RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 1(145), January 2024

UDC 639; DOI 10.18551/rjoas.2024-01.07

QUALITY CHARACTERISTICS OF TILAPIA SEAWEED BOBA DURING STORAGE

Aisyah Siti, **Khotimah Iin Khusnul**, **Rahmawati Hafni***, **Normah**, **Amalia Juniar**, **Candra**, **Adawyah Rabiatul**
Study Program of Fish Product Technology, Faculty of Fisheries and Marine Science, University of Lambung Mangkurat, Banjarbaru, Indonesia
*E-mail: hafni.rahmawati@ulm.ac.id

ABSTRACT
Boba from previous research obtained the best formulation, namely the ratio of tapioca flour: tilapia meal: seaweed porridge = 37.5: 12.5: 50. Based on this formulation, further research is needed to determine the shelf life of tilapia seaweed boba. The experimental design used in this research was a factorial RAL using 4 factors consisting of factors A (mixed natural preservatives), B (type of packaging), C (storage temperature), and D (storage time). The natural preservative factor and type of packaging each consist of two levels. The storage temperature and storage time factors each consist of three levels. The natural preservative used in this research was a mixture of cinnamon and cloves, lemon and honey. The types of packaging used are plastic cups and vacuum plastic. The storage temperatures used are room temperature (25°C), cold temperature (4°C), and frozen temperature (-17°C). Storage time was at room temperature on days 1 and 5. Storage time was at a cold temperature (4°C) during the 7th and 14th days. Long storage time at frozen temperature (-17°C) for the 30th and 60th days. The parameters observed consisted of moisture, pH, TVB, and TPC.
The results of this research showed that the tilapia seaweed boba with the best shelf life is the tilapia seaweed boba using a natural preservative, a mixture of lemon and honey, with vacuum plastic packaging, which can last up to 14 days in cold storage (4°C) and at freezing temperatures (-17°C) up to 60 days of safe storage for consumption according to SNI 7266:2014 standards. The quality of tilapia seaweed boba using a natural preservative, a mixture of lemon and honey, with vacuum plastic packaging during cold storage (4°C) for up to 14 days of storage has a moisture value of 64.688%, pH value of 5.6, TVB value of 6 mg/100 grams, and TPC value of 9.1×10^3 cfu/gram. At freezing temperature, storage (-17°C) for up to 60 days of storage has a moisture value of 63.601%, pH value of 4.5, TVB value of 6 mg/100 grams, and TPC value of 1.2×10^3 cfu/gram.

KEY WORDS
Boba, storability, quality, packaging, natural preservative.

Boba is a wet product in small ball form, brownish balls made from tapioca flour as a complementary ingredient or topping to attractive tea drinks or some wet snacks such as Japanese pancakes. The use of boba products is growing in line with the increasing variety of foods and drinks that use boba as an additional ingredient or topping to make the appearance of food and drinks more beautiful and impressive. Apart from making food more attractive, boba also has its own sensation when consumed. The need for boba is also increasing with the increasing popularity of contemporary foods and drinks, so efforts are needed to increase the shelf life of boba products.

The shelf life of a product can be determined by looking at its shelf life. This is important for food products, especially if the food has high moisture content, such as boba. Several things to consider in calculating the shelf life of a product include the preservatives used, whether natural or artificial, the type of packaging, and storage conditions such as temperature and storage time. During storage, there are several changes in chemical and microbiological properties that can be assessed by objective testing (moisture, pH, TVB, and TPC).

Aisyah (2023), the best boba formulation was obtained, namely the ratio of tapioca flour: tilapia meal; and seaweed porridge, namely 37.5:12.5:50, with proximate values of 51.08% moisture, 0.51% ash, protein 8.16%, fat 1.99%, and carbohydrates 89.34%. Next, the research will examine the shelf life and changes in quality of boba during storage using natural preservatives, different types of packaging, temperatures, and storage times.

Natural preservatives commonly used for food in general are salt and sugar crystals, herbs such as cloves and cinnamon, ginger and turmeric rhizomes, onion and garlic bulbs, spices such as pepper and coriander, fruit that can lower pH such as lemon and lime, and leaves such as teak leaves and guava leaves. Meanwhile, the types of packaging that can be used for wet products are plastic, laminated cardboard, aluminum, cans, and glass. Storage conditions, namely the temperature used, usually include cooling and freezing temperatures, low pH, and storage times in days, weeks, months, or years.

