Fisheries Journal, 14(3), 1507-1517 (2024)
http://doi.org/10.29303/jp.v14i3.1006

POST-HARVEST HANDLING TECHNIQUES OF PACIFIC OYSTER (*CRASSOSTREA GIGAS*) FOR SALE AS KARATSUKI IN SAKOSHI BAY, JAPAN. (CASE STUDY OF KOBAYASHI SUISAN, CO.LTD)

Teknik Penangangan Pasca Panen Tiram Pasifik (*Crassostrea Gigas*) Untuk Karatsuki Di Teluk Sakoshi, Jepang. (Studi Kasus Kobayashi Suisan, Co.Ltd)

Raqil Gilang Fathurohman[1*], Junianto[2]

Fisheries Study Program, Faculty of Fisheries and Marine Science, Padjadjaran University

Sumedang KM.21 Street, Hegarmanah, Jatinangor Subdistrict, Sumedang Disteict, West Java 45363

[*]Coresponding author: raqil20001@mail.unpad.ac.id

(Received July 4th 2024; Accepted September 16th 2024)

ABSTRACT

Pacific oysters (Crassostrea gigas) are a species that is widely commercialized because they grow quickly and taste better. One of the countries developing Pacific oyster cultivation is Japan with production in the last year of 160,000 tons. The oyster cultivation method currently used is the hanging raft method/Ikadashiki suika-hō. One of the results of oyster production is oysters with shells or in Japan known as Karatsuki. This product has a target market of high class hotels and restaurants so that good appearance is an obligation in the post-harvest handling process. Once harvested, oysters will be selected based on size and shape. Oysters that are large in size will be selected and go through a washing stage using fresh water to remove mud sediment. Newly harvested oysters will generally stick together so they need to be separated, then the oysters will be cleaned using a Karashoji machine to remove biofouling attached to the shell and then stored in a hanging raft using a marukago net. Karatsuki that will be sold will be taken back and go through a washing stage using a pressure machine to remove biofouling, oysters that are ready to be sold are stored in a fiber tub. Karatsuki packaging uses a Styrofoam box filled with dry ice to keep the temperature cool. Post-harvest handling of Pacific oysters for sale as karatsuki or oysters with shells has several stages that need to be carried out to maintain the quality and appearance of the oysters so that they have good results.

Key words: Japan, Oyster with Shell, Post-Harvest, Sakoshi Bay, Pacific Oyster

ABSTRAK

Tiram Pasifik *(Crassostrea gigas)* merupakan spesies yang banyak dikomersialkan karena memiliki pertumbuhan yang cepat dan rasa yang lebih nikmat. Salah satu negara yang mengembangkan budidaya Tiram Pasifik adalah Jepang dengan hasil produksi pada tahun terakhir sebesar 160.000 Ton. Metode budidaya tiram yang digunakan saat ini adalah metode rakit gantung/*Ikadashiki suika-hō*. Salah satu hasil produksi tiram adalah tiram dengan cangkang atau di Jepang dikenal dengan istilah *Karatsuki*. Produk ini memiliki target pasar hotel dan restauran kelas atas sehingga penampilan yang baik merupakan suatu kewajiban dalam proses penanganan pasca panen. Setelah dipanen, tiram akan diseleksi berdasarkan

e-ISSN : 2622-1934, p-ISSN : 2302-6049

ukuran dan bentuk. Tiram yang memiliki ukuran besar akan dipilih dan melalui tahap pencucian menggunakan air tawar untuk menghilangkan sedimen lumpur. Tiram yang baru dipanen umumnya akan menyatu satu sama lain sehingga perlu dipisahkan, selanjutnya tiram akan dibersihkan menggunakan mesin *Karashoji* untuk menghilangkan biofouling yang menempel pada cangkang dan selanjutnya disimpan di rakit gantung menggunakan jaring *marukago. Karatsuki* yang akan dijual akan diambil kembali dan melalui tahap pencucian menggunakan mesin bertekanan untuk menghilangkan biofouling, tiram yang telah siap dijual disimpan di bak fiber. Pengemasan *Karatsuki* menggunakan kotak styrofoam yang diberi *dry ice* untuk menjaga suhu tetap dingin. Penanganan pasca panen tiram pasifik untuk dijual sebagai *karatsuki* atau tiram dengan cangkang memiliki beberapa tahapan yang perlu dilakukan untuk menjaga kualitas dan penampilan tiram agar dapat diterima oleh pasar.

