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Research Paper

The Effect of Temperature and Storage Time on the Quality of Frozen Food Nuggets

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***ABSTRACT**: This study aims to determine the effect of storage temperature on the quality of nuggets (frozen food) and the effect of storage time on their quality.The test results showed that the Total Plate Count at room temperature (28℃-30℃) on day 1 did not meet the standard. Similarly, at refrigerator temperature (10℃), the values on days 12 and 16 did not meet the standard. Meanwhile, at freezer temperature (-16℃), all samples met the standard of <105 cfu/g. For the Yeast and Mold test, the results did not meet the standard at room temperature (28℃-30℃) on day 1 and at refrigerator temperature (10℃) on days 12 and 16. However, at freezer temperature, the nugget samples met the standard requirement of a maximum of 1 × 10^4 cfu/g.The E. coli test results for all storage conditions (room temperature, refrigerator, and freezer) met the requirement of <3 cfu/g. For the Coliform test, the sample stored at room temperature on day 1 did not meet the requirement, whereas samples stored at refrigerator and freezer temperatures met the standard of 10 cfu/g. In the Proximate Analysis, nuggets stored at room temperature had a moisture content of 51.66%, protein content of 9.62%, and fat content of 10.05%. Meanwhile, those stored at freezer temperature had a moisture content of 61.48%, protein content of 10.23%, and fat content of 10.36%. However, some proximate components, such as moisture and fat content, increased during storage.*

***Keywords:** Nugget; Chicken; Temperature; Storage; Microbiology.*

1. INTRODUCTION

The chicken-based foodstuffs are becoming increasingly popular with a growing consumption mainly as “ready-to-eat” products, such as frozen chicken nuggets since less spending time on preparation, good nutritional quality as a protein source and low cost are provided [1]. One of the ways taken to prevent damage to chicken meat is by processing it into nugget products. Food or food is needed by humans as a source of nutrients and also a source of energy. The existence of frozen food products is also used to present practicality and increase the added value of processed meat products [2]. Chicken meat is one of the animal protein foods that has high nutritional value, has good taste, and is easy to obtain in fresh form and is abundant in the market [3]. However, chicken meat spoils quickly because it is easily contaminated with microbes. One of the ways taken to prevent damage to chicken meat is by processing it into nugget products [4]. Nugget is a processed ground beef product that is added with binding agents and mixed with spices then covered with egg whites (batter) and bread flour (breading) then pre-fried then packaged and frozen to maintain quality [5]. Chicken nuggets are increasingly known as highly nutritious processed meat foods and their availability in supermarkets is relatively abundant and increasingly preferred by consumers [6]. Shifts in habits and lifestyles, especially in urban communities that consume hygienic, ready-to-eat, time-saving, practical, easy-to-cook, and easy-to-obtain food products, have had an impact on the increasingly open market opportunities for frozen food products that meet consumer tastes. One of the ready-to-eat processed foods that people like today is chicken nuggets [7]. Frozen food are processed food products that are instant and frozen, have a relatively long shelf life, and are easy to process and serve. The preservation technology that has been applied is to lower the storage temperature to the freezing point to reduce the rate of decay [8]. Processed meat products are highly-perishable

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food products, food that has a high risk of damage so that it requires a preservation process with low temperatures to maintain its quality. The freezing process will slow down the rate of biochemical and microbiological changes in food, frozen food products must be delivered at temperatures between -1°C and -8°C [9]. Microorganisms will not thrive in food stored below the minimum temperature required for their growth, but if the temperature increases, bacteria can survive and continue to thrive [10]. Total bacteria is one of the microbiological quality standards regulated in food regulations. Food that has been contaminated with pathogenic bacteria in excess of the standard can cause food poisoning, which can result in illness for the person who consumes it [11].

Chicken nuggets are processed chicken meat that has been ground and mixed with binders and fillers, with or without food additives permitted according to BPOM (Food and Drug Administration) regulations, which are then molded in various forms, cooked, and served in the form of frozen food [12]. Nuggets are processed meat products made from various types of meat, such as chicken, beef, and fish. According to Indonesian National Standard (SNI) 01-6683, chicken nuggets must meet certain nutritional standards, namely a maximum moisture content of 60%, a minimum protein of 12%, a maximum of 20% fat, and a maximum of 25% carbohydrates [13]. However, chicken nuggets are susceptible to spoilage due to their nutritional content that can trigger microbial growth. Therefore, it is important to ensure that the chicken nuggets consumed are safe and healthy. In this era of globalization, people's consumption patterns tend to choose food that is practical and quickly available. However, it can also increase the risk of food contamination by physical, chemical, and microbial contamination. Therefore, it is necessary to make efforts to ensure the safety and quality of the food consumed [14].

