AG RE | Agriculture Reports

Volume 2 Issue 2 (2023) Pages 17-24

Acceptability of Minimally Processed Sea Urchin (*Tripneustes gratilla*) Roes

Adalin H. Arupin[1,2], Usman U. Hajan[1], Jurma A. Tikmasan[1,2], Merilyn Q. Amlani[1], Iannie P. Maribao[1], Albaris B. Tahiluddin[1*]

[1]College of Fisheries, Mindanao State University-Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi 7500, Philippines

[2]Food Innovation Center, Mindanao State University-Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi 7500, Philippines

*Correspondence: albarist20@gmail.com at College of Fisheries, Mindanao State University-Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi 7500, Philippines

Citation: Arupin, A.H., Hajan, U.U., Tikmasan, J.A., Amlani, M.Q., Maribao, I.P., Tahiluddin, A.B. (2023). Agriculture Reports, 2(2): 17-24.

Received: 30 July 2023
Accepted: 15 August 2023
Published: 31 August 2023
eISSN Number: 2948-4138

Keywords: Sea urchin roes, minimally processed, brining, vinegar, sensory evaluation.

Abstract: Due to the perishable nature of sea urchin roe, it is necessary to study its preservation techniques. In this work, we evaluated the quality of minimally processed roes of sea urchin (*Tripneustes gratilla*). The roe samples were subjected to steaming, underwent various pre-treatments, then eventually chilled before sensory evaluation. These pre-treatments were Treatment A (water), Treatment B (2% brine solution), and Treatment C (2% vinegar). The sensory characteristics such as color, odor, flavor, texture, and the overall acceptability of the minimally processed sea urchin roes were evaluated by the panelists using the three (3) - point hedonic scales. Results showed that there were no significant differences ($p>0.05$) among the overall acceptability, color, odor, and texture. However, in terms of flavor attributes of the minimally processed sea urchin roes, it showed that there was a significant difference ($p<0.05$) between treatment A and B on day 1 of storage, but for the succeeding days of storage, there were no significant differences ($p>0.05$) among the mean scores. Overall, the current study suggests that sea urchin roes can be minimally processed by steaming, undergoing pre-treatment in water, brine, and vinegar, and subsequently chilling for 6 days, with general acceptability attributes. This study's findings offer valuable insights into preserving the sea urchin roes and recommend standard marketing practices to enhance its shelf life, ensuring consumer safety and product quality.

INTRODUCTION

Sea urchin (*Tripneustes gratilla*) sea urchin roes, known for its distinct flavor and texture, is a highly sought-after delicacy in many culinary cultures (Stefánsson et al., 2017). It is considered the expensive traditional delicacy "*uni*" in Japanese cuisine (Soleimani et al., 2022). However, the perishable nature of minimally processed sea urchin roes presents challenges in maintaining its quality and extending its shelf life (Verachia et al., 2022; Tahiluddin et al., 2022). To ensure consumer satisfaction and reduce post-harvest losses, it is crucial to evaluate the quality of minimally processed sea urchin roes. This study aimed to assess the sensory attributes, processing techniques, and storage conditions that impact the quality of sea urchin roes.

Sensory evaluation plays a pivotal role in determining the acceptability and desirability of seafood products (Ajik-Cerbas et al., 2022). Previous studies have emphasized the importance of sensory attributes such as taste, texture, and odor in evaluating the quality of sea urchin roes (Siikavuopio et al., 2007; Walker et al., 2015; Baião et al., 2021; Verachia et al., 2022; Amlani et al., 2022). Understanding the sensory properties of minimally processed sea urchin roes provides valuable insights into consumer preferences and aids in the development of proper processing and storage practices. Various processing techniques have been explored to maintain the quality and extend the shelf life of the sea urchin roes. Cold storage or chilling is a commonly employed method to slow down enzymatic reactions and microbial growth, thus preserving the freshness of the sea urchin roes (Ali et al., 2022). Additionally, brining solutions have shown promise in enhancing the texture and flavor of sea urchin roes while maintaining their overall quality (Verachia et al., 2022). These processing techniques offer potential strategies for enhancing the marketability and value of the minimally processed sea urchin roes.

Furthermore, storage conditions significantly influence the shelf life of seafood products. Research has shown that modified atmosphere packaging (MAP) with controlled gas composition and appropriate packaging materials can effectively extend the shelf life of fish and fishery products (DeWitt & Oliveira, 2016). Optimizing the storage conditions, including temperature control and oxygen levels, is essential for preserving the sensory characteristics and overall quality of the sea urchin roes (Zhao et al., 2019).