Kata Kunci: Jepang, Tiram dengan Cangkang, Pasca Panen, Teluk Sakoshi, Tiram Pasifik

INTRODUCTION

The Pacific oyster (*Crassostrea gigas*) is one of the species that is widely commercialized because it has fast growth and a more delicious taste (Fujiya, 1970). One of the countries developing Pacific Oyster cultivation is Japan with a production output of 200,000 tons per year (Hasegawa et al., 2015). According to the Hiroshima Agriculture, Forestry and Fisheries Promotion Center (2024), the history of oysters in Japan begins in ancient times. Oysters were harvested naturally from rocks during the Jomon and Yayoi Periods in Hiroshima Bay. The methods used in production include the crack culture method/Hibi date yoshoku-ho, namely the method of planting stones and bamboo in tidal areas (Park et al., 1988), but due to exploitation and thinning of sandy tidal zones and rising water levels sea (Mori, 2015 in Botta *et al*., 2020) this method was deemed unable to be used for large-scale production, so in 1900 the hanging rack/Kuiu suika-hō cultivation method was developed which was also used to collect spat in Kanagawa Prefecture. In 1925-1930 several experimental stations in Japan developed hanging raft cultivation/Ikadashiki suika-hō. Oysters would be tied to fine wire or rope which would then be hung on the raft, this method resulted in good growth and fattening of oysters. In 1935, methods for collecting spat began to be developed using other mollusk shells, these shells act as a place to attach Pacific Oyster spat, the mollusk shell commonly used is Hotate Shells (Huang et al., 2014; Kusuki, 2018).

The latest production of oyster cultivation in Japan produced 160,000 tons nationally. The prefectures with the highest production volumes are Hiroshima, Miyagi, Okayama, Hyogo and Iwate. Oyster production in Hyogo Prefecture in 2022 will be 9,484 tons (Ministry of Agriculture, Foresty and Fisheries, 2022). One of the areas in Hyogo Prefecture that produces Pacific Oysters is Sakoshi Bay, Ako city. Management of the fishing industry in Japan is carried out by local fisheries associations. Local governments only have the right and obligation to determine cultivation areas. The association plays a role in determining the cultivation location of each company within the area determined by the government and determining the methods used in cultivation (Komatsu & Aoki, 2020 in Ibrahim & Andriyani, 2022; Japan Fisheries Association, 2020) The management of the fishing industry in Sakoshi Bay is under the direct sales office of the Ako Sakoshi Oyster City Fisheries Cooperative Association/Akō shigyogyōkyōdōkumiai Sagoshi kaki chokuhanjo which oversees several oyster farming companies including Kobayashi Suisan, Co.Ltd.

The results of Pacific oyster cultivation produce two types of products, namely shelled oysters and oysters with shells. In Japan, shucked oysters are known as kaki muki, which literally means "shucked shellfish", while oysters with shells are known as Karatsuki, which means "with shell". In the marine fisheries commodity market, demand for oysters with shells or Karatsuki is increasing (Sackton et al., in Mizuta & Wikfors, 2019). The target market for

e-ISSN : 2622-1934, p-ISSN : 2302-6049

this product is high-class hotels and restaurants, so beautiful appearance and characteristics are mandatory in the post-harvest handling process for Pacific oysters (Botta *et al.*, 2020). Oysters that have a good shell shape and appearance indicate that the oysters have good meat quality. The oysters must be clean and have no traces of sediment or biofouling attached. Oysters that are in poor shape are considered unsuitable and undesirable by the market and farmers (Mizuta & Wikfors, 2019).

There is not much research that discusses Pacific oyster cultivation and the post-harvest handling processes that are applied. This research aims to determine the implementation of post-harvest handling and the Pacific oyster cultivation process carried out in Japan. It is hoped that this article can become material for study and contribution to the development of oyster cultivation in Indonesia, especially Pacific oysters.

METHODS

Place and Time

The research method used is the Participant Observation method by directly participating in activities at the Kobayashi Suisan company. Observations were carried out to identify post-harvest handling of oysters for sale as karatsuki. The preparation of the report was carried out using the descriptive literature exploration method through journals, Japanese government reports and credible websites to collect literature reviews regarding the basis for implementing activities.

