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The Production Process of Oysters (Cassostrea gigas) for High Quality Products in the Sakoshi Fishermen's Group, Ako, Japan

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ABSTRACT

Pacific oysters can be marketed either dead or alive with their shells (karatsuki), which are known for their high quality due to their ability to retain moisture, natural flavor, and luxurious appeal. This study examines the production process of oysters by fishermen in Sakoshi Bay, Ako, utilizing precise methods from cleaning, sorting, storing, to packaging. Observation and interview methods were used to obtain data on the production process. The results show that processing according to standards and the skilled experience of Sakoshi fishermen maintain the quality of the oysters. The combination of modern technology and traditional knowledge provides a competitive advantage. This research emphasizes the importance of proper production methods in maintaining the quality of fishery products and offers insights into best practices that other producers can adopt.

INTRODUCTION

The Pacific oyster (*Cassostrea gigas*), also known as Makagi oyster, is a species of oyster frequently utilized and cultivated in coastal regions such as China, the United States, South Korea, and Japan (Hasegawa et al., 2021). Japan is the third-largest producer of Pacific oysters (Botta et al., 2020). In fact, half of Japan's Bivalvia production consists of Pacific oysters. The oyster meat is often used as a raw material for cosmetics, medicines, and primarily as food. Oyster meat is a high-protein source rich in zinc, which is necessary for tissue repair, boosting the immune system, wound healing, and cell growth (Trumbo et al., 2001). Additionally, the omega-3 and vitamin B12 content in oysters helps enhance brain function and can help reduce the risk of neurodegenerative diseases (Calder, 2013) and is beneficial for heart health (Kris et al., 2002).

In Japan, Pacific oysters can be sold either alive or dead. Oysters sold alive with their shells (*karatsuki*) are of higher quality and have greater economic value. Live oyster products are often marketed as raw materials for food in high-end restaurants or special events (Gempesaw et al., 1995). The advantage of karatsuki

oysters is their better-maintained freshness, as their shells help protect the oyster meat from contamination and evaporation (Li and Southgate, 2008). Additionally, serving oysters with their shells provides a more authentic and luxurious dining experience, as consumers can open the shells themselves and enjoy fresh oyster meat directly from the source.

The Pacific oyster is a hermaphrodite. Sperm and eggs are simultaneously released into the sea during the summer. The fertilized eggs develop into larvae and float in the ocean. After two weeks, the larvae attach to a hard surface, such as rocks or specially prepared oyster shells for cultivation. Unlike mussels, oysters remain attached for their entire lives and do not move. Oysters have two shell parts, a left and a right shell, which can open and close using the adductor muscle. Oyster shells tend to be rougher and more textured compared to mussel shells. Like other Bivalvia, Pacific oysters are filter feeders. They obtain food by filtering plankton and other suspended organic materials from the water in their habitat.

Due to their feeding habits, the quality of oysters can be influenced by their production location. According to Babaei et al. (2010) in Abelha and Goulart (2008), the quality, growth, and shell shape of oysters are also affected by biological factors (such as age and seed quality) and environmental factors (such as food availability, water quality, depth and current, sediment type, and density). Oysters produced in polluted waters will have contaminated meat. Oyster production is typically carried out in calm waters that are rich in nutrients and plankton. One area in Japan suitable for Pacific oyster production is the waters of Sakoshi Bay in Ako City, Hyogo Prefecture.

In addition to the environment, the production methods from start to finish must be carefully considered to obtain a high-quality product. Sorting and processing oysters are crucial to ensure the best quality product, as these steps help remove impurities, ensure uniformity in size and condition, and maintain cleanliness and freshness. This ensures that the final product meets quality and food safety standards (Gentry et al., 2017).

LITERATURE REVIEW

Oysters sold with their shells (Karatsuki) are generally of higher quality compared to those marketed without shells. However, not all oysters sold with their shells (Karatsuki) are of high quality. Oysters with shells tend to be fresher because their shells retain moisture and the natural flavor of the oysters (Xu et al., 2020), and they provide a more authentic and enjoyable eating experience (Smith & Davis, 2019). Additionally, their nutritional content is better preserved due to less exposure to air and contamination (Johnson et al., 2018). Aesthetically, oysters in shells are more appealing and are often used in food presentations in upscale restaurants (Smith & Davis, 2019). The oyster shell also helps protect the oyster meat from damage and contamination, allowing the oysters to stay fresh longer and

reducing the risk of contamination (Xu et al., 2020; Johnson et al., 2018). One common indicator can be the price and the place where the oysters are sold. Typically, oysters sold in supermarkets or similar places at affordable prices are not of high quality.