Based on several factors that influence the shelf life of the product, the factor that has the most influence on boba products is chosen, namely the use of natural preservatives that are suitable and do not affect the sensory quality of the product and can even increase the organoleptic value of products such as cloves and cinnamon, lemon and honey. The use of all types of packaging is dominated by plastic packaging because, apart from being flexible, it is easy to obtain and relatively cheap. The types of packaging chosen are plastic cups and vacuum plastic. Meanwhile, the storage temperature is observed at room temperature (25°C) after storage days 1 and 5, cold temperature (4°C) after storage days 7 and 14, and freezing temperature (-17°C) after storage days 30 and 60.

The purpose of the research is to determine the shelf life of tilapia seaweed boba using natural preservatives (cloves and cinnamon, lemon and honey), type of packaging (plastic cup and vacuum plastic), storage temperature (room, cold, and frozen), and observe changes in quality during storage time (day 1 and day 5 at room temperature; day 7 and day 14 at cold temperature; and day 30 and day 60 at frozen temperature) as seen from the testing parameters of moisture, pH, TVB, and TPC.

METHODS OF RESEARCH

The equipment used includes boba making equipment, boba storage equipment, namely refrigerators and freezers, as well as testing equipment, including for testing moisture (oven, analytical balance, desiccator, crussable), pH (pH meter), TPC (autoclave, incubator, laminar air flow, colony counter), and TVB (Conway cup, extraction, distillation, and titration equipment).

The main ingredients used in this research to make boba products are tilapia fish meat obtained from the Bauntung Market in Banjarbaru, dried seaweed obtained from Kotabaru, tapioca flour, flavors, and coloring. Natural preservatives consist of cloves, cinnamon, lemon, and honey. Plastic packaging materials consist of plastic cups and vacuum plastic. Apart from that, chemicals are also used for each boba product test.

This research was carried out in the Banjarbaru and Kotabaru City areas to obtain raw materials for making tilapia meal, seaweed porridge and boba products. Boba making is carried out in the PHP FPK ULM laboratory. Product testing at the Faculty of Fisheries and Marine, Lambung Mangkurat University, accredited laboratories, namely, and centers that can collaborate and support research, such as the Cempaka Fishery Products Quality Testing and Monitoring Laboratory and the Banjarbaru Industrial Research and Standardization Center.

This research was carried out in two main stages, namely preparing raw materials for processing boba and observing boba during storage. The first stage is preparing the two main raw materials for making boba consisting of tilapia meal and seaweed porridge, then processing tilapia seaweed boba using the best formula obtained from previous research, namely the ratio of tapioca flour: tilapia meal: seaweed porridge = 37.5:12.5:50, then testing changes in the quality of the boba product during storage.

Research activities are focused on observing changes in the quality and shelf life of tilapia seaweed boba by formulating boba products using the research of Aisyah (2023). Boba product testing includes moisture, pH, TVB, and TPC. More clearly, for research on changes in the quality and shelf life of tilapia seaweed boba, the diagram flow for tilapia meal and seaweed porridge processing can be seen in Figures 1 and 2, and the diagram flow for processing tilapia seaweed boba can be seen in Figure 3.

Tilapia fish obtained from the Bauntung Market in Banjarbaru were selected because they were still alive and weighed around 250 grams. The tilapia fish are then weeded, cleaned, and washed, then taken to the PHP FPK ULM Laboratory to be processed into tilapia meal. The procedures for processing tilapia meal are:

- Separate the meat (fillet) from the bones and skin of the tilapia, then wash the meat with running water until clean;
- Give 1:10 lime juice, namely 1 milliliter of lime juice for 100 grams of tilapia meat, then let it sit for 5 minutes, then wash the meat again until clean;
- Steam the fish meat at 100°C for 30 minutes to soften the meat so it is easy to shred. When steaming, pandan leaves are added to remove the fishy smell of the fish meat and give it the distinctive aroma of pandan;
- Pressing fish meat using a press is intended to reduce water and fat content;
- Roast the fish meat using a frying pan over medium heat at around 70°C for 1 hour while continuing to stir until the fish meat is dry;
- Flour the fish meat using a dry blender, and sift the tilapia meal so that the resulting flour is homogeneous.

