian Gizi Dan Makanan (The Journal of Nutrition and Food Research)*, 40(2). <https://doi.org/10.22435/pgm.v40i2.7579.55-62>
- Badan Standarisasi Nasional (BSN). (2014). SNI.01-6683-2014. Nugget Ayam. BSN Press. Jakarta.
- Bakoil, J. (2022). Pengaruh Penambahan Tepung Wortel terhadap Kualitas Biskuit. *Jurnal Ilmiah Wahana Pendidikan*, 8(5), 305-309. <https://doi.org/10.5281/zenodo.6474260>

- Barbosa-Canovas, G V., Fontana, Jr. A. J., Schmidt, S. J., & Labuza, T. P. (2020). *Water Activity in Foods*. United States of America: Blackwell Publishing. [10.1002/9780470376454](https://doi.org/10.1002/9780470376454)
- Carcelli, A., Masuelli, E., Diantom, A., Vittadini, E., & Carini, E. (2020). Probing the Functionality of Physically Modified Corn Flour as Clean Label Thickening Agent with a Multiscale Characterization. *Foods*, 9(8), 1105. <https://doi.org/10.3390/foods9081105>
- Cempena, I. B., Barata, C. F. A., & Yasin, M. (2024). Pelatihan Olahan Produk Makanan Berbahan Dasar Lele (Olahan Nugget dan Abon) dan Jamur Dalam Rangka Penguatan dan Ketahanan Ekonomi Masyarakat Perkotaan Bagi Anggota Kelompok Tani “Elok Mekar Sari”. *Kegiatan Positif: Jurnal Hasil Karya Pengabdian Masyarakat*, 2(2), 55-62. <https://doi.org/10.61132/kegiatanpositif.v2i2.952>
- Chan, R., Sidoretno, W. M., & Lestari, R. (2023). Penetapan Kadar Amilosa Pada Mi Sagu Secara Spektrofotometri Uv-Vis. *JFARM-Jurnal Farmasi*, 1(1), 12-18. <https://doi.org/10.58794/jfarm.v1i1.490>
- Christie, T. M., Ma'ruf, W. F., Susanto, E. (2016). Mereduksi Oksidasi Ian Manyung (*Arius thalassinus*) Jambal Roti dengan Implikasi *Edible Film* Selama Penyimpanan Suhu Ruang. *J. Peng. & Biotek. Hasil Pi*, 5(1), 94-100. <https://ejournal3.undip.ac.id/index.php/jpbhp/article.view/10830/10508> (Accessed on 12 October 2024)
- Dahiya, P.K., Linnemann, A. R., Van Boekel, M. A. J. S., Khetarpaul, N., Grewal, R. B., & Nout, M. J. R. (2015). Mung bean: Technological and nutritional potential. *Critical reviews in food science and nutrition*, 55(5), 670-688. <https://doi.org/10.1080/10408398.2012.671202>
- Ernaningtyas, N., Wahjuningsih S. B., & Haryati, S. (2020). Sustitusi Wortel (*Daucus carota L.*) dan Tepung Mocaf (*Modified Cassava Flour*) terhadap Sifat Fisikokimia dan Organoleptik Mie Kering. *Jurnal Teknologi Pangan dan Hasil Pertanian*, 15(2): 23-32. <http://dx.doi.org/10.26623/jtphp.v13i1.1845>
- Fauziah, A., Fajri, R., & Hermanto, R. A. (2019). Daya Terima dan Kadar Zat Besi Nugget Hati Ayam dengan Kombinasi Tempe Sebagai Pangan Olahan Sumber Zat Besi. *Journal of Holistic and Health Science*, 3(2), 65-74. <https://doi.org/10.51873/jhhs.v3i2.48>
- Harsita, P. A., Setyawan, H. B., & Amam. (2022). Analisa Mutu Produk Naget Subtitusi Hati Ayam Kampung Unggul Balitbang (KUB). *Bulletin of Applied Animal Research*, 4(1), 35-40. [10.36423/baar.v4i1.941](https://doi.org/10.36423/baar.v4i1.941)
- Hetikisworotriningtyas, M., & Runik A. 2019. Nugget Ikan Daun Kelor Sebagai Jajanan Anak Sekolah kaya Protein. *Edugy: Jurnal Pendidikan IGI DIY*, 3(1), 16-20.