In a study conducted by Defniwita Yuska [15] in 2022 with the title Storage and Acceptability of Chicken Nuggets Aloe Vera Gel (AVG) as an Alternative to School Food, Based on this study, the results were inversely proportional between temperature and shelf life, namely the lower the storage temperature, the longer the shelf life of a food product, but nevertheless in accordance with the maximum standard reference of microbes in food ingredients based on SNI 2897 and ISO 4833-1 obtained the results that for pureed and frozen chicken meat products, the maximum ALT limit is 1 x 10^5 colonies/g, and that the storage temperature with the longest shelf life is -20°C with a shelf life of 26.65 weeks [16]. This study concluded that the lower the temperature, the higher the shelf life of AVG chicken nuggets. This proves that increasingly freezing temperatures will be able to inhibit the development of microbes [17].

Therefore, this study aims to evaluate that temperature and storage time are two main factors that can affect the quality of frozen food nuggets. Proper freezing processes and consistent storage temperature control are essential to maintain product quality. Inappropriate storage temperatures or excessively long storage times can lead to significant deterioration in quality and the potential for unwanted microbial growth. Then analyzed by Testing Total Plate Count(TPC), Yeast and Mold, Coliform and E.Coli as well as Analysis of Moisture, Fat and Protein Content.

2. RESEARCH METODOLOGI

2.1 Tools and Materials

The tools used in this research were refrigators, petri dishes, fintips, erlenmeyers, test tubes, incubators, hot plates, autoclaves and analytical balances. The ingredients used are chicken nuggets, aquadest, Pepton Water Buffer solution as a diluent and bacterial growth medium (Plate Count Agar, Chromocult Coliform Agar, Sabouroud Dextrose Agar).

2.2 Research Methods

The main ingredients such as chicken meat are ground until smooth and then mixed with minced chicken meat along with garlic, salt, pepper, powdered broth and a few eggs then stirred until evenly distributed, after that the dough is transferred to a baking dish. Then take enough dough and shape it into nuggets and then, the nuggets are dipped in wheat flour, then into the beaten egg, and finally rolled in the breadcrumbs until smooth

Next, the coated nuggets are then steamed for 20 minutes until cooked. Observations on Chicken Nuggets will be carried out at room temperature storage temperature (28ºC-30ºC), refrigerator temperature (10ºC) for 0, 1, 4, 8, 12 and 16 days and frezeer temperature (-16ºC) for 0, 1, 4, 8, 12, 16 and 30 days.

2.3 Obeservation

Observations in this study were made by observation at room temperature, which is 0 and 1 day, at refrigerator temperature, which is 0, 1, 4, 8, 12, and 16 days, and frezeer temperature , which is 0, 1, 4, 8, 12, 16, and 30 days. Observations were made on Total Plate Count, Yeast and Mold Numbers, Escherechia Coli and Coliform and Proximat Analysis.

2.4 Analytical Procedure

2.4.1 Total Plate Count Procedure

The purpose of this test is to determine the total number of mesophilic aerobic microbes in a frozen chicken nugget sample as an indicator of hygiene and microbiological quality. Twenty-five grams of chicken nuggets were taken aseptically and placed in a sterile plastic bag. Then, 225 ml of the first dilution solution (1:10) was added and homogenized using a stomacher for 1–2 minutes. Serial dilutions were performed from 10^{-1} to 10^{-6} by taking 1 ml of the previous dilution and adding it to 9 ml of sterile dilution solution. From each dilution level (usually 10^{-3} to 10^{-6}), 1 ml of each dilution was added to a sterile Petri dish, followed by approximately 15–20 ml of sterile Plate Count Agar (PCA) medium that had been thawed and cooled to 45–47°C. The Petri dish was gently swirled to ensure uniform distribution and allowed to solidify. The next step was incubation at 35–37°C for 48 ± 2 hours in an inverted position. After incubation, colonies were counted on plates containing 30–300 colonies.