Time and Place

Observations were carried out in Sakoshi Bay, Ako City, Hyogo Prefecture, Japan in October 2023-April 2024 following the oyster harvesting time at the Kobayashi Suisan company. The harvested oysters are then taken to the company office located at 319 Sakoshi, Ako City, Hyogo Prefecture 678-0172 for post-harvest handling.

Cultivation Method

The method used for cultivation is the hanging raft method, as seen in Figure 1.

Fig 1. Hanging Raft Method in Sakoshi Bay, Japan

The Pacific oyster cultivation method that is widely used in Japan is the Hanging Raft Method, which uses rope or fine wire hung from a raft. According to Lin & Liang (1982) and Parson (1974), the use of raft cultivation results in faster growth because it allows for longer filter feeding times, is less susceptible to pollution, and has less disease (Figure 2). Using this cultivation method also has advantages including better survival rates, easier control of fouling and producing oysters with good shape compared to using the bottom planting method (Walton et al., 2012).

e-ISSN : 2622-1934, p-ISSN : 2302-6049

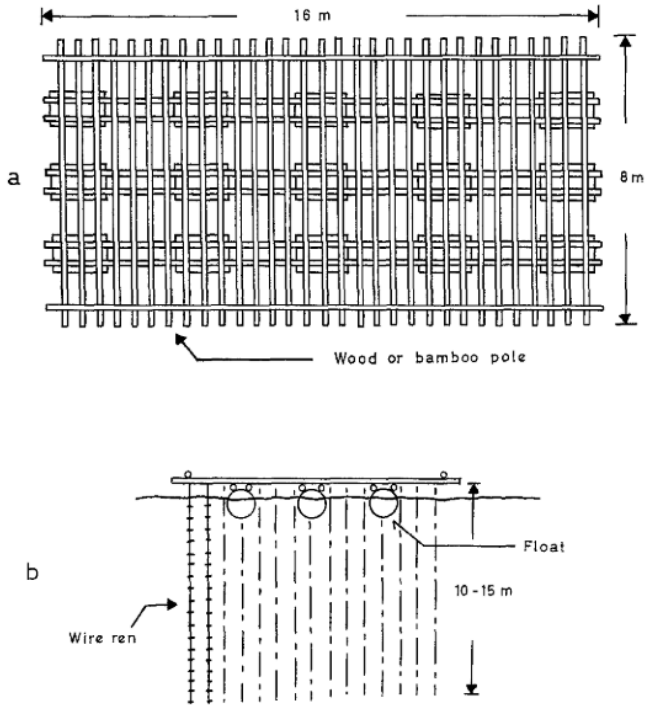

Figure 2. Cultivation model using hanging rafts, top view (a), side view (b)
Source: Fujiya (1970)

Oyster Spat Use and Rearing

Pacific oyster cultivation in the Sakoshi Bay area is limited to growing and harvesting activities because it is not a tidal flat so seed production cannot be carried out. The oyster spat used in Sakoshi Bay is imported from Hiroshima and Miyagi Prefectures (Hasegawa *et al.*, 2015). Pacific oyster seed or spat production in Japan is carried out during the summer, namely from June – August (Miossec *et al.*, 2009) (Figure 3). Seed collection is carried out by installing attachment media so that floating oyster larvae can stick to the tool. The attachment media commonly used is Hotate clam shells which are attached to a wire and given a distance of 1-2 cm between the shells using plastic or bamboo and then the chain of shells is hung into the sea. After the larvae have been collected, the attachment medium will be moved to a growth control rack located in tidal waters. In this phase, the growth of the mussels will slow down because they are lifted from sea water, but the seeds will become strong because they adapt to environmental conditions (Fujiya, 1970; Japan Fisheries Association, 2020).