- Indrawati, C., Harsojuwono, B. A., & Hartiati, A. 2019. Karakteristik Komposit Bioplastik Glukomanan dan Maizena dalam Pengaruh Variasi Suhu dan Waktu Gelatinisasi. *Jurnal Rekayasa dan Manajemen Agroindustri*, 7(3), 468-477. [10.24843/jrma.2019.v07.i03.p14](https://doi.org/10.24843/jrma.2019.v07.i03.p14)
- Kaemba, A., Suryanto, E., & Mamuja, C. F. (2017). Karakteristik Fisiko-Kimia dan Aktivitas Antioksidan Beras Analog dari Sagu Baruk (*Arenga microcarpha*) dan Ubi Jalar Ungu (*Ipomoea batatas L. Poiret*). *Jurnal Ilmu dan Teknologi Pangan*, 5(1), 1-8. <https://doi.org/10.35799/cp.10.2.2017.27748>
- Kementerian Kesehatan Republik Indonesia. 2018. Data Komposisi Pangan Indonesia. Accessed on 25 August 2024. <https://repository.ub.ac.id/id/eprint/188030/>
- Kurnia, S. G. (2015). Kualitas Fisik dan Kimi Gelatin Tulang Kepala Sapi dengan Lama Perendaman yang Berbeda Menggunakan Asam Klorida. *Skripsi*. Program Studi Peternakan Fakultas Pertanian dan Peternakan Universitas Islam Negeri Sultan Syarif Kasim Riau. Pekanbaru. <http://repository.uin-suska.ac.id/id/eprint/6153> (Accessed on 2 September 2024)
- Lekahena, V. N. J. (2016). Pengaruh Penambahan Konsentrasi Tepung Tapioka terhadap Komposisi Gizi dan Evaluasi Sensori Nugget Daging Merah Ikan Madidihang. *Agrikan: Jurnal Agribisnis Perikanan*, 9(1), 1-8. <https://doi.org/10.29239/j.agrikan.9.1.1-8>
- Lestari, T. I., Nurhidajah, & Yusuf, M. (2018). Kadar Protein, Tekstur dan Sifat Organoleptik Cookies yang Disubstitusi Tepung Ganyong (*Canna Edulis*) dan Tepung Kacang Kedelai (*Glycine Max L.*). *Jurnal Pangan Dan Gizi*, 8(6).
- Mahmud, M. K., Hermana, Nazarina, & Zulfianto M. S. N. A. 2018. *Tabel Komposisi Pangan Indonesia*. Direktorat Jenderal Kesehatan Masyarakat. Jakarta
- Mutia, Hikmah, S., & Amertaningtyas, D. (2022). Uji Kadar Air, Aktivitas Air dan Tekstur Nugget Hati Ayam dengan Penambahan Susu Bubuk Skim pada Level yang Berbeda. *Sarjana Thesis*. Fakultas Peternakan Universitas Brawijaya. . <http://repository.ub.ac.id/id/eprint/193002> (Accessed on 2 September 2024)
- Nisah, K., (2018). Study Pengaruh Kandungan Amilosa dan Amilopektin Umbi-Umbian Terhadap Karakteristik Fisik Plastik Biodegradable dengan Plastizicer Gliserol. *BIOTIK: Jurnal Ilmiah Biologi Teknologi Dan Kependidikan*, 5(2), 106-113. <https://dx.doi.org/10.22373/biotik.v5i2.3018>
- Nurkistin, D., Estiani, K., Billah, M. M. & Maulaya, M. (2024). Analisis Sifat Kimia Nugget Ayam dengan Koombinasi Wortel dan Misoa sebagai Makanan Tambahan Tinggi Energi dan Protein. *Journal of Social Science Research*, 4(4), 3903-3912. <https://doi.org/10.31004/innovative.v4i4.12662>

- Paldiari, R., Ayu, D. F., Rahmayuni. 2023. Penambahan Tepung Wortel pada Pembuatan Nugget Ikan Kembung. *Jurnal Teknologi Pertanian*. 12(1), 81-89. Doi: [10.30598/jagritekno.2023.12.1.81](https://doi.org/10.30598/jagritekno.2023.12.1.81)
- Permatasari, N., Angkasa, D., Swamilaksana, P. D., Melani, V., & Dewanti. (2020). Pengembangan Biskuit MPASI Tinggi Besi dan Seng dari Tepung Kacang Tunggak (*Virginia unguiculata L.*) dan Hati Ayam. *Jurnal Pangan dan Gizi*, 10(2), 33-48. <https://doi.org/10.26714/jpg.10.2.2020.33-48>
- Purwadhani, R. B., Sugesti, R., & Ginting, A. S. 2024. Pengaruh Pemberian Hati Ayam dan Pemberian Tablet Fe terhadap Peningkatan Kadar Haemoglobin pada Remaja Putri di UPT Puskesmas Jawilan Tahun 2024. *Journal of Social Science Research*, 4(3), 12002-12015. <https://doi.org/10.31004/innovative.v4i3.11746>
- Ratnasari, D., Dewi, Y. R., & Purniasih, L. 2021. Pengaruh Penambahan Tepung Maizena Terhadap Mutu Nugget Ikan Gabus (*Channa striata*). *Jurnal Ilmiah Gizi dan Kesehatan*, 2(2), 7-14. Doi: [10.46772/jigk.v2i02.451](https://doi.org/10.46772/jigk.v2i02.451)