In light of the limited research available on the quality evaluation of the minimally processed sea urchin roes, this study aimed to fill the existing knowledge gap. By conducting a comprehensive assessment, this research will provide valuable insights into the sensory attributes, processing techniques, and storage conditions that may impact the quality of the sea urchin roes. The findings in this study will contribute to the development of standardized practices, thereby enhancing the marketability, safety, and consumer satisfaction of minimally processed sea urchin roes.

MATERIALS AND METHODS

Study Site

The study was conducted at the College of Fisheries, Mindanao State University Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines.

Preparation of the Raw Materials

The raw materials, sea urchins (*T. gratilla*), were purchased from the Badjao community near the study site at a rate of ₱1.50 per unit, with a total of 1,000 pieces required for this study. The purchased sea urchins were transported to the study site. Upon arrival at the study site, the sea urchins were weighed, cleaned, and steamed for 2 minutes before the collection of the sea urchin roes. Then, the shell of each sea urchin was opened across the body near the ventral side, and sea urchin roes were collected by scraping with a rubber spatula.

Treatment of the Sea urchin roes

After steaming, the collected sea urchin roes were treated with water, a 2% brine solution, and a 2% vinegar solution. The treated sea urchin roes were chilled and stored at a temperature of 4ºC. Table 1. Represents the code for the identification of the samples. The entire process can be seen in Figure 1.

Table 1. Sample Identification and its corresponding treatment used.

Code	Treatment	Storage
A	Water	6 days
B	2% Brine Solution	6 days
C	2% Vinegar	6 days

Sensory Evaluation of the Sea urchin roes

All treated sea urchin roes were evaluated by ten panelists. Sensory attributes such as color, odor, flavor, texture, and general acceptability were evaluated using the 3-point hedonic scale ranging from score 1-3: orange to greenish brown for color, fishy to aromatic for odor, salty to sweet for flavor; smooth to sticky for texture, and not acceptable to highly acceptable for general acceptability. The sensory evaluation of the sea urchin roes took place on the first, third, and sixth day of the storage under 4ºC. The whole process is illustrated in Figure 1.