e-ISSN : 2622-1934, p-ISSN : 2302-6049

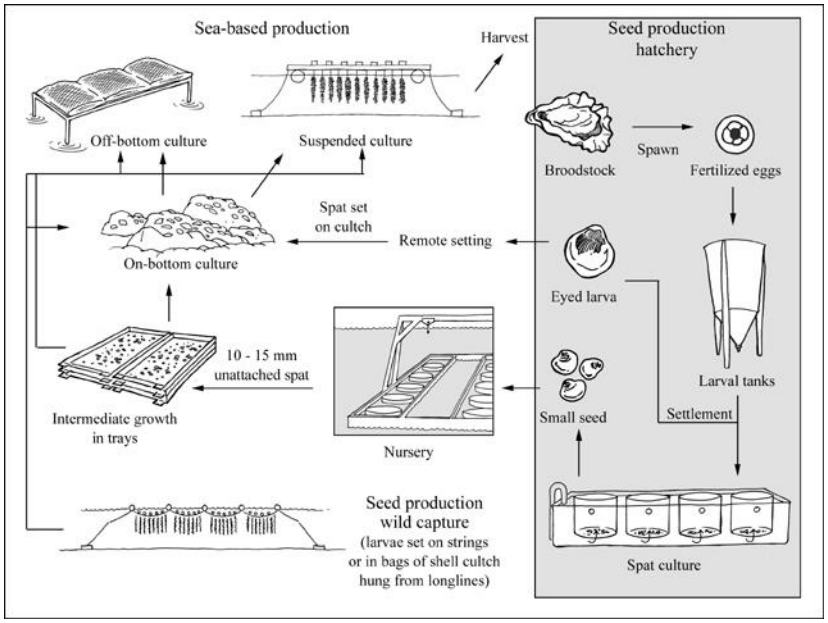

Figure 3. Pacific oyster seed production cycle
Source: FAO (2024)

The seed sowing phase or tanetsuke is carried out at the beginning of summer, April – May 2023 and is carried out before observation activities are carried out. Seeding is done by releasing the hotate shell chain and moving the seed plate to a wire or rope hanger and then the seeds will be carried on a raft to be raised (Japan Fisheries Association., 2020). In Pacific oyster cultivation in Sakoshi Bay, the storage of seed plates on ropes is 23 – 30 plates/rope. The process of storing these seed plates is known as To-Shi kae or replacement and oysters that have been hanging on the raft are called Honsuika (Figure 4).

Figure 4. Hanging method using wire & rope (Left), Seed plate front view (Middle) and Seed plate rear view (Right)
Source: Japan Fisheries Association (2020) and personal documentation

Oysters that have been hung will continue to grow and be cared for until harvest. The growth and survival rate of oysters depends on the availability of phytoplankton, zooplankton and suspended organic matter (Zainura et al., 2016). If the cultivation environment contains plankton in large quantities then oyster growth will be fast, but if the water temperature increases then oyster growth will be delayed or die (Sühnel et al., 2017). One of the challenges in cultivating Pacific oysters in Japan is the typhoons that hit from summer to autumn which

e-ISSN : 2622-1934, p-ISSN : 2302-6049

can damage cultivation facilities (Kusuki, 2018) so farmers need to pay attention to weather forecasts and move the rafts to a safe place to avoid the influence of waves and wind (Japan Fisheries Association., 2020).

RESULT

Oyster Harvesting

The first stage in the harvesting process is taking shellfish from the rearing raft to be taken to the company office (Figure 5). According to Fujiya (1970), one harvest of shellfish using a crane generally weighs 50 -100 kg. After the rope used as a growing medium is attached to a hook, the oyster will be lifted using a crane to a minimum height of 10 meters and dropped onto the ship's deck so that the oyster will be separated from the rope used as a cultivation medium. In one day, oysters are taken from the Kobayashi Suisan company 8-10 times or ± 800-1000 kg.

Figure 5. Taking Pacific Oysters (Left) and Oysters that have been separated from the string (right)

Post-Harvest Handling

After harvesting the oysters will be selected based on size and shape (Figure 6). Small sized oysters or hane (shellfish with poor or damaged shape) will be moved to the indoor working room for the process of handling the muki feet or stripping them to be sold as muki clams, while large oysters will be moved to the outdoor working room to be cleaned from biofouling. contained in the shell and sold as karatsuki (Figure 7). After being selected based on the size and shape of the large oysters, they will be washed using fresh water flowed through a hose and pump machine to remove mud and sand (Figure 8).

Newly harvested oysters will generally stick together so they need to be separated using a putty knife, then the separated oysters will be cleaned from attached biofouling such as barnacles and Sea Squirt using a Karashoji (Shell Cleaner) machine.

e-ISSN : 2622-1934, p-ISSN : 2302-6049

Figure 6. Oysters that have not been separated (left) and oysters that have been separated (right)

Figure 7. Comparison of oysters that have not been cleaned of barnacles (left) and oysters that have been cleaned (right)