- Ratulangi, Y. A., Siswosubroto, S. E., Ratulangi, F., Rompis, J. E. G. 2018. Sifat Organoleptik Nugget Ayam yang Menggunakan Tepung Kedelai Sebagai Penggantian Sebagian Daging. *Jurnal Zootek*, 38(1), 131-141. <https://ejournal.unsrat.ac.id/v3/index.php/zootek/article/download/18566/18093/7479>
- Rosnah, & Zulhija, W. (2018). Penambahan Tepung Ampas Kelapa Mempengaruhi Karakteristik Sensorik Dan Kadar Serat Kasar Nugget Ikan Cakalang (*Thunnus macoyii*). *Jurnal Penelitian Kesehatan Suara Forikes*, 9(4), 238-247. <http://dx.doi.org/10.33846/sf9403>
- Sadih, S., Subangkit, M., & Tanjung, J. S. (2022). Efektivitas Kombinasi Jus Hati Ayam dan Serbuk Biji Melinjo Sebagai Bahan Penginduksi *Hiperurisemia* pada Tikus. *Jurnal Ilmiah Manuntung: Sains Farmasi dan Kesehatan*, 8(1), 136-144. <https://doi.org/10.51352/jim.v8i1.515>
- Safitri, R. K. A., Soeyono, R. D., Sulandjari, S., & Sutiadiningsih, A. (2021). Pengaruh Jumlah Ikan dan Maizena Terhadap Sifat Organoleptik Nugget Ikan Kembung (*Rastrelliger kanagurta*). *Jurnal Tata Boga*. 10(1), 122-128. <https://ejournal.unesa.ac.id/index.php/jurnal-tata-boga/article/view/38021>. (Accessed on 2 September 2024)
- Safitri, W. & Anggrayni, Y. L. (2019). Pengaruh Penambahan Tepung Susu Sebagai Bahan Pengikat Terhadap Kandungan Nutrisi Nugget Ayam. *Journal of Animal Center*, 1(2), 124-138
- Santosa, H., Handayani, N. A., Nuramelia, C., & Sukma, N. Y. T. 2016. Pemanfaatan Hati Ayam sebagai Fortifikan Zat Besi Dalam Bubur Bayi Instan Berbahan Dasar Ubi Jalar Ungu. *Inovasi Teknik Kimia*, 1(1), 27-34. <http://dx.doi.org/10.31942/inteka.v1i1.1641>

- Saleh, E. R. M. & Yusniani. (2022). Model Hubungan Antara Pengeringan Oven Terhadap Nilai Kapasitansi, Kadar Air, dan Rendemen Biji Pala (*Myristica Fragrans Houtt*). *Prosiding the 13<sup>th</sup> Industrial Research Workshop and National Seminar*. Bandung, 13-14 Juli 2022, 25-31. <https://jurnal.polban.ac.id/proceeding/article/view/4339/2897>
- Sari, H.A. & Widjanarko S.B. (2015). Karakteristik kimia bakso sapi (kajian proporsi tepung tapioka: tepung porang dan penambahan NaCl). *Jurnal pangan dan Agroindustri*, 3(3), 784-792. <https://jpa.ub.ac.id/index.php/jpa/article/view/200>. (Accessed on 2 September 2024)
- Sinaga, A.S. (2019). Segmentasi Ruang Warna  $L^*a^*b$ . *Jurnal Mantik Penusa*, 3 (1), 43-46. <http://download.garuda.kemdikbud.go.id/article.php?article=1042044&val=11774&title=SEGMENTASI%20RUANG%20WARNA%20Lab>
- Sudarwati, H., Natsir, M. H., & Nurgartiningih, V. M. A. (2018). *Statistika dan Rancangan Percobaan: Penerapan dalam Bidang Peternakan*. Malang. UB Press
- Susanti, I., Afifah, D. N., Wijayanti, H. S., & Rustanti, N. (2021). Nutrien Content, Protein Digestibility, and Acceptability of Subtituting Tempeh Gembus Nuggets with Tilapia Fish. *National Nutrition Journal*, 16(2), 139-149. <https://doi.org/10.20473/mgi.v16i2.139-149>
- Syafie, Y., & Djumadil, N. 2023. Subtitusi Filler dengan Penambahan Tepung Labu Kuning (*Cucurbitamoschata*) terhadap Uji Organoleptik dan Kadar Air Nugget Ayam Petelur Afkir. *Prosiding Seminar Nasional Pertanian*. 3(1), 13-19. <https://ejournal.unkhair.ac.id/index.php/agri/article/view/5894/3768>
- Syahadah, M. M. (2016). Formulasi Sosis Tinggi Zat Besi dan Vitamin A dari Hati Ayam dan Wortel (*Daucus carota l.*) untuk Anak Usia Sekolah. Institut Pertanian Bogor. <https://Repository.ipb.ac.id/Handle/12345689/86890> (Accessed on 29 October 2024)
- Taus, A. L., Tahuk, P. K., & Kia, K. W. (2022). The Effect Use of Different Binding Materials on Water Holding Capacity, Water Content and Crude Fiber Content of Chicken Nuggets. *Journal of Tropical Animal Science and Technology*, 4(1), 74–81. [10.32938/jtast.v4i1.1330](https://doi.org/10.32938/jtast.v4i1.1330)