2.4.2 Mold and Yeast Test Procedure

This test aims to measure the number of mold and yeast colonies in frozen chicken nuggets, as the presence of these fungi can degrade sensory quality, accelerate spoilage, and indicate inadequate sanitation or storage. Twenty-five grams of chicken nuggets were taken with sterile equipment and placed in a stomacher bag containing 225 ml of diluent solution (0.1% peptone buffer) and homogenized for 1–2 minutes. Next, serial dilutions (10^{-1} to 10^{-6}) were made by adding 1 ml of the homogenized sample to 9 ml of sterile diluent solution and gently shaking to ensure homogeneity. From each dilution, 1 ml was taken and placed in a sterile Petri dish. Then, 15–20 ml of thawed Potato Dextrose Agar (PDA) medium (approximately 45°C) was added. The plate was then rotated until the solution was evenly distributed (pour plate method) and allowed to solidify at room temperature. The plates were incubated in an inverted position at 25°C to 28°C for 3 to 5 days. After incubation, mold and yeast colonies were counted and expressed as CFU/gram (colony-forming units per gram).

2.4.3 Escherichia Coli Test

The purpose of this test is to detect and quantify the number of E. coli bacteria in frozen chicken nuggets. E. coli is an indicator of fecal contamination and poor sanitation during food production or handling. This test involves several steps:

1. Presumptive Test: Twenty-five grams of frozen chicken nuggets are placed in a stomacher bag containing 225 mL of 0.1% peptone buffer and then homogenized. Next, serial dilutions are performed (e.g., 10^{-1} to 10^{-6}). One milliliter of each dilution is inoculated into lactose broth tubes (3 or 5 tubes per dilution). Each tube contains a Durham tube for gas detection. The tubes are then incubated at 35–37°C for 24–48 hours. Tubes that show turbidity and gas formation indicate a positive result.
2. Confirmation Test: From a positive lactose broth tube, a loop of fluid is taken and placed into a tube of Brilliant Green Lactose Bile (BGLB) broth. This is then incubated again at 35–37°C for 24–48 hours. Tubes that show gas and turbidity indicate a positive E. coli result.

3. Completed Test: Based on the results, a loop is taken from a positive BGLB tube and streaked onto Eosin Methylene Blue (EMB) agar, then incubated at 35–37°C for 24 hours. Colonies with a metallic green sheen are observed, indicating typical E. coli colonies. An indole test (using Kovac's reagent) is then performed for further confirmation. A positive E. coli result is indicated by the formation of a pink ring.

2.4.4 Moisture Content Analysis

First, an empty cup was dried in an oven at 105°C for 1 hour and weighed (W1). A 5-gram sample of nuggets was weighed into the cup (W2), and then the cup with the sample was dried in an oven at 105°C for 5 to 6 hours until a constant weight was achieved. The cup was cooled in a desiccator and reweighed (W3). Moisture content was calculated using the following formula:

$$\text{Moisture Content (\%)} = ((W_2 - W_3) / (W_2 - W_1)) \times 100.$$

2.4.5 Fat Content Analysis

A 2–5 gram sample is weighed and placed into an extraction cartridge. The cartridge is then placed in a Soxhlet apparatus containing n-hexane or ether solvent. It is heated for 4 to 6 hours to fully extract the fat. Afterward, the solvent is evaporated, and the Soxhlet flask is oven-dried and weighed. Fat content is calculated using the formula:

$$\text{Fat Content (\%)} = (\text{Weight of fat} / \text{Weight of sample}) \times 100$$

2.4.6 Protein Content Analysis

There are three stages in protein content analysis: digestion, distillation, and titration.

2.4.6.1 Digestion

A 0.5–1 gram nugget sample is weighed and placed in a Kjeldahl flask. Concentrated H_2SO_4 and a catalyst are added, and the mixture is then heated until the solution is clear.

2.4.6.2 Distillation

Next, NaOH is added to the Kjeldahl flask, which is then connected to the distillation apparatus. Ammonia is captured by the H_3BO_3 solution using an indicator.

2.4.6.3 Titration

The resulting solution is titrated with 0.1 N HCl until the color changes. Protein content is calculated using the formula: $\text{Protein Content (\%)} = (V \times N \times 14 / \text{Sample Weight}) \times 6.25$

Where:

- V: Volume of HCl (mL)

- N: Normality of HCl

- 14: Atomic weight of nitrogen

- 6.25: Nitrogen-to-protein conversion factor

3. RESULT AND DISCUSSION

This research uses nugget samples obtained from a nugget manufacturing site in the city of Makassar. The purpose of the study was to determine the effect of temperature and storage time on the quality of chicken nuggets. In the Total Plate Count test, Plate Count agar media is used, while for E.coli Coliform testing, Chromocult Coliform agar media is used where for coliform colonies will be red while E.coli colonies will be blue, while for testing Yeast & Mold Saboroud Dextrose agar media is used.