High-quality oysters with shells can be sold at a premium price. Usually, high-quality oysters are sold directly to restaurants or through special orders. In contrast, medium-quality Karatsuki oysters are sold in stores or modern markets. In restaurants, Karatsuki oysters are often served as luxurious and exclusive dishes, often as raw oysters on ice or in various gourmet recipes (Brown et al., 2019). Additionally, Karatsuki oysters are also exported to various countries with high demand for fresh and high-quality seafood, such as the United States, Canada, France, and other European countries (Johnson & Smith, 2020; Jones et al., 2018).

METHOD

This study was conducted from October 2023 to June 2024. The research was carried out descriptively with a quantitative approach, observing and contributing to the production process of an oyster farming company in Sakoshi Bay, Ako City, Hyogo Prefecture, Japan.

The data collection methods included direct observation of daily activities in the production of high-quality oysters (Karatsuki) and in-depth interviews with operators directly involved. This approach aimed to gain firsthand insights from their perspectives on the challenges, best practices, and opportunities for improving the quality and efficiency of the process. Documentation of activities was also an essential part of this study, ensuring that every detail of the process was accurately recorded for further analysis and the development of improvement recommendations. After the data was collected, descriptive analysis was conducted based on the oyster production process, from sorting to packaging, which was directly observed, along with interviews with relevant sources. This approach aimed to provide a detailed overview of the methods used in oyster production and the practical insights and experiences of the interviewees.

RESULT AND DISCUSSION

Oyster Processing Process

The first stage is sorting. The sorting process is carried out immediately after the oysters are harvested each day. Sorting is done three times in one day of production. The first sorting takes place on the boat by selecting large-sized oysters. The pile of oysters is transported via a conveyor into the production area. The sorted oysters are picked by hand and placed in basket containers.

The oysters sorted in the first stage are washed and sorted again. This second sorting process is accompanied by the separation of oysters that are stuck together. The attached oysters are separated using a manually operated separator. According

to Comeau (2013), separating attached oysters before sale ensures that each oyster has a good shape and uniform size, thereby enhancing the quality and market value of the product. This separation also helps reduce the risk of contamination and maintains the freshness of the oysters until they reach the consumer. Operators in this stage are required to have the ability to carefully distinguish the quality of the oysters. Mistakes made at this stage can impact the efficiency of subsequent processes. Oysters that do not pass the selection are transferred to the shucking section (kaki muki) to have their meat removed from the shells.

Picture 1. Oyster separator (left) and oyster shell cleaning machine (right).

After the first and second sorting processes, the oysters undergo the first cleaning process. The first cleaning involves removing hard objects or organisms attached to the shells, such as barnacles. According to Patrick & Kerrigan (2014), cleaning barnacles off oyster shells prevents shell damage and enhances the quality and market value of the oysters. Barnacles can obstruct oyster growth, affect their health, and cause mechanical damage to the shells, so cleaning them is crucial to ensuring optimal growth and high-quality oysters. The cleaning process is carried out using a barnacle-removing machine that operates like a drill and a sander. This machine is manually operated by hand. After cleaning, the oysters are placed in baskets until the baskets are full.

Picture 2. Oysters before (left) and after cleaning (right).

To maintain their freshness during the production process, cleaned oysters will be stored and re-immersed in seawater. There are two storage processes for the oysters. In the first storage process, the oysters will be kept and re-immersed in the sea in special nets near the dock for seven days. One set of nets consists of two containers (marukago). Each marukago holds approximately 40% of one basket of oysters. The marukago are not fully filled to minimize damage to the nets, which could cause the oysters to fall during storage or during lifting. Additionally, limiting the capacity can prevent resource competition, enhance individual growth, and avoid massive disease transmission (Goulletquer & Héral, 1997).

Picture 3. Oysters that have been put into marukago

The next stage involves harvesting the oysters that have undergone the previous processes. After that, the oysters will be washed using a special machine with high-pressure water (Figure 4). The purpose of this cleaning is to remove small and fine dirt attached to the oyster shells. This process results in very clean and predominantly white oyster shells, aided by the prior cleaning steps. According to Troost (2010), all the previous cleaning processes have several purposes, including:

1. Aesthetics and Visual Appeal: Cleaning the dirt from oyster shells helps maintain the product's appearance, making it looking more attractive and cleaner. This is important because a good appearance can enhance the product's market appeal.
2. Quality and Safety: Dirt adhering to oyster shells can be a potential medium for bacterial contamination or other microorganisms that could threaten food quality and safety. Cleaning the dirt helps reduce the risk of such contamination.
3. Consumer Experience: Consumers generally prefer products that appear clean and free from dirt or unwanted particles. Cleaning the oyster shells can enhance the consumer's overall experience with the product.