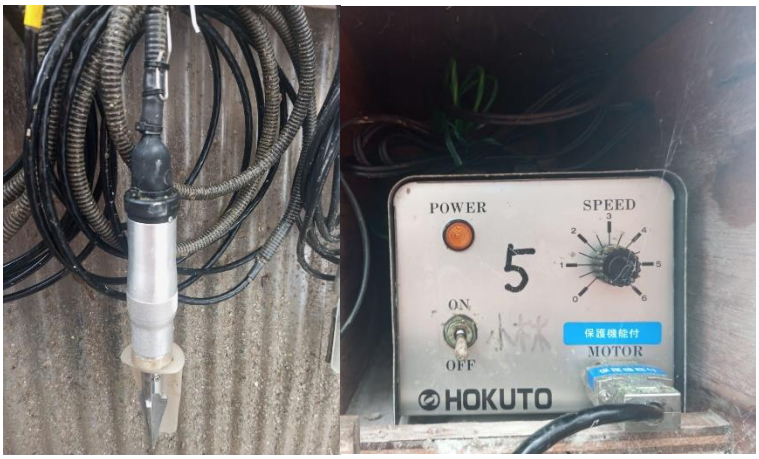

Figure 8. Karashoji Hokuto HS-55R machine for cleaning oyster shells

The cleaned oysters will then be put into Marukago nets to be stored in hanging rafts (Figure 9).

e-ISSN : 2622-1934, p-ISSN : 2302-6049

Figure 9. Oysters in Marukago Nets

When they are to be sold, the oysters that have been stored in the marukago are taken back and washed using a pressure machine to clean the oysters from biofouling (Figure 10). Next, the oysters will be stored in a fiber tub with aeration (Figure 11).

Figure 10. Oyster washing using a pressure machine

Figure 11. Mussels stored in a fiber tub

Product Packaging

Based on observations, the packaging of Pacific Oyster products in Sakoshi Bay uses Styrofoam boxes of various sizes according to the number of products sent and Dry Ice to keep the temperature cool, as in the data in Table 1 below.

Table 1. Types and sizes of Styrofoam boxes for land transportation of Oysters in Sakoshi Bay

Box Code	Size (cm)	Product Capaciy (kg)
1	30 x 18 x 11	1 – 1,5
2	30 x 23 x 14	2
3	33 x 26 x 14	3
4	33 x 26 x 14	4

e-ISSN : 2622-1934, p-ISSN : 2302-6049

O-30	40 x 33.5 x 27	10
O-37	38 x 28.5 x 18	10
O-37-1	38 x 29 x 19	10
A-50	44.5 x 40 x 28	15

Source: (Ibrahim & Andriyani, 2022)

The product packaging for transportation is as shown in Figure 12 below.

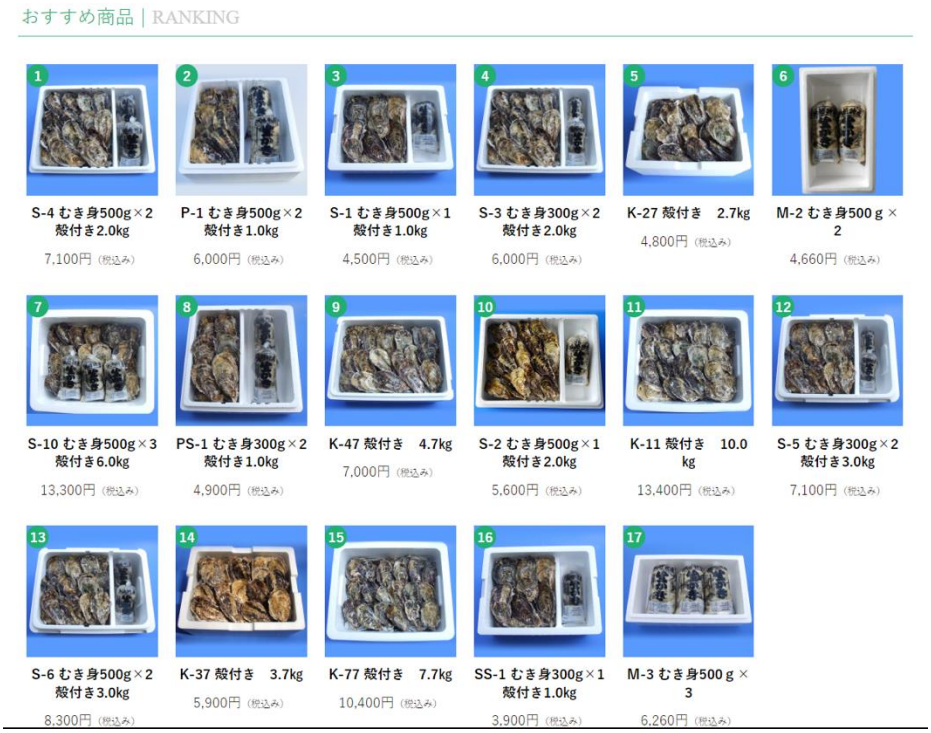

Figure 12. Product packaging for transportation using styrofoam at the Kobayashi Suisan company
Source: https://kaki-kobayashi.com/