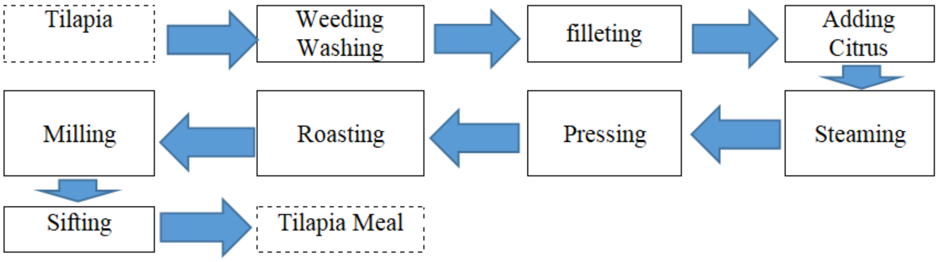

Figure 1 – Tilapia Meal Procedure

The seaweed is obtained from a commercial market that sells dry seaweed of the *Eucheuma cottoni* type, which is of good quality. After arriving at the laboratory, it is tested for proximates and then prepared into seaweed porridge to be used as an ingredient for making boba. The procedures for processing seaweed porridge are:

- Soaking dried seaweed using fresh water at room temperature with a ratio of 1:4, namely 1 kilogram of dried seaweed is soaked in 4 liters of fresh water. Soaking is done overnight, and the soaking water is changed every 3 hours until the seaweed swells and becomes soft again;
- Wash the seaweed with running water until clean, then drain;
- Reduce the size by cutting it into pieces of around 3 cm to make grinding easier, then puree it using a blender, but don't make it too soft.

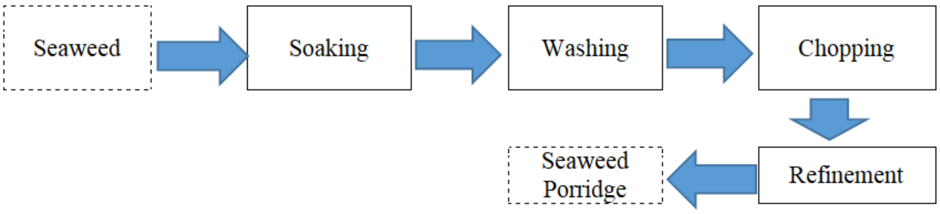

Figure 2 – Seaweed Porridge Procedure

The tilapia meal and seaweed porridge that are ready to be used from the stages above are then mixed to produce boba. The procedures for processing tilapia seaweed boba are:

- Mix tilapia meal, seaweed porridge, and tapioca flour according to the specified treatment until homogeneous;
- Mold the boba dough in the shape of small dots like pearls or bubble balls;
- Boil the molded boba at 100^{o}C for 10–15 minutes until the boba is cooked as indicated by the boba floating;

- Drain the boba until there is no more water left from cooking. This is done so that the boba produced does not contain a lot of water, which can affect the quality and shelf life of the boba. Next, the boba is ready to be stored and analyzed.

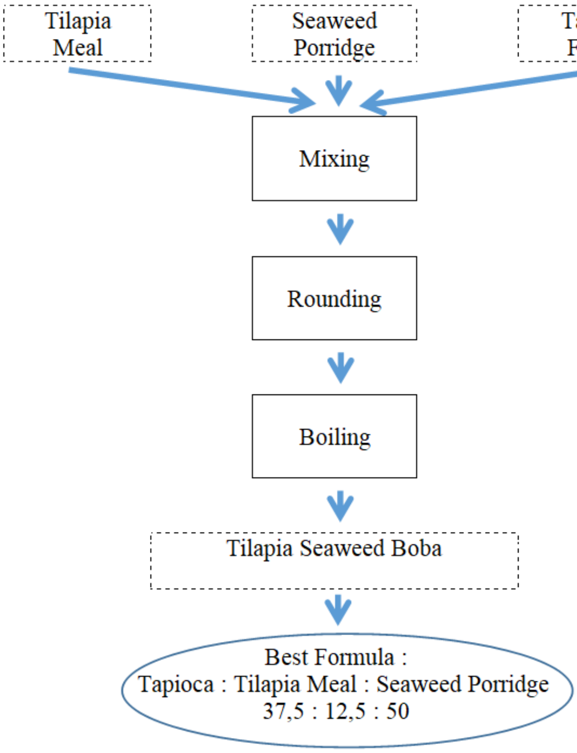

Figure 3 – Tilapia Seaweed Boba Procedure

The testing procedures are based on the following methods: moisture (gravimetry, AOAC, 2005), pH, TVB (Conway method with TCA), and TPC (SNI, 2008).