4. Oyster Health: Accumulated dirt can affect oyster health by impacting their growth and development. Regularly cleaning the oyster shells helps maintain their overall condition.

Picture 4. Oysters before (left) and after washing (right).

After the oysters are cleaned, they are placed in baskets and taken for sorting before packaging. At this stage, the oysters are separated into three categories characterized by color codes: high quality (blue), medium quality (yellow), and low quality (red). High and medium quality oysters will be sold live, while low quality oysters are combined with shucked oysters and only their meat is taken. Medium quality oysters (yellow) are typically sold at a lower price compared to high quality oysters (blue). Oysters that were initially of high quality but got damaged during the process before packaging are categorized as low quality. This is done to ensure and maintain the quality of the marketed products to meet market criteria standards.

Visually, high-quality oysters must meet several standard aspects, such as being sufficiently large in size, having large and full meat, having a well-shaped shell, and being free from shell damage. Quality control of oysters before packaging is crucial to ensure that the products reaching consumers meet the established quality standards. This process involves inspecting the size, cleanliness, health, and freshness of the oysters to ensure there is no contamination or defects that could lower the quality of the final product. By implementing strict quality control,

companies can maintain their reputation, comply with food safety regulations, and enhance consumer satisfaction and trust (Gentry et al., 2017).

The final step in the production process before marketing is packaging. Although oysters are sold with their shells still protecting the meat, proper packaging is still necessary. Karatsuki oysters are often packaged in two types of containers. For long-distance shipping, styrofoam boxes are used. Styrofoam packaging offers several important advantages for storing and shipping live oysters. Styrofoam has excellent thermal insulation properties, maintaining a stable and optimal internal temperature during transport and storage (Park & Hur, 2007). Additionally, lightweight styrofoam helps reduce shipping costs and facilitates easier handling. This material is also waterproof, maintaining moisture and preventing leaks, ensuring that the oysters remain in proper condition (Lagaron et al., 2004). Styrofoam's shock-absorbing capability protects the oysters from physical damage during shipping. Moreover, styrofoam is relatively inexpensive to produce and use, making it an economical choice for live oyster packaging (Green et al., 2017).

Karatsuki oysters sold directly on-site are packaged using paper bags. Wrapping the oysters in paper bags ensures optimal protection and maintains product quality during transport and storage. Paper bags help regulate the humidity around the oysters, which is crucial for preserving their freshness. The use of paper bags is also environmentally friendly and easily recyclable, aligning with sustainability practices in the seafood packaging industry. Additionally, paper bags provide extra physical protection, minimizing the risk of damage during shipping, and allow better air circulation compared to plastic materials.

The use of paper bags for packaging fresh products has many advantages compared to plastic bags. First, paper bags are more environmentally friendly because they decompose and recycle easily, which helps reduce negative environmental impacts (Calder, 2013). Second, paper bags can regulate humidity, which is crucial for maintaining the freshness of products such as oysters, vegetables, and fruits (Comeau, 2013). Moreover, using paper bags supports sustainable practices in the packaging industry because their raw materials come from renewable resources (Gentry et al., 2017). Paper bags also provide adequate physical protection during transport and storage and allow better air circulation compared to plastic materials, thereby reducing the risk of product damage (Lagaron, Catalá, & Gavara, 2004).

CONCLUSION

Karatsuki oysters are considered higher quality and fresher because their shells maintain the oyster's moisture and natural flavor, providing an authentic and delightful dining experience. Their nutritional content is better preserved, and aesthetically, oysters in their shells are more appealing for presentation in fine

dining restaurants. This quality is maintained through good production processes and strict quality control. The production process for high-quality oysters includes sorting, cleaning, proper storage, and packaging.

The oyster production process by the fishing group in Sakoshi Bay, Ako, demonstrates appropriate methods for achieving high-quality products. The Sakoshi Bay fishing group combines traditional knowledge and modern technology to produce high-quality oysters. Every stage of production, from cleaning, sorting, and storage to packaging, is carried out with precision to ensure the oysters' freshness and nutritional quality. The expertise and sustainable practices of the Sakoshi fishermen contribute to their reputation for producing delicious and healthy oysters recognized in international markets.

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