Figure 1. Chicken Nugget Day-0

Figure 2. Chicken Nugget Day-30

The image above is a comparison of chicken nugget samples on day 0 and on day 30 at freezer temperature (-16°C), from the picture it can be seen that the chicken nugget sample has not undergone significant changes, this indicates that the chicken nugget sample is still well maintained at freezer temperature (-16°C) for 30 days. This can be confirmed by the results of microbiological tests that have been carried out where in the sample of chicken nuggets at freezer temperature (-16°C) there is no bacterial growth at all.

The protein content in this nugget sample did not meet the SNI 01-6683-2014 standard. This is due to the lack of chicken meat used when making nuggets. This is in line with research conducted by Suryani, et al. 2019 [18] where it is said that the protein content in chicken nuggets is influenced by the ingredients used in the nugget making process.

3.1 Total Plate Count Test

Table 1. Total Plate Count Test Result

Sample	Temperature (°C)	Time	Result (cfu/g)	Requirement	Note
Nugget Room Temperature	28-30	Day-0	$< 10^5$	Max 1×10^5	Qualify
		Day-1	TNTC		Not qualify
Nugget Refrigator Temperature	10	Day-0	$< 10^5$	Max 1×10^5	Qualify
		Day-1	$< 10^5$		Qualify
		Day-4	$< 10^5$		Qualify
		Day-8	$< 10^5$		Qualify
		Day-12	11×10^5		Not qualify
		Day-16	TNTC		Not qualify
Nugget Freezer Temperature	-16	Day-0	$< 10^5$	Max 1×10^5	Qualify
		Day-1	$< 10^5$		Qualify
		Day-4	$< 10^5$		Qualify
		Day-8	$< 10^5$		Qualify
		Day-12	$< 10^5$		Qualify

	Day-16	$< 10^5$		Qualify
	Day-30	$< 10^5$		Qualify

Note = TNTC = Too Numerous To Count

The results of the TPC test that have been carried out on chicken nuggets with storage time at 28-30°C, that are 0 and 1 day, at 10°C, that are 0, 1, 4, 8, 12 and days, and at -16°C, that are 0, 1, 4, 8, 12, 16 and 30 days. The results of observation in the sample showed microbial growth in chicken nugget samples with a storage time of 1 day at a temperature of 28-30°C and with a storage time of day 12 and day 16 at a temperature of 10°C. The results of the Total Plate Number test can be seen in Table 1.

Based on Table 1, it can be seen that the test results of the total plate number in the chicken nugget sample with a storage time of 1 day at a temperature of 28-30°C obtained the results of TNTC or microbes could not be calculated. This is in line with a study conducted by Manullang (2020) [19] where if the meat is left at room temperature for more than 20 minutes, bacteria can grow and develop every second. For the temperature of 10°C on the 12th and 16th days, the results of TNTC were obtained. Furthermore, at a temperature of -16°C, there was no bacterial growth and met the standards according to SNI 01-6683-2014. This is in line with research conducted by Domili et al., (2021) [20] where it is said that the shelf life of nuggets at 28-30°C lasts less than 1 day and at 10°C lasts less than 12 days while at -16°C it can last for 3 months.

TPC (Total Plate Count) describes the total number of aerobic microorganisms that are growing. At higher temperatures, such as those found at room temperature or in a refrigerator, microbial metabolism increases, which results in faster bacterial growth and reproduction. Biological processes like bacterial cell replication, nutrient utilization from food, and the excretion of proteolytic or lipolytic enzymes all contribute to the increase in bacterial colony count. In contrast, freezing temperatures inhibit microbial metabolism and division, thereby preventing cell growth.

Based on the discussion above, it can be seen that storage temperature greatly affects the growth of microorganisms. For this reason, attention is needed in storing food products such as chicken nuggets so that the quality can be maintained.