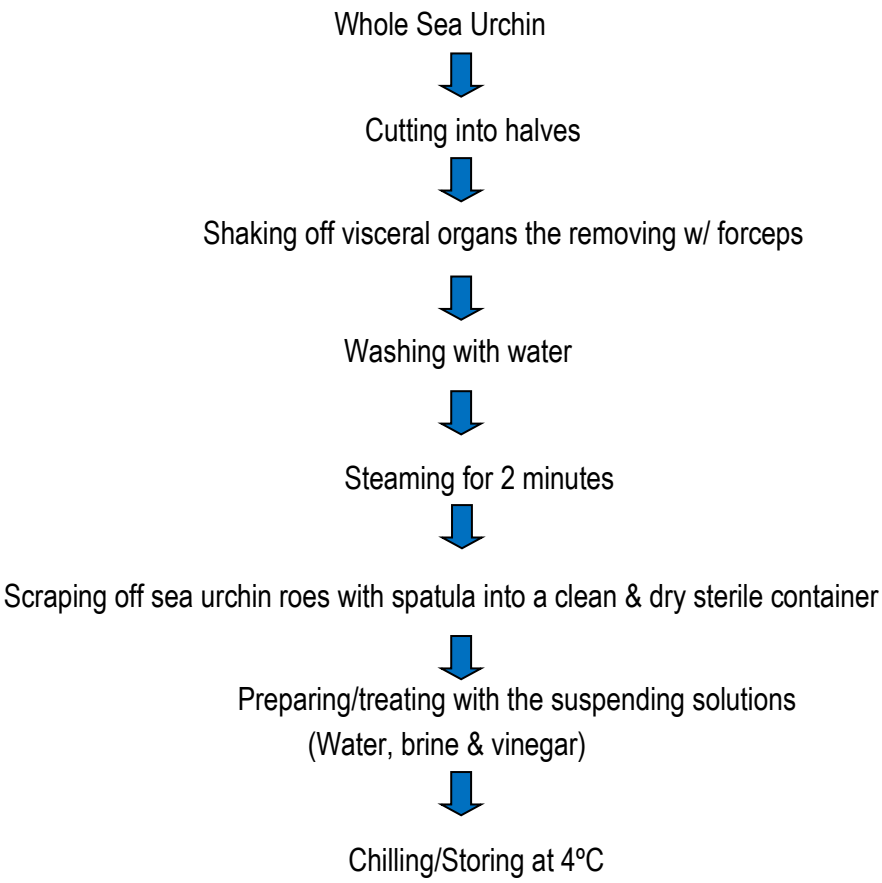

Figure 1. Processing of sea urchin sea urchin roes

Statistical Analysis

To determine the best treatment among the three, a one-way Analysis of Variance (ANOVA) statistical tool was used to analyze the data collected. A post-hoc test was employed to rank the means. The level of significance was set to 0.05.

RESULTS

The general acceptability of minimally processed sea urchin roes is shown in Table 2. All treatments (A, B, and C) showed no significant difference ($p>0.05$) in terms of general acceptability with mean scores of 2.35± 0.53, 2.45 ± 0.50, and 2.20 ± 0.42, respectively, on day 1, 2.22 ± 0.35, 2.38 ± 0.36, and 2.20 ± 0.35 on day 3, and remain acceptable on day 6 with mean scores of 2.05 ± 0.44, 2.35 ± 0.67, and 2.00 ± 0.47, respectively.

Table 2. General acceptability score of minimally processed sea urchin roes.

Treatments	Day 1	Day 3	Day 6
A (water)	2.35±0.53[a]	2.22±0.35[a]	2.05±0.44[a]
B (2% brine)	2.45±0.50[a]	2.38±0.36[a]	2.35±0.67[a]

C (2% vinegar)	2.20±0.42[a]	2.20±0.35[a]	2.00±0.47[a]

Scale: 3-highly acceptable, 2-acceptable, and 1-not acceptable.

Regarding the sensory evaluation of the texture of fresh sea urchin roes (Table 3), the three treatments (A, B, and C) displayed no significant difference ($p>0.05$) on day 1 with mean scores of 2.15 ± 0.70, 2.15 ± 0.67, and 1.90 ± 0.57, indicating of almost tender in texture. On day 3, the mean scores of texture were 1.75 ± 0.76, 1.85 ± 0.75, and 2.00 ± 0.47, respectively, and slightly changed on day 6 with mean scores of 1.5 ± 0.67, 1.95 ± 0.55, and 1.70 ± 0.59, respectively, indicating between tender to smooth textures. However, statistical analysis revealed no significant difference ($p>0.05$) among the treatments on days 3 and 6.

Table 3. Texture score of minimally processed sea urchin roes.

Treatments	Day 1	Day 3	Day 6
A (water)	2.15±0.70[a]	1.75±0.76[a]	1.5±0.67[a]
B (2% brine)	2.15±0.67[a]	1.85±0.75[a]	1.95±0.55[a]
C (2% vinegar)	1.90±0.57[a]	2.00±0.47[a]	1.70±0.59[a]

Scale: 3-sticky, 2-tender, and 1-smooth.

The flavor score of minimally processed sea urchin roes is given in Table 4. On day 1, the flavor scores of Treatment A (2.85 ± 0.24) and Treatment C (2.50 ± 0.82) were significantly higher ($p<0.05$) than Treatment C (1.60 ± 0.57), which is described as nearly sweet. However, no substantial difference ($p>0.05$) in flavor scores of Treatment A, B, and C were observed on day 3 (1.70 ± 0.76, 1.70 ± 0.75, and 2.45 ± 0.55) and day 6 (2.00 ± 1.03, 1.65 ± 1.06, and 2.25 ± 1.03), indicating of flavor between bitter and sweet.

Table 4. Flavor score of minimally processed sea urchin roes.

Treatments	Day 1	Day 3	Day 6
A (water)	2.85±0.24[a]	1.70±0.76[a]	2.00±1.03[a]
B (2% brine)	1.60±0.57[b]	1.70±0.75[a]	1.65±1.06[a]
C (2% vinegar)	2.50±0.82[ab]	2.45±0.55[a]	2.25±1.03[a]

Scale: 3-sweet, 2-bitter, and 1-salty.