The experimental design used in this research was a factorial RAL using 4 factors consisting of factors A (mixed natural preservatives), B (type of packaging), C (storage temperature), and D (storage time). The natural preservative factor and type of packaging each consist of 2 levels, and the storage temperature and storage time factors each consist of 3 levels.

The independent variables in this study are variations of four treatment factors, namely:

- A = Mixed natural preservatives;
- A1 = cinnamon and cloves;
- A2 = lemon and honey;
- B = Type of packaging;
- B1 = vacuum plastic;
- B2 = plastic cup;
- C = Storage temperature;
- C1 = room temperature 25^{o}C;
- C2 = cold temperature, 4^{o}C;
- C3 = freezing temperature, -17^{o}C;
- D = Storage time;
- D1 = day 1 and day 5 of storage (D11 and D15);
- D2 = day 7 and day 14 of storage (D27 and D214);
- D3 = day 30 and day 60 of storage (D330 and D360).

The dependent variable in this research is the test parameters consisting of moisture, pH, TVB, and TPC.

The research data was analyzed using the one-way Anova statistical method and continued with the Duncan test using SPSS version 28.0.1 in 2023. Some data was only analyzed narratively by comparing the research results with existing literature or references.

RESULTS AND DISCUSSION

The analysis of variations in moisture, pH, and TVB from tilapia seaweed boba showed that treatments A (mixed natural preservative), B (type of packaging), C (storage temperature), and D (storage time) had a very significant effect on the observed parameters (Tables 1 and 3).

Table 1 – Data on natural preservatives mixed and packaging type of tilapia seaweed boba

Treatment	Parameters		
	Moisture (%)	pH	TVB (mgN/100 gram)
A1B1	67.154 [a]	5.342 [a]	5.333 [a]
A1B2	66.909 [a]	5.342 [a]	10.000 [b]
A2B1	60.423 [b]	5.175 [b]	11.000 [b]
A2B2	61.048 [b]	5.175 [b]	11.333 [b]
SNI 01-2729-2006			<30
SNI 7266:2014	Maks 65		

Note: the same letters in the parameter column indicate no difference significant at p<5%.

The higher moisture results were 66.909–67.154% in treatments A1B1 and A1B2, namely natural preservatives from cinnamon and cloves packaged in vacuum plastic or plastic cups. It is compared with the moisture value in SNI 7266:2014, tilapia seaweed boba in the A1B1 and A1B2 treatments does not meet the SNI standards.

The moisture in treatments A2B1 and A2B2, namely tilapia seaweed boba with natural preservatives from lemon and honey using vacuum plastic packaging, has the lowest moisture, namely 60.423-61.046% (set to the SNI 7266:2014 standards). According to Handayani (2009), lemon juice contains many bioactive compounds, such as citric acid, flavonoids, saponins, limonoids, tannins, and terpenoids. The bioactive compounds contained in lemons each have antibacterial properties.

The lowest moisture is because the effect of vacuum packaging causes decreasing the water content compared to plastic cups, the moisture of tilapia seaweed boba increases according to the water vapor in the air. Products packaged using the vacuum technique have a lower moisture content than those packaged using the non-vaccum technique (Liuhartana and Harris, 2011), and further state that vacuum packaging is more effective in reducing water content during storage due to the vacuum treatment of all water vapor and air contained in the packaging having been sucked out of the packaging first. Vacuum packaging is in a tight vacuum condition and is very dense so that it inhibits the penetration of water into the material from the environment. Harris and Liuhartana (2011) stated that vacuum packaging is waterproof, which acts as a barrier against the entry of water vapor, so that vacuum packaging can inhibit the growth of aerobic microbes, which can damage the tissue structure of the material, so that the process of decomposing bound water into free water in the material can be further prevented.