3.2 Yeast and Mold Test

The results of the Yeast & Mold test that has been carried out on chicken nuggets with storage time at 28-30°C, that are 0 and 1 day, at 10°C, that are 0, 1, 4, 8, 12 and days and at -16°C, that are 0, 1, 4, 8, 12, 16 and 30 days. The results of observation in the sample showed microbial growth in chicken nugget samples with a storage time of 1 day at 28-30°C and with a storage time of day 12 and day 16 at a temperature of 10°C. The results of the Khamir mold test can be seen in Table 2.

Table 2. Yeast & Mold Test Result

Sample	Temperature (°C)	Time	Result (cfu/g)	Requirement	Note
Nugget Room Temperature	28-30	Day-0	Nil	Max 1×10^4	Qualify
		Day-1	TNTC		Not qualify
Nugget Refrigator Temperature	10	Day-0	Nil	Max 1×10^4	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	TNTC		Not qualify

		Day-16	TNTC		Not qualify
Nugget Freezer Temperature	-16	Day-0	Nil	Max 1 x 10^4	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	Nil		Qualify
		Day-16	Nil		Qualify
		Day-30	Nil		Qualify

Note = TNTC = Too Numerous To Count

Based on Table 2. It can be seen that the results of the Yeast & Mold test on chicken nugget samples with a storage time of 1 day at 28-30°C obtained TNTC results and TNTC results obtained on days 12 and 16 at 10°C so that they do not meet the requirements. The growth of yeast and mold can occur because the sample has been damaged, this is in line with research conducted on Hastuti (2023) [21], that lowering the temperature can prevent damage to food and the higher the storage temperature, the faster the rate of food spoilage.

The number of molds and yeasts exceeded the standard at room temperature on day 1 and at refrigerator temperature on days 12 and 16. In the freezer, all samples still met the requirements (<10^4 CFU/g). Molds and yeasts are eukaryotic microorganisms that thrive in humid and warm conditions. They ferment the carbohydrates contained in nuggets, producing ethanol, gas, and organic acids. At low temperatures, the enzymatic activity of molds and yeasts is inhibited because the cellular metabolic process slows down.

3.3 Coliform and Escherechia Coli Test

The results of the Coliform and Escherechia Coli tests that have been carried out on storage with a room temperature of 28-30°C, a refrigator temperature of 10°C and a freezer temperature of -16°C can be seen in Table 3 and Table 4.

Table 3. Coliform Test Result

Sample	Temperature (°C)	Time	Result (cfu/g)	Requirement	Note
Nugget Room Temperature	28-30	Day-0	Nil	10	Qualify
		Day-1	TNTC		Not qualify
Nugget Refrigator Temperature	10	Day-0	Nil	10	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	Nil		Qualify
		Day-16	Nil		Qualify
Nugget Freezer Temperature	-16	Day-0	Nil	10	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	Nil		Qualify
		Day-16	Nil		Qualify

Sample	Temperature (°C)	Time	Result (cfu/g)	Requirement	Note
		Day-30	Nil		Qualify

Note = TNTC = Too Numerous To Count

Table 4. Escherechia Coli Test Result

Sample	Temperature (°C)	Time	Result (cfu/g)	Requirement	Note
Nugget Room Temperature	28-30	Day-0	Nil	< 3	Qualify
		Day-1	Nil		Qualify
Nugget Refrigator Temperature	10	Day-0	Nil	< 3	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	Nil		Qualify
		Day-16	Nil		Qualify
Nugget Freezer Temperature	-16	Day-0	Nil	< 3	Qualify
		Day-1	Nil		Qualify
		Day-4	Nil		Qualify
		Day-8	Nil		Qualify
		Day-12	Nil		Qualify
		Day-16	Nil		Qualify
		Day-30	Nil		Qualify

Note = TNTC = Too Numerous To Count

The results of the Coliform and Escherechia Coli tests that have been carried out on storage with a temperature of 28-30°C, a temperature of 10°C and a temperature of -16°C can be seen in Table 3 and Table 4. In the chicken nugget sample at a temperature of 28-30°C where on the 1st day coliform bacteria were found where the number of colonies was TNTC (Too Numerous To Count) it did not meet the requirements of SNI 01-6683-2014, where for coliform bacteria the maximum was only 10 cfu/g. This is due to the condition of chicken meat that has rotted, triggering the growth of microorganisms such as coliforms. This is in accordance with research conducted by Zelpina, et al., (2020) [22] said that the condition of chicken meat in open spaces is one of the factors that supports the growth of coliform bacteria. This is also explained in a study conducted by Manullang, et al., (2020) [19] which explains that if the meat is left at a simmering temperature for more than 20 minutes, bacteria can grow and develop every second, causing spoilage in the meat