The evaluation of odor in the fresh sea urchin roes revealed is shown in Table 5. The odor scores of Treatments A, B, and C were 2.35 ± 0.88, 2.25 ± 0.43, and 2.10 ± 0.77, respectively, on day 1, describing an odor ranging from strong to aromatic. On day 3, the odor scores of Treatments A, B, and C were 2.05 ± 0.93, 1.90 ± 0.97, and 2.05 ± 0.76, respectively. After six days of storage, the mean scores of odor on Treatments A, B, and C were 1.95 ± 0.60, 2.10 ± 1.08, and 1.95 ± 0.88, respectively, which described as nearly strong odor. Analysis showed that all treatments were not significantly different ($p>0.05$) on days 1, 3, and 6.

Table 5. Odor score of minimally processed sea urchin roes.

Treatments	Day 1	Day 3	Day 6
A (water)	2.35±0.88[a]	2.05±0.93[a]	1.95±0.60[a]
B (2% brine)	2.25±0.43[a]	1.90±0.97[a]	2.10±1.08[a]
C (2% vinegar)	2.10±0.77[a]	2.05±0.76[a]	1.95±0.88[a]

Scale: 3-aromatic, 2-strong, and 1-fishy

The color score of minimally processed sea urchin roes is depicted in Table 6. The color scores of Treatment A (1.70 ± 0.86), Treatment B (1.95 ± 0.50), and Treatment C (1.80 ± 0.75) on day one did significantly vary, which were described as almost yellow in color. On day 3 of evaluation, the color scores of Treatment A (1.80 ± 0.89), Treatment B (1.55 ± 0.50), and Treatment C (1.85 ± 0.53) also showed no remarkable difference ($p>0.05$). After six days of storage, the color scores of Treatments A, B, and C were 2.00 ± 0.62, 1.50 ± 0.82, and 1.60 ± 0.88, respectively, indicating color ranging from orange to yellow. However, there was also no statistical difference ($p>0.05$) in the color scores as evaluated by the panelists.

Table 6. Color score of minimally processed sea urchin roes.

Treatments	Day 1	Day 3	Day 6
A (water)	1.70±0.86[a]	1.80±0.89[a]	2.00±0.62[a]
B (2% brine)	1.95±0.50[a]	1.55±0.50[a]	1.50±0.82[a]
C (2% vinegar)	1.80±0.75[a]	1.85±0.53[a]	1.60±0.88[a]

Scale: 3-greenish brown, 2-yellow, and 1-orange

DISCUSSION

Sea urchin roe has great potential in the food processing sector due to its high demand worldwide, especially in Japan, where it is considered a delicacy and consumes 80-90% of the current global supply (Food Export Association, 2016; Stefánsson et al., 2017). It can be eaten in a variety of forms, such as raw, served with rice, added to soups and stews, or used as a garnish, dip, sauce, or patés (Andrew et al., 2002; Stefánsson et al., 2017). Tawi-Tawi, Philippines, is renowned for its abundance of sea urchins (*T. gratilla*), which are commonly sold and consumed by locals. In the Islamic holy month of Ramadan, Tawi-Tawi people usually eat sea urchin roe to break their fast, whether processed minimally or cooked with rice (Amlani et al., 2022). In spite of the obvious demand for sea urchin roes, post-harvest losses are still increasing due to its high perishability caused by a number of factors, such as improper handling and processing as well as storage temperature, leading to a reduction in quality and shelf life. As a result, this study utilized both traditional (the addition of salt and vinegar and the application of heat through steaming) and non-traditional (chilling) preservation techniques. Salt and vinegar have long been appreciated for their ability to tenderize, preserve, enhance flavor and color, and minimize unwanted odors in aquatic food, meat, and poultry processing (Barbut, 2015; Sarker et al., 2021., Palma et al., 2023). Moreover, steaming is one of the most convenient means of food preservation, for it retains more of the nutrients present in the food product. Since most foods are perishable, lowering their temperatures, such as chilling, is a common method for extending shelf life and reducing bacterial growth that can cause food-borne illnesses (Stonehouse & Evans, 2015).

Sensory evaluation is a common and widely used method to evaluate the quality of food products. It involves all the human senses where such attributes are evaluated, such as color, odor, flavor, and texture. The results of the sensory evaluation represent the consumer's perception of the quality of the products as a basis for development, marketing, and safety (Amlani et al., 2022). Roe's quality is heavily influenced by its appearance. There are a number of factors that Japanese buyers and wholesalers consider when purchasing or trading roe in the market, including color, size, texture, presentation, season, origin, and quality of roe. An excellent sea urchin roe will have an orange-to-yellow color and a delicate ocean flavor. In lower grades, sea urchin roe is brown and bitter (Stefánsson et al., 2017). Today, minimally processed food is becoming more popular than frozen and canned foods (Mohan et al., 2017). Thus, the results mentioned above are important for future post-harvest applications for the preservation of minimally processed sea urchin roes.