The pH value of tilapia seaweed boba ranges between 5.175 and 5.342 (acid). In treatments using natural preservatives like cinnamon and cloves, there was no difference in those packaged in vacuum plastic or plastic cups; likewise, for the pH value using natural preservatives like lemon and honey, there was no difference in those packaged in vacuum plastic or plastic cups. The highest TVB content of tilapia seaweed boba was 11.333 mgN/100 grams in the A2B2 treatment, namely a natural preservative made from lemon and honey packaged in a plastic cup. The lowest TVB level was 5.333 mgN/100 grams produced in the A1B1 treatment, namely tilapia seaweed boba, which was added with natural preservatives from cinnamon and cloves in vacuum plastic packaging. According to the Food and Agriculture Service (2021), the contents of cinnamonaldehyde, eugenol, carophyllen, and cineole in cinnamon have been proven to be used as antimicrobials and antifungals.

RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 1(145), January 2024

Table 2 – Data TPC tilapia seaweed boba with mixed natural preservatives and different packaging types at storage temperature

Treatment	Parameter TPC (cfu/g)			SNI Fish Ball (SNI 7266:2017)
	Room Temp (suhu 25°C)	Cold Temp (suhu 4°C)	Frozen Temp (suhu -17°C)	
A1B1	7.1 X 10^7	1.2 x 10^4	3.3 x 10^4	maks 1 x 10^5
A1B2	1.2 X 10^9	6.8 x 10^3	9.6 x 10^3	
A2B1	2.3 x 10^7	0	8.3 x 10^2	
A2B2	TBUD	1.6 x 10^2	7.0 x 10^2	

Note: TBUD = too many to count.

The lowest TPC content value for tilapia seaweed boba stored at room temperature (25°C) was obtained in the A2B1 treatment, namely natural preservatives from lemon and honey with vacuum plastic, amounting to 2.3 x 10^7 cfu/g. When compared with the SNI 7266:2017 standard, it has exceeded the SNI threshold value for fish balls, namely a maximum of 1 x 10^5 cfu/g, so tilapia seaweed boba stored at room temperature (25°C) is no longer suitable for consumption. The TPC content of tilapia seaweed boba stored at cold temperatures (4°C) had the highest value in the A1B1 treatment, namely tilapia seaweed boba, which added natural preservatives from cinnamon and cloves with vacuum plastic packaging, amounting to 1.2 x 10^4 cfu/g. Likewise for tilapia seaweed boba, which is stored at frozen temperatures (-17°C), which is 3.3 x 10^4 cfu/g. The TPC value of tilapia seaweed boba stored at cold and freezing temperatures was compared with the SNI for fish balls (SNI 7266:2017), and the TPC content is still lower, so it is safe for consumption.

Table 3 – Data results from storage temperature and storage time of tilapia seaweed boba

Treatment	Parameter			
	Moisture (%)	pH	TVB	TPC
C1D11	63.800 ^{a}	5.650 ^{a}	6.0 ^{ab}	2.4 x 10^8
C1D15	65.471 ^{ab}	5.625 ^{a}	27.5 ^{c}	1.2 x 10^9
C2D27	64.400 ^{a}	5.663 ^{ac}	2.5 ^{a}	4.5 x 10^2
C2D214	64.688 ^{ac}	5.613 ^{a}	6.0 ^{ab}	9.1 x 10^3
C3D330	61.343 ^{a}	4.500 ^{b}	8.5 ^{b}	2,1 x 10^4
C3D360	63.601 ^{bc}	4.500 ^{b}	6.0 ^{ab}	1.2 x 10^3
SNI 7266:2014	Maks 65			maks 1 x 10^5
SNI 01-2729:2006			<30	

Note: the same letters in the parameter column indicate no difference significant at p<5%.

The highest moisture result was 65.471% in the C1D15 treatment, namely storage at room temperature for 15 days. When compared with the moisture value set by SNI 7266:2014, the tilapia seaweed boba in the C1D15 treatment does not meet the set standards. The water content of tilapia seaweed boba stored at cold temperatures (4°C), namely treatments C2D27 and C2D214, ranged from 64.4 to 64.688%. The water content of boba tilapia seaweed in treatments stored at freezing temperatures (-17°C), namely treatments C3D330 and C3D360, ranged from 61.343 to 63.601%, still within the limits set by SNI 7266:2014, namely a maximum of 65%.