3.4 Proximate Analysis

The results of the Proximate Analysis test which included water content analysis, fat content analysis and protein content analysis were carried out on Chicken Nuggets on day 0 and day 30 at a temperature of -16°C. The results of the proximat analysis test can be seen in the following Figure 3;

From the results of the proximat analysis carried out on day 0 and day 30 at a temperature of -16°C, it can be seen that the sample does not experience a large change in fat content or protein content, this is because at low temperatures the growth of microorganisms will be inhibited so that the sample will be maintained in

its condition. This is also explained in a study conducted by Suryani, et al., (2019) [23] where it is explained that the lower the storage temperature, the longer the life of the sample. There was an increase in the moisture content of the chicken nugget sample.

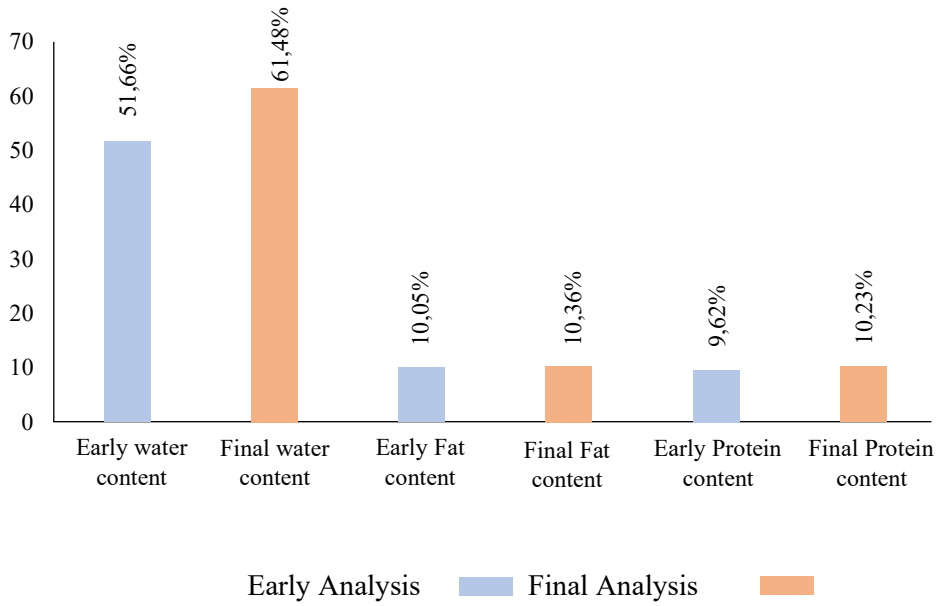

Figure 3. Proximate Analysis of Chicken Nuggets

There was an increase in the water content of the chicken nugget samples. This is because when stored in a refrigerated room, fresh food is exposed to the movement of cold air with relatively low humidity, resulting in a difference in vapor pressure between the food and the air around the food, thereby increasing the water content [24]. Water is an important component in food because water can affect the appearance, texture and taste of food. The water content in food determines the quality of freshness and durability of the food, if the water content is high it will make it easy for bacteria, mold and yeast to breed, making it easy for changes to occur in the food [25].

Based on Figure 3, the change in fat content slightly increased from 10.05% to 10.36%. This change is not significant. The increase in relative fat content may occur due to a reduction in overall water mass, which results in a higher concentration of fat components. Changes in the internal structure of the product during frozen storage may make fat more easily detected during analysis, for example, due to damage to fat cells. Similarly, the protein content changed from 9.62% to 10.23%. This change is not very significant, but it can be caused by changes in protein structure or protein hydration during freezing, leading to a slight increase in its determination. According to Winarno (2004), frozen storage can cause redistribution of water and fat, as well as changes in protein structure [26].

4. CONCLUSION

Based on the research that has been conducted, it can be concluded that there is an influence of temperature on the quality of chicken nuggets. At 28-30°C chicken nuggets only last less than 1 day while at 10°C, chicken nuggets can last for less than 12 days and at -16°C chicken nuggets can last for 30 days. There is an effect of storage time on the quality of chicken nuggets, where at a temperature of 28-30°C the storage time is only less than 1 day, while at a temperature of 10°C the storage time of chicken nuggets can last up to 12 days and at a temperature of -16°C the storage time can last for 30 days. So the lower the storage temperature, the longer the storage time will be. Then in the proximat analysis test on day 0 and day 30 at -16°C, the chicken nugget sample did not experience a significant change in fat and protein content, but

experienced an increase in moisture content. From the results of the study, it can be concluded that for storage of chicken nuggets at room temperature (28ºC-30ºC) it should be less than one day, while for storage at refrigerator temperature (10ºC) it should be less than 12 days and for freezer temperature (-16ºC) the storage can last up to 30 days.