The study revealed that steamed sea urchin roes treated with either water, brine, or vinegar and stored at 4˚C have been found to be acceptable to consumers and can be applicable for the preservation of the roe. It was noted that the product was still fresh and delicious on the first day of evaluation. As of the 3rd day, the sea urchin roes were still edible and did not show any signs of deterioration.

Nevertheless, after the sixth day, the sea urchin roes were soft and melted from absorption of the solutions, although they remained tasty and acceptable. The delicate roe will only last for a few days in the chiller, even if treated with the utmost care (Stefánsson et al., 2017). For this reason, brine and vinegar solutions can be added to improve the sensory properties and lengthen the shelf-life of sea urchin roe, similar to other seafood products (Tahiluddin & Kadak, 2022). Steaming as pre-treatment also contributed to the preservation of a fragile and perishable sea urchin roe, as proven in the findings of Amlani et al. (2022), which studied the roe's different steaming times. The sensory properties of brined and marinated Pacific saury fillets were examined by Sallam et al. (2007), who concluded that marination enhances the sensory properties and extends the shelf life of the product. In a similar study, Lingham et al. (2012) determined that vinegar diluted to 0.5% acetic acid could extend shelf life and increase consumer appeal in catfish fillets. Sea urchin roe is also a popular Japanese food, usually preserved in bottles with brine (Andrew et al., 2002).

Comparing these findings to existing literature, it is important to note that research on the sensory evaluation of sea urchin roes treated with different solutions may vary. Some studies may highlight the effectiveness of brine solutions in enhancing the sensory attributes and shelf life of sea urchin roes, aligning with the current findings. Other research may explore alternative treatments or combinations of solutions to achieve similar or even better results. It is crucial to consider the specific context, such as regional preferences, processing techniques, and variations in sea urchin species, as these factors can influence the outcomes and may differ across studies. Furthermore, the sensory evaluations in this study were conducted over a period of six days, which may differ from the evaluation durations used in other research. All in all, this study provides options for the minimal processing of sea urchin roe, providing significant information for the possible post-harvest processing technique, enhancing its market potential, and being economically established.

CONCLUSION

In conclusion, these findings provide valuable insights into the sensory acceptability of sea urchin roes treated with different solutions. They contribute to the existing literature by emphasizing the favorable outcomes of the water, 2% brine, and 2% vinegar solution treatments after steaming and subsequently chilling for up to 6 days. Further research can build upon these findings to explore additional treatments, evaluate longer shelf life periods, and consider other factors that may impact the sensory qualities of sea urchin roes.

Patents

Not applicable.

Author Contribution

Conceptualization, A.H.A. & J.A.T.; Investigation, A.H.A. & U.U.H.; Writing—original draft preparation, A.H.A., U.U.H, M.Q.A., I.P.M. & A.B.T; Writing—review and editing, J.A.T., M.Q.A., I.P.M. & A.B.T.

Funding: This research was funded by the Mindanao State University-Tawi-Tawi College of Technology and Oceanography.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable

Conflicts of Interest: No conflict of interest

References

Ajik-Cerbas, Q. H., Jumdain, R. T., & Tahiluddin, A. B. (2022). Acceptability and shelf-life testing of newly formulated crab balls from blue swimming crab (*Portunus pelagicus*). *Akademik Gıda, 20(3)*, 199-210.

Ali, A., Wei, S., Ali, A., Khan, I., Sun, Q., Xia, Q., ... & Liu, S. (2022). Research progress on nutritional value, preservation and processing of fish—A review. *Foods, 11(22)*, 3669.

Amlani, M. Q., Abubakar, N. A., Deong, N. M., Tikmasan, J. A., Abduhasan, F. S., Imlani, A., & Tahiluddin, A. B. (2022). Sensory characteristics of dried and rehydrated sea urchin *Tripneustes gratilla* roe with different steaming times as pre-treatment. *Food Bulletin*, *1*(1), 1-6. https://doi.org/10.29329/foodb.2022.495.01

Andrew, N. L., Agatsuma, Y., Ballesteros, E., Bazhin, A. G., Creaser, E. P., Barnes, D. K. A., ... & Xiaoqi, Z. (2002). Status and management of world sea urchin fisheries. *Oceanography and marine biology*, *40*(40), 343-425.