DISCUSSION

In post-harvest handling of Pacific Oysters (*Crassostrea gigas*), shellfish selection is carried out based on size and shape (FAO, 2024). According to (Mizuta & Wikfors, 2019), good oysters have thick and strong shells, a shape that resembles a drop of water. The appearance and durability of the shell are influenced by genetics, environmental conditions and cultivation practices. In Pacific oyster cultivation in Sakoshi Bay, oysters that have poor shape will be classified with the term hane. In Australia, the term for oysters that are long and thin is called 'bunny rabbits', or 'sneakers' (Kube *et al.*, 2011 in Mizuta & Wikfors, 2019).

Biofouling is one of the factors that causes the poor shape of oyster shells on Karatsuki, because it leaves permanent scars. However, the growth parameters and survival rate of biofouling show a commensalism symbiosis in Pacific oysters, where the biofouling gets the advantage of a place to live while the oysters are not affected (Mizuta & Wikfors, 2019; Lacoste *et al*., 2015). Increased biofouling in oysters will excite the edge of the shell and stimulate shell growth, this occurs because of competition for living space (Arakawa & Kohman, 1990).

Types of biofouling in Pacific oyster cultivation include sea squirts, macro algae and invertebrates. Biofouling cleaning in harvesting is necessary to meet quality standards and market acceptance standards (Mizuta & Wikfors, 2019). Cleaning biofouling on Pacific oysters is carried out by cleaning barnacles and pests attached to the oyster shells (Kawabe *et al*., 2019

e-ISSN : 2622-1934, p-ISSN : 2302-6049

in Ibrahin & Andriyani 2022).. The use of pressure machines in washing oysters is also necessary to remove biofouling and other marine animals (Curtis et al., 2021).

CONCLUSION

Pacific oysters (*Crassostrea gigas*) are a species that is widely cultivated, one of which is in Japan. For Karatsuki products or oysters with shells, to meet market acceptance standards, post-harvest handling is required, including selecting shells based on size and shape. For Karatsuki products, the type of oyster chosen is one that has a large size and intact shape, none damage to the shell. The next step is to separate the oysters that are still attached to each other and clean the oysters from biofouling and pests attached to the oyster shells using a karashoji machine. The clean oysters will be put into a marukago net and stored in a hanging raft. When the oysters are to be sold they will be taken and cleaned again using a pressure machine to remove biofouling. The oyster packaging process uses Styrofoam boxes and dry ice to keep the temperature cool.

ACKNOWLEDGEMENT

The author would like to express special thanks to the Faculty of Fisheries and Marine Sciences and the Kibo Trading agency for holding internship activities in Japan. The author would like to thank Hideo Kobayashi and Hiroshi Segawa as CEO and President of Kobayashi Suisan, Co. Ltd. for allowing the author to carry out an internship and learn about the harvest, post-harvest and harvest preparation processes for the next cycle in Pacific Oyster cultivation.

REFERENCES

Arakawa, K. Y. (1990). Competitors and Fouling Organisms in the Hanging Culture of the Pacific Oyster, *Crassostrea gigas* (thunberg). *Marine Behaviour and Physiology*, *17*(2), 67-94

Botta, R., Asche, F., Borsum, J. S., & Camp, E. V. (2020). A Review of Global Oyster Aquaculture Production and Consumption. *Marine Policy*, *117*, 103952.

Curtis, L. J. F., Pearce, C. M., Hodes, V., Nelson, J. C., Wasser, C., Savery, J., & Therriault, T. W. (2021). Mitigating Non-indigenous Species Movements: Effects of Pressure-Washing Intensity and Duration on The Removal of Biofouling and Mobile Invertebrates from Cultured Pacific Oysters (*Crassostrea gigas* (Thunberg, 1793)). *Management of Biological Invasions*, *12*(3), 618-639

Doiron S. (2008). Reference Manual for Oyster Aquaculturists. New Brunswick Department of Agriculture and Aquaculture.