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REFERENCES

[1] W. Kamilan, "Analisis Daya Terima dan Zat Gizi Nugget Ayam dengan Penambahan Tempe," Pekanbaru, 2023.

[2] S. Rohaya, F. Rahmat, and I. Sulaiman, "Shelf-life prediction of chicken nuggets based on the thickness level of composite plastic packaging using accelerated shelf-life testing (ASLT) method by the Arrhenius equation approach," IOP Conf Ser Earth Environ Sci, vol. 1297, no. 1, p. 012078, Feb. 2024, doi: 10.1088/1755-1315/1297/1/012078

[3] Novita, "Pelatihan Pembuatan Produk Frozen Food Pada Kelompok Usaha Bersama," Jurnal Pengabdian Kompetitif, vol. 1, no. 1, pp. 9–17, 2022.

[4] R. Maulidina, E. T. Marlina, and D. T. Utama, "Kualitas Mikroba Produk Olahan Daging yang Dijual Secara Daring Dari UMKM di Kota Bandung," Jurnal Teknologi Hasil Peternakan, vol. 4, no. 2, p. 83, Sep. 2023, doi: 10.24198/jthp.v4i2.47313.

[5] A. Sulistiani and Hafiludin, "Karakteristik Mikrobiologi (ALT, E.Coli dan Salmonella) pada produk hasil perikanan di BPMHP Semarang," Jurnal Ilmiah Kelautan dan Perikanan, vol. 3, no. 1, pp. 39–42, 2022.

[6] J. Syam, "Aplikasi Ekstrak Wortel sebagai Pengawet Alami pada Nugget Ayam," Jurnal Agrisitem, vol. 13, no. 2, pp. 112–120, 2017.

[7] Mawla, A.M., Sultan, S.M, and Hawa, L.C, "Karakteristik Berbagai Jenis Nuget Pada Penyimpanan Suhu Dingin," *Jurnal Teknotan,* vol. 12, no. 2, pp. 17, (2019).

[8] N. A. Nurulita, E. Sundhani, I. Amalia, F. Rahmawati, and N. N. Dian Utami, "Uji Aktivitas Antioksidan dan Anti Aging Body Butter dengan Bahan Aktif Ekstrak Daun Kelor," *J. Ilmu Kefarmasian Indones.*, vol. 17, no. 1, p. 1, 2019, doi: 10.35814/jifi.v17i1.543.

[9] M. Salim and L. Triana, "Pengaruh Variasi Waktu Simpan terhadap Kadar Protein pada Ikan Tongkol," *J. Lab. Khatulistiwa*, vol. 1, no. 1, p. 1, 2017, doi: 10.30602/jlk.v1i1.87.

[10] Agata Kinanthi, E. Dyah Yuliarti, and W. Tjahjaningsih, "Test of Total Volatile Base Nitrogen (TVB-N) in Tuna (Thunnus Sp.) at the at the Technical Implementation Unit for Quality Testing and Development of Marine and Fishery Product Banyuwangi, East Java," *J. Mar. Coast. Sci.*, vol. 11, no. 2, pp. 49–55, 2022, doi: 10.20473/jmcs.v11i2.36710.

[11] R. Hayati, N. Mayani, R. Husna, and I. Sulaiman, "Pengolahan Nugget Ayam dan Penerimaannya Melalui Uji Organoleptik di Desa Krueng Lam Kareung Kecamatan Indrapuri Aceh Besar," *J. Pengabdi. Mahakarya Masy. Indones.*, vol. 1, no. 1, pp. 19–24, 2023, doi:

10.24815/pemasi.v1i1.30198.

[12] C. N. Hayati and H. Hafiludin, "Karakteristik Kimia (Kadar Air, TVB-N, dan Protein) pada Produk Perikanan di BPMHP Semarang," *Juv. Ilm. Kelaut. dan Perikan.*, vol. 4, no. 1, pp. 13–20, 2023, doi: 10.21107/juvenil.v4i1.17389.