Baião, L. F., Rocha, C., Lima, R. C., Marques, A., Valente, L. M., & Cunha, L. M. (2021). Sensory profiling, liking and acceptance of sea urchin roes from the north atlantic coast of Portugal, aiming future aquaculture applications. *Food Research International*, 140, 109873.

Barbut, S. (2015). The science of poultry and meat processing. 1-93.

DeWitt, C. A. M., & Oliveira, A. C. (2016). Modified atmosphere systems and shelf life extension of fish and fishery products. *Foods,* 5(3), 48.

Food Export Association. (2016). European market profile. Retrieved from Food Export Association: https://www.foodexport.org/get-started/country-market-profilesOLD/european-market-profile

Lingham, T., Besong, S., Ozbay, G., & Lee, J. L. (2012). Antimicrobial activity of vinegar on bacterial species isolated from retails and local channel catfish (*Ictalurus punctatus*). *J. Food Process Technol,* S11-001. *S11-001*, *2*, 25-28.

Mohan, C. O., Ravishankar, C. N., & Srinivasa Gopal, T. K. (2017). Effect of vacuum packaging and sous vide processing on the quality of Indian white shrimp (*Fenneropenaeus indicus*) during chilled storage. *Journal of Aquatic Food Product Technology*, *26*(10), 1280-1292.

Palma, R. M., Panglilingan, J., Salasain, I. M., Alawi, A. A., Tikmasan, J., Abduhasan, F., Shariff, R., Sarri, J., & Maribao, I. (2023). Sensory properties of sweet and spicy fish flakes using vinegar and water as pre-treatment. *European Food Science and Engineering*, *4*(1), 10-14.

Sallam, K. I., Ahmed, A. M., Elgazzar, M. M., & Eldaly, E. A. (2007). Chemical quality and sensory attributes of marinated Pacific saury (*Cololabis saira*) during vacuum-packaged storage at 4 C. *Food Chemistry*, *102*(4), 1061-1070.

Sarker, M. I. A., Hashem, M. A., Azad, M. A. K., Ali, M. S., & Rahman, M. M. (2021). Food grade vinegar acts as an effective tool for short-term meat preservation. *Meat Research*, *1*(1) doi:10.55002/mr.1.1.5

Siikavuopio, S. I., Dale, T., & Carlehög, M. (2007). Sensory quality of gonads from the green sea urchin, *Strongylocentrotus droebachiensis*, fed different diets. *Journal of Shellfish Research*, *26*(2), 637-643.

Soleimani, S., Mashjoor, S., Yousefzadi, M., & Kumar, M. (2022). Multi-target bioactivity of summer quinones production in the Persian Gulf burrowing black-type sea urchin. *Heliyon, 8(3)*, e09044.

Stefánsson, G., Kristinsson, H., Ziemer, N., Hannon, C., & James, P. (2017). Markets for sea urchins: a review of global supply and markets. *Skýrsla Matís*, 45, 10-17.

Stonehouse, G. G., & Evans, J. A. (2015). The use of supercooling for fresh foods: A review. *Journal of Food Engineering*, *148*, 74-79.

Tahiluddin A.B. & Kadak A.E. (2022). Traditional fish processing techniques applied in the Philippines and Turkey. *Menba Kastamonu University Faculty of Fisheries Journal, 8(1)*, 50-58.

Tahiluddin, A. B., Maribao, I. P., Amlani, M. Q., & Sarri, J. H. (2022). A Review on Spoilage Microorganisms in Fresh and Processed Aquatic Food Products. *Food Bulletin*, *1*(1), 21-36

Verachia, W., Bekhit, A. E. D. A., Carne, A., & Bekhit, A. A. (2022). Fish sea urchin roes from sea urchin: composition, processing, and quality aspects. In Fish Sea urchin roes (pp. 143-181). Academic Press.

Walker, C. W., Böttger, S. A., Unuma, T., Watts, S. A., Harris, L. G., Lawrence, A. L., & Eddy, S. D. (2015). Enhancing the commercial quality of edible sea urchin roes—technologies emphasizing nutritive phagocytes. *Echinoderm Aquaculture*, 263-286.

Zhao, Y. M., de Alba, M., Sun, D. W., & Tiwari, B. (2019). Principles and recent applications of novel non-thermal processing technologies for the fish industry—A review. *Critical Reviews in Food Science and Nutrition, 59(5)*, 728-742.