FAO. (2024). Cultured Aquatic Species Information Programme. Crassostrea gigas. Cultured Aquatic Species Information Programme. Text by Helm, M. M. In: FAO Fisheries and Aquaculture Department.

Fujiya, M. (1970). Oyster Farming in Japan. *Helgoländer Wissenschaftliche Meeresuntersuchungen*, *20*(1–4), 464-479.

Hasegawa, N., Onitsuka, T., Takeyama, S., & Maekawa, K. (2015). Oyster Culture in Hokkaido, Japan. *Bull. Fish. Res. Agen*, 173-177

Hiroshima Agriculture, Foresty and Fisheries Promotion Center. (2024). Tiram Hiroshima. (Dalam bahasa Jepang.

Huang, J. F., & Lee, J. M. (2014). Production Economics and Profitability Analysis of Horizontal Rack Culture and Horizontal Rack Culture Coupled with Raft-String Culture Methods: A Case Study of Pacific Oyster (*Crassostrea gigas*) Farming in Chiayi and Yunlin Counties, Taiwan. Aquaculture International, 22(3). 1131-1147

e-ISSN : 2622-1934, p-ISSN : 2302-6049

Ibrahim, S., & Andriani, Y. (2022). Oyster Mussels (*Crassostrea gigas*) Transport System (Case Study in Kamashima Company) in Hyogo, Japan. *Marine Fisheries: Journal of Marine Fisheries Technology and Management*, *13*(2), 219-231.

Japan Fisheries Association. (2020). Perihal Budidaya Tanpa Pakan dalam *Buku Teks Untuk Tes Keterampilan Perikanan: Budidaya Edisi Pertama*. Japan: Japan Fisheries Association.

Kusuki, Y. (1991). Oyster Culture in Japan and Adjacent Countries: *Crassostrea gigas* (Thunberg). *Estuarine and Marine Bivalve Mollusk Culture*, *242*(242), 227-242

Lacoste, E., & Gaertner-Mazouni, N. (2015). Biofouling Impact on Production and Ecosystem Functioning: A Review For Bivalve Aquaculture. *Reviews in Aquaculture*, *7*(3), 187-196.

Lin, Y. S. & Liang, M. H. (1982). Growth and Setting of Cultured Oyster (*Grassostrea gigas* Thunberg) in Putai bay. *Bull Inst Zool Acad Sinica*, 21, 129–143

Miossec, L., Deuff, R. M. L., & Goulletquer, P. (2009). *Alien species alert: Crassostrea gigas (Pacific oyster)*. *ICES Cooperative Research Reports (CRR)*, 299.

Ministry of Agriculture, Foresty and Fisheries. (2022). Survei Statistik Produksi Perikanan Laut. (Dalam bahasa Jepang)

Mizuta, D. D., & Wikfors, G. H. (2019). Seeking the Perfect Oyster Shell: A Brief Review of Current Knowledge. *Reviews in Aquaculture*, *11*(3), 586-602.

Park, B. H., Park, M. S., Kim, B. Y., Hur, S. B., & Kim, S. J. (1989). Culture of the Pacific Oyster (*Crassostrea gigas*) in the Republic of Korea.

Parsons, J. (1974). Advantages in tray cultivation of Pacific oysters (Crassostrea gigas) in Strangford Lough, N. Ireland. *Aquaculture*, *3*(3), 221-229.

Sühnel, S., Picanço, T., Medeiros, S. C., Rachelmagentamagalhães, A., & Demelo, C. R. (2017). Effects of Seeding Date and Seed Size on *Crassostrea gigas* (Thunberg, 1793) Culture in A Subtropical Climate. *Journal of Shellfish Research*, *36*(2), 303-313.

Walton, W. C., Davis, J. E., Chaplin, G. I., Rikard, F. S., Hanson, T. R., Waters, P. J., & LaDON SWANN, D. (2012). Off-bottom Oyster Farming. Agriculture and Natural Resources Timely Information: Fisheries and Aquaculture Series. *Alabama Cooperative Extension System*, 8.

Zainura, Z., Rusydi, R., & Khalil, M. (2016). Studi Pembesaran Tiram (*Crassostrea* sp) Melalui Desain Tata Letak Yang Berbeda. *Acta Aquatica: Aquatic Sciences Journal*, *3*(2), 54-61.

e-ISSN : 2622-1934, p-ISSN : 2302-6049