The pH value of tilapia seaweed boba was the lowest in the treatment stored at frozen temperature (-17°C), namely 4.5 (acid). In treatments stored at room temperature and cold temperature, the pH value was almost the same, namely around 5.613–5.663. The highest TVB content of tilapia seaweed boba was 27.5 mgN/100 grams in the C1D15 treatment, namely in the treatment stored at room temperature for 5 days of storage. This is in line with the increase in TPC content in the same treatment, namely 1.2 x 10^9 cfu/g. These parameters are closely related; if TVB levels increase due to an increase in the number of TPC microorganisms that produce volatile bases, The higher the TPC level in tilapia seaweed boba, the higher the TVB level. According to Chamidah (2000), during cold storage, proteins decompose into basic compounds, including ammonia. The pH value of food ingredients during storage can change due to proteins being broken down by proteolytic enzymes and the help of bacteria into carboxylic acid, sulfide acid, ammonia, and other types of acids.

The lowest TVB level of 2.5 mgN/100 grams was produced in the C2D27 treatment, namely tilapia seaweed boba, which was stored at cold temperatures (4°C) for 7 days. This is in line with TPC data in the same treatment, namely 4.5 x 10^2 cfu/g, but the TPC content value of tilapia seaweed boba at room temperature on both the first and 5th days of storage has exceeded the standard limit of SNI 7266:2014 set for fish balls, namely a maximum of 1 x 10^5 cfu/g, so tilapia seaweed boba is not safe to consume if stored at room temperature.

At cold temperatures (4°C), the highest TPC content value was in the A1B1 treatment, namely 1.2 x 10^4 cfu/g. Likewise for tilapia seaweed boba, which is stored at frozen temperatures (-17°C), which is 3.3 x 10^4 cfu/g. The TPC value of tilapia seaweed boba stored at cold and freezing temperatures was compared with the SNI for fish balls (SNI 7266:2017). The TPC of tilapia seaweed boba is still lower, so it is safe for consumption. The process of storing at cold temperatures can inhibit the process of deterioration in the quality of fish and other processed products, including boba, tilapia, and seaweed, when compared to storing at room temperature. According to Erikson and Misimi (2008), enzyme activity and the growth of spoilage bacteria in fish meat can be inhibited if stored at a temperature of 0-4°C. The activity of enzymes and spoilage bacteria can cause various biochemical changes, resulting in changes to the physical, chemical, microbiological, and sensory properties of materials. Anhar (2018) further stated that the use of low temperatures in fishery products is able to inhibit enzyme activity and bacterial growth, so that fish decline will be much slower. The process of storing at cold temperatures can inhibit the process of deterioration in fish quality compared to storing at room temperature.

CONCLUSION

The tilapiaseaweed boba product uses a natural preservative mixed with lemon and honey in vacuum plastic packaging. During cold storage (4°C), it can last until the 14th day of storage, and at frozen temperatures (-17°C), it is safe for consumption according to SNI 7266:2014 standards.

The quality of tilapiaseaweed boba using a natural preservative mixed with lemon and honey in vacuum plastic packaging during cold storage (4°C temperature) until the 14th day of storage has a moisture content of 64.688%, a pH of 5.613, a TVB of 6 mg/100 grams, and a TPC of 9.1 x 10^3 cfu/gram.

The quality of tilapia seaweed boba using a natural preservative mixed with lemon and honey in vacuum plastic packaging during cold storage (temperature -17°C) until the 60th day of storage has a moisture content of 63.601%, a pH of 4.5, a TVB of 6 mg/100 grams, and a TPC of 1.2 x 10^3 cfu/gram.

ACKNOWLEDGMENTS

The researchers would like to express deepest gratitude to LPPM ULM for providing research funding through DIPA Lambung Mangkurat University for Fiscal Year 2023 for the PDWM Intermediate Cluster and Gender Studies program with contract number 065.109/UN8.2/PG/2023.

REFERENCES

1. AOAC. 2005. Official Methods of Analysis. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24.
2. Abdillah AS, D Kristiastuti, A Bahar, A Sutiadiningsih. 2021. Pengaruh Suhu Penyimpanan Terhadap Daya Simpan Selai Lembaran Belimbing Wuluh dan Pepaya. Jurnal Tata Boga 10(1):185-193.