[13] Badan Standarisasi Nasional, "Naget Ayam (Chicken Nugget) ," SNI 01-6683-2014. Jakarta: BSN, 2014

[14] S. Andriyono, F. Kusumaningrum, and S. Suciyono, "Analysis Of Antibiotic Residue On Vaname Shrimp (Litopenaeus Vannamei) In Kalipuro Intensive Pond, Banyuwangi," *Barakuda 45 J. Ilmu Perikan. dan Kelaut.*, vol. 4, no. 2, pp. 180–186, 2022, doi: 10.47685/barakuda45.v4i2.274.

[15] D. Yuska, R. Afriza, and R. Hasniyati, "Shelf Life and Acceptance of Aloe Vera Gel (AVG) Chicken Nuggets as an Alternative Food for School Children," *J. Ilm. Kesehat.*, vol. 6, no. 1, pp. 169–178, Apr. 2024, doi: 10.36590/jika.v6i1.448.

[16] J. Santoso, A. W. N. Yasin, and Santoso, "Pengaruh Pengkomposisian Dan Penyimpanan Dingin Daging Lumat," *Teknol. dan Ind. Pangan*, vol. XIX, no. 1, pp. 57–66, 2008.

[17] I. Sangadji, Jurianto, and M. Rijal, "Lama Penyimpanan Daging Ayam Broiler Terhadap Kualitasnya Ditinjau Dari Kadar Protein Dan Angka Lempeng Total Bakteri ," Jurnal Biology Science & Education, vol. 8, no. 1, pp. 47–56, 2019.

[18] Kurahman, T., Rohama, R. and Saputri, "Analisis Cemaran Bakteri Coliform dan Identifikasi Bakteri Escherechia Coli Pada Air Galon di Desa Sungai Danau, " Journal Pharmaceutical Care and Sciences, vol. 3, no. 1, pp. 76-86, 2022.

[19] M. P. Manullang, I. B. N. Swacita, and I. K. Suada, "Angka Lempeng Total Bakteri pada Daging Ayam Broiler yang Dijual di Beberapa Pasar Tradisional di Denpasar Selatan," *Bul. Vet. Udayana*, p. 1, Feb. 2020, doi: 10.24843/bulvet.2020.v12.i01.p01.

[20] I. Domili, "Tingkat Kesukaan Dan Umur Simpan Nugget Ikan Gabus (Channa Striata) Dengan Penambahan Jagung (Zea Mays L)," *J. Heal. Sci. Gorontalo J. Heal. Sci. Community*, vol. 5, no. 1, pp. 133–145, Apr. 2021, doi: 10.35971/gojhes.v5i1.9346.

[21] A. Hastuti, A. Rahmawati, I. Muharexza, N. Choironi, R. Fatma Pradita, and D. S. Muthiatulmillah, "Analisis Pendugaan Umur Simpan Produk Pangan Beku dalam Kemasan Menggunakan Metode Accerelated Shelf Life Testing (ASLT) Model Arrhenius," *Karimah Tauhid*, vol. 2, no. 3, pp. 665–678, 2023.

[22] E. Zelpina, T. Purnawarman, and D. Widaya, "The presence of coliform in shredded chicken meat of chicken porridge sold around Dramaga Bogor," *J. Food Technol. Nutr.*, vol. 19, no. 1, pp. 1–6, 2020.

[23] I. Suryani, M. Taufik, and A. Sirajuddin, "Kualitas Kimia Nugget Ayam dengan Penambahan Daging Puyuh," *J. Agrisistem*, vol. 15, no. 2, pp. 46–49, 2019.

[24] Fitriyani, D.N., Rahayuni, T. dan Hartanti, L. (2024) 'Formulasi Nugget Tempe dengan Penambahan Jamur Kuping dan Wortel terhadap Karakteristik Fisikokimia dan Sensoris', Jurnal Teknologi dan Industri Pertanian Indonesia, 16(1), Hal. 72, doi.org: 10.17969/jtipi.v16i1.31087.

[25] Sudarta, "Penambahan Natrium Benzoat Dan Kalium Sorbat (Antiinversi) Dan Kecepatan Pengadukan Sebagai Upaya Penghambatan Reaksi Inversi Pada Nira Tebu," vol. 16, no. 1, pp. 1–23, 2022.

[26] F.G. Winarno, " Kimia Pangan dan Gizi", Gramedia Pustaka Utama, Jakarta, 2024.