Global Scientific JOURNALS

GSJ: Volume 8, Issue 6, June 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

INCREASING AWARENESS OF ABALONE CULTURE TO SUPPORT SUSTAINABLE AQUACULTURE IN INDONESIA

Roffi Grandiosa

Roffi Grandiosa is currently a staff member at the Faculty of Fisheries and Marine Science Padjadjaran University, Indonesia
PH +62 22 7801953. E-mail: roffi.grandiosa@unpad.ac.id

KeyWords
Abalone, Aquaculture, Sustainable, Indonesia.

ABSTRACT

Sustainable aquaculture in Indonesia especially the development of shellfish has been conducted. Until now, the culture of abalone that have been developed in are *Haliotis asinina* and *Haliotis squamata*. The potential for developing abalone for sustainable aquaculture in Indonesia is very high because the need for abalone feed as herbivorous organisms can be fulfilled throughout the year from the cultivation of *Gracilaria* sp. Abalone cultivation can also be integrated with fish culture or seaweed culture. Recently, the supply of abalone from major producer countries, namely Japan, Taiwan, the United States, Australia and New Zealand, still cannot meet the needs of the world market. The current global abalone production was known to only come from capture fisheries which yielded around 6500 mt in 2016/2017. The trend of harvest decline was seen since previously the worldwide abalone harvest in 1970 was around 20 000 mt (Cook, 2019). The declined harvest was known to occur in South African countries, Australia, New Zealand and the United States (Cook, 2019). However, declined production of abalone was thought to occur also in Indonesia, one of which is caused by illegal capture (WWF.or.id, 2019). This paper discuss the recent trend of aquaculture to support the development sustainable aquaculture in Indonesia.

INTRODUCTION

Abalone (*Haliotis* spp.) is the genus within the invertebrate molluscs of the gastropods class which has very high prospect to be developed in Indonesia considering the demand of consumption which is quite high in the world market (Cook, 2019). High nutritional value and the influence of prestige for those who consume it, especially in Japan and China, causes abalone to have high economic value and become the target of consumers. Abalone species are low tropic level where larvae eat benthic diatoms and adults eat seaweed or macroalgae. Therefore, abalone could be categorized as species that can support sustainable aquaculture. In addition to abalone as a consumed product, abalone is also known to have bioactive content that can be applied to health, namely as an anticancer, anti-oxidant, anti-microbial, anti-coagulant and benefits for cosmetics (Nguyen et al., 2013; De Zoysa, 2013). Abalone shells also have a very good opportunity in Indonesia to be used as raw material for art crafts that can be marketed and enhance its value.

The abalone aquaculture industry and its development through research in various parts of the world is currently quite rapid, especially in the development of broodstock management, larval rearing, nursery and enlargement techniques. In Indonesia alone

there are seven potential abalone species namely *Haliotis asinina, H. varia*, *H. squamosa, H. ovina*, *H. glabra*, *H. planata*, and *H. crebrisculpta* (Dharma, 1988), but only *Haliotis asinina* and *Haliotis squamata* were considered as potential aquaculture species in Indonesia since their growth performance were known to be significantly higher.

One of the integral issued for the development of abalone production in Indonesia was that the production data of abalone is still poorly managed and not publicly available. In this article, we review the awareness of abalone culture to support sustainable aquaculture in Indonesia. Main issues on how Indonesia could take advantage of abalone cultivation will be discussed with management strategy solutions that can be taken for further policy determination. As for this paper, it also discusses challenges in the field of abalone research in Indonesia for the development of better cultivation in the future.

DISCUSSION

Abalone Cultivation in Indonesia

The documented abalone aquaculture production in Indonesia especially for the *Haliotis salina* and *Haliotis squamata* species has only been pursued through collaborative research between universities and marine aquaculture research centers in Indonesia to provide the baseline knowledge of abalone in Indonesia. The study that have been done in Indonesia was quite diverse based on detailed data between 2000 and 2020. Research efforts have been prioritized by identifying abalone in Indonesia with various research methods including abalone heterogeneity studies, studies of genetic variation, biometric characteristics, studies of potential and level of exploitation, estimation of spawning seasons, estimation of habitats and characteristics environment (Daniarsih et al., 2018; Yuniarti et al., 2009 ; Litaay et al., 2012 ; Ishak et al ., 2020; Setiawati et al., 2017; Mahardika & Danoedoro 2017 ; Bachry et al ., 2019; Pebriani et al ., 2016) . The research on engineering aquaculture to support the cultivation of abalone has been done on the topic of optimization of juvenile maintenance, abalone nursery engineering, abalone culture and enlargement of animals using the Integrated Multi-Trophic Aquaculture (Susanto et al., 2012; Setyono, 2005; Sofyan 2017; Setyono, 2007; Hamzah et al., 2012; Hayati et al., 2018; Loekman et al ., 2018; Rezeki & Ariyati, 2014; Deni et al., 2018; Effendy & Balubi, 2018; Giri et al ., 2014).