3. Aisyah S, Agustiana, TM Siregar, RA Putri, H Rahmawati. 2023. Formulation and Nutrition of Boba Tilapia Fish and Seaweed as A Generation Z Immune Boost Drink. RJOAS 3(135):157-161.
4. Anhar R. 2018. Quality Deterioration of Catfish (Clarias sp.) During Chilling Storage. Jurnal Perikanan Tropis 5(2): 169-179.
5. Anggraini R, T Sugiarti. 2018. Analisis Pengemasan Jagung Manis (Zea mays l. Saccharata Sturt) Berkelobot dengan Berbagai Bahan Pengemas. FoodTech Jurnal Teknologi Pangan 1(1):25-31.
6. Atmaka W, R Utami, S Raharjo. 2011. Aplikasi Madu sebagai Pengawet Daging Sapi Giling Segar selama Proses Penyimpanan IV(1):58-65.
7. Badan Pengawasan Obat dan Makanan. 2019. Kemasan Pangan. BPOM. Jakarta.
8. Chamidah A, Tjahyono A, dan Rosidi D. 2000. Penggunaan Metode Pengasapan Ikan Cair dalam Pengembangan Ikan Bandeng Asap Tradisional. Jurnal Ilmu-ilmu Teknik 12(1): 1-10.
9. Diyantoro. 2007. Pengaruh Lama Penyimpanan yang Berbeda dalam Campuran Air Laut dan Es Terhadap Kemunduran Mutu Kesegaran Ikan Nila. http://elibrary.ub.ac.id/handle/123456789/24788. 01 April 2023.
10. Dinas Pertanian Pangan. 2021. Perlunya Mengenal Bahan-bahan Alami yang Berpotensi sebagai Pengawet Makanan. https://dinpertanpangan.demakkab.go.id/?p=3750. 01 April 2023.
11. Erlina. 2021. Aplikasi Kitosan sebagai Pengawet pada Produk Bakso Ikan Kambing-kambing (Abalistes stellaris). Arwana: Jurnal Ilmiah Program Studi Perairan 3(1):52–59.
12. Erikson U and Misimi E. 2008. Atlantic Salmon Skin and Fillet Colour Changes Effected by Pre Mortem Handling Stress, Rigormortis, and Ice Storage. Journal of food Science 73(2): 50-259.
13. Fajri DL. 2022. 7 Bahan Pengawet Makanan Alami yang Aman Dikonsumsi. https://katadata.co.id/safrezifitra/berita/6218cb702ab43/7-bahan-pengawet-makanan-alami-yang-aman-dikonsumsi. 01 April 2023.
14. Gitacinta. 2017. Update Resep dan Cara Memasak Rumput Laut Kering jadi Hidangan yang Lezat. https://gitacinta.com/resep-dan-cara-memasak-rumput-laut-kering-jadi-hidangan-yang-lezat.htm. 30 Januari 2022.
15. Handayani VV. 2020. Kandungan Nutrisi yang Terdapat dalam Ikan Nila. https://www.halodoc.com/artikel/kandungan-nutrisi-yang-terdapat-dalam-ikan-nila. 30 Januari 2022.
16. Hidayati L. 2005. Pengaruh Suhu dan Lama Penyimpanan dalam Freezer Lemari Es Terhadap Kandungan Protein dan Jumlah Total Koloni Bakteri Ikan Bandeng (Chanos chanos Forskal). Tesis. UMM. Malang.
17. Kartikorini N. 2018. Pengaruh Lama Perendaman dengan Perasan Jeruk Lemon dan Garam Dapur Terhadap Kadar Protein Tahu. The Journal of Muhammadiyah Medical Laboratory Technologist 1(1):1-8.
18. Labuza TP. 1982. Shelf Life Dating of Foods. Food & Nutrition Press, Inc. Westport.
19. Liu Y, H Cheng and D Wu. 2021. Preparation of the Orange Flavoured “Boba” Ball in Milk Tea and Its Shelf-Life. Appl. Sci. 11(200):1-10.
20. Liuhartana R dan Harris H. 2011. Identifikasi Teknologi Proses Pengolahan dan Analisa Mutu Seluang Kering (pundang) pada Pengolahan secara Tradisional. Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan, 6(1). https://jurnal.univpgri-palembang.ac.id.
21. Mahendradatta M, Adiansyah. 2008. Penggunaan Ekstrak dan Bubuk Cengkeh dan Kayumanis untuk Meminimalkan Kandungan Histamin pada Ikan Kembung Perempuan (Rastrelliger neglectus). Jurnal Perikanan (J. Fish. Sci.) X (1):110-119.
22. Marada H. 2012. Pengaruh Lama Penyimpanan Ikan Cakalang pada Suhu Freezer Terhadap Jumlah Bakteri. Public Health Journal 1(1):1-4.
23. Muliadi D. 2015. Pengaruh Suhu dan Waktu Penyimpanan Terhadap Pertumbuhan Bakteri Staphylococcus aureus pada Makanan Sosis Siap Santap di Medan. Tesis. USU. Medan.

24. Ninsix R, F Azima, Novelina, N Nazir. 2018. Metode Penetapan Titik Kritis, Daya Simpan dan Kemasan Produk Instan Fungsional. Jurnal Teknologi Pertanian 7(1):46-52.
25. Pandit IGS, PANK Permatananda. 2022. Pengaruh Pengemasan Vakum Terhadap Mutu dan Daya Simpan Pindang Tongkol (Auxis tharzad, Lac.). Jurnal Teknologi Pangan dan Gizi 21(1):19-31.
26. Rahmawati ZN, RI Mulyani, KD Utami. 2022. Pengaruh Suhu dan Waktu Penyimpanan dengan Masa Simpan Sosis Ikan Gabus (Channa striata) dan Bayam Merah (Amaranthus SP). Formosa Journal of Science and Technology 1(6):663-672.
27. Safitri D, I Widiada, I Swiryajaya, R Sofiyatin. 2018. Pengaruh Penambahan Bubur Rumput Laut (Eucheuma cottoni) Terhadap Sifat Organoleptik dan Kadar Iodium Dodol Rumput Laut. Jurnal Gizi Prima 3(1):49-53.
28. Siburian ETP, P Dewi, N Kariada. 2012. Pengaruh Suhu dan Waktu Penyimpanan Terhadap Pertumbuhan Bakteri dan Fungi Ikan Bandeng. Unnes Journal of Life Science 1(2):101-105.
29. Siregar SS, F Abadi. 2021. Penerapan Frozen Food Technology di UKM Mimingfish untuk Meningkatkan Diversifikasi Produksi dan Ekonomi. Prosejahtera 3 Maret 2021.
30. Sitakar NM, Nurliana, F Jamin, M Abrar, ZH Manaf, Sugito. 2016. Pengaruh Suhu Pemeliharaan dan Masa Simpan Daging Ikan Nila (Oreochromis niloticus) pada Penyimpanan Suhu -20OC Terhadap Jumlah Total Bakteri. Jurnal Medika Veterinaria 10(2):162-165.
31. SNI. 2006. SNI 01-2346-2006 Petunjuk Pengujian Organoleptik dan atau Sensori. Standar Nasional Indonesia. Jakarta.
32. SNI. 2008. SNI 2897:2008 Metode Pengujian Cemaran Mikroba dalam Daging, Telur, dan Susu, serta Hasil Olahannya. Badan Standardisasi Nasional. Jakarta.
33. Shanti DGDD. 2016. Plastik sebagai Kemasan Makanan dan Minuman. PSPD FK UNUD. Padang.
34. Simatupang YC, MS Mahendra, AAG Sugiarta. 2021. Pengaruh Ukuran Wadah Kemasan Mika Terhadap Kualitas dan Umur Simpan Buah Stroberi (Fragaria sp.). Agrotrop 11(1):50-62.
35. Sudarmadji S, B Haryono dan Suhardi. 2015. Prosedur Analisa untuk Bahan Makanan dan Pertanian. Liberty. Yogyakarta.
36. Suparmi, A Sahri. 2009. Mengenal Potensi Rumput Laut: Kajian Pemanfaatan Sumber Daya Rumput Laut dari Aspek Industri dan Kesehatan. Sultan Agung 44(118):95-116.
37. Tantalu L, Isrofatin, IG Bano, YD Kaka. 2018. Efektivitas Kemasan Standing Pouch Pasta Bawang Merah pada Penyimpanan Suhu Beku dan Suhu Ruang. Prosiding Seminar Nasional Teknologi Industri, Lingkungan dan Infrastruktur (SENTIKUIN) Vol 1 Tahun 2018 B3.1-B3.6.