The tendency of abalone cultivation in Indonesia still utilize natural food such as *Gracilaria* seaweed, *Ulva* and *Spinosum* (Prihadi et al., 2018). However, dependence on seaweed should also be avoided although Indonesia is one of the countries with the highest seaweed production in the world (FAO, 2016). Currently, abalone culture trends in various parts of the world are reducing natural feed since artificial feed is more supportive for growth (Naidoo et al., 2006). Indonesian researchers have been conducting the application of commercial feed for the growth of important species, especially in the juvenile phase and enlargement of abalone (Marzuki et al., 2012; Sinaga et al., 2015; Giri et al., 2015; Susanto et al., 2016; Primaningsih et al., 2016; Rusdi et al., 2018 ; Syahrin et al., 2018; Khotimah et al., 2018) .

It must be realized that the development of abalone species is very promising to be developed in the aquaculture industry that can certainly increase income. Although the awareness of abalone culture is still lacking, the development of abalone research in Indonesia is currently ongoing in the Gondol Bali Aquaculture Research Center (BBRPBL), Bali's Shrimp and Shellfish Development Center Center (BPIU2K) and the Lombok Sea Aquaculture and Fisheries Center. These are the main centers in Indonesia rensponsible for the rapid information research and development experience that has been done since 15 years ago. In general, abalone natural resources in Indonesia are widely distributed in the waters of Sumatra, Sulawesi, NTT, Madura, Maluku and Bali. Through several collaborative programs, abalone has also been spread to several regions in Indonesia, one of which is at the Brackish and Marine Aquaculture Development Center located in Pangandaran. The program that has been carried out om West Java was abalone (antaranews, 2019)

The Indonesian abalone is known to have a high market value (30 USD per kg) however the supply is still below demand (CNN, 2019). One reason for the limited supply was the low occurrence of the abalone aquaculture production activity. In addition, the cultivation cycle requires a long time between 6-8 months to reach harvest size. The preferred size for the Asian market is the size of the cocktail so it can be harvested when measuring 7-8 cm. This causes low enthusiasm for the aquaculture community to carry out cultivation compared to other culture species such as shrimp, fish and seaweed. Besides that, the contribution of the abalone fishing industry was unindetified properly since capture data and illegal catches and trade of wild abalone were not recorded.

At present there is an increase of interest for the investment in abalone cultivation from private parties and foreign investors, since the business potential is still wide open. One of the success factor of the abalone culture is the availability of abalone seeds in Indonesia. Currently abalone seed production can already be produced considering that the technique of producing abalone larvae is well mastered by the aquaculture research centers in Indonesia. The relatively stable water temperature in Indonesia and the availability of cultivation facilities and the ease of transportation are other things that could benefit the program of abalone aquaculture.

The aquaculture society should be aware that the opportunity to increase abalone seed production in Indonesia is very possible considering that the current production technology can be adapted, modified and scaled up. China produced 7 billion seeds in 2013 (Wu & Zhang, 2016). It is expected that seed production of tropical abalone species (*H. asinina* & *H. squamata*) developed in the territory of Indonesia will be able to pursue the production target of at least 1 billion seeds by 2023 to support the target of increasing exports by 250% by 2024 (detik.com, 2020). Although abalone species have not yet become the prime product for cultivation, government attention needs to be increased by taking more strategic steps to support sustainable aquaculture. The program that needs to be carried out immediately by the government is the introduction of innovative abalone cultivation assistance to the community. Although without the presence of the government, the potential for abalone shellfish cultivation has begun to be discovered by the private sector with the basis of community empowerment in various regions in Indonesia namely Batam and Maluku. Opportunities to conduct intensive abalone cultivation are actually wide open considering the open access to information. One of the things is the application of artificial feeding technology which with this effort, aquaculturist can overcome the obstacles of lack of natural food

Obstacles in Indonesian abalone culture

The sustainability of the abalone aquaculture business can be said to be very dependent on the availability of quality seeds. In various countries the post larvae stage becomes a major problem considering that at that phase the larvae undergo a change in eating habits from zooplankton to periphyton. The variation of the physiological factors that accompany it still needs to be explored in more (Wu & Zhang, 2016).

In addition to physiological factors, the presence of disease outbreaks caused by the bacterium *Vibrio parahaemolyticus* must be discussed by farmers since it has occurred in abalone producing countries namely China, Japan and Korea (Cai et al ., 2006). The malignant pathogenic bacteria are also found in Indonesia but often attack cultured shrimp (*Vannamei* sp.). Ambiguity often arise when trying to determine whether the bacterial infection is the cause of primary or secondary disease. Therefore, an approach must be developed to correlate potential pathogenic phenotypes and genotypes. Evaluation of the mechanisms of virulence must be done using new diagnostic tools to characterize the genes that are involved in the pathogenesis (Paillard et al., 2004). Since the 1950s, various pathogens which have been linked to various pathogens including prokaryotic bacteria, eukaryotic parasites and viral organisms, have been identified as causes of clinical signs of disease and mass death of a balloon in the wild and aquaculture (Grandiosa et al 2018).

Disease factors are already known to be a common problem in fish and shrimp species in marine aquaculture, therefore government attention through aquaculture disease monitoring strategies must be tightened. The existence of fish quarantine centers in various regions of Indonesia is expected to support the program. One strategic step is that abalone seedlings developed in Indonesia are expected to continue to be produced in the government-owned Aquaculture Center given that the standard procedures are good enough for aquaculture biosecurity. Disease factors can be overcome by feeding with immunostimulants such as probiotics given that the method, in addition to the faster growth of abalone, immunity and survival of abalone seeds can be significantly increased (Grandiosa et al., 2018).

Efforts to conduct breeding in abalone is an idea that can be implemented at this time considering breeding is an effective effort to increase growth and resistance to stress. Although abalone breeding programs have not been recorded in Indonesia, some researchers have tried to hybridize *H. asinina* and *H. squamata* species (Soelistyowati et al., 2013). Strategic steps are actually more sought towards breeding in one species by intraspecific methods. Although breeding takes a longer path, but the process to improve genetic characteristics are more likely to happen (Wu & Zhang 2013).

The challenges in abalone aquaculture engineering, especially the enlargement of abalone in open seas are often hampered by bad weather. This can be overcome by efforts to move the enlargement of culture from Sea Based Aquaculture to Land Based Aquculture (Chen & Lee 1999). Although operational costs are much higher, land based abalone cultivation with examples such as those developed at New Zealand can guarantee biosecurity from aquaculture. Seawater used for land based cultivation can

be maximized by the recirculation method so that wastewater from aquaculture does not pollute the aquatic environment. The circulation method can apply various technologies namely water disinfection with ultraviolet and ozonation, biological filtration and mechanical filtration. To support such a cultivation program, the openness of both central and regional government regarding private investment in the aquaculture sector must be pursued, considering regulations and policies can be discussed for the common good.

The challenge that can also be said as an opportunity is that there is no special feed producer for abalone. The main player in the aquaculture feed industry, namely PT. Central Proteina Prima can be used as a partner to develop artificial feed with special characteristics for the raising and enlargement of abalone. One characteristic of abalone feed as developed by Abfeed South Africa is that the feed must sink and survive for a long time in water given the abalone eating habits that are relatively greedy and grazer. The supply of abalone feed needs actually does not rely too much on imported raw materials , but the availability of adequate nutritional elements from protein, carbohydrate and fat factors must still be sought . The use of artificial feed has been widely studied in abalone species in other parts of the world. The obstacle that may exist at this time is the market for such artificial feed which has not been properly identified. If the government is able to promote the cultivation of abalone by feeding the commercial, it certainly will form a good business ecosystem and support the interests of all parties, both public, industry, government and stakeholders other interested parties.

To support the accelerated growth of abalone there are actually challenges that are being pursued by researchers in various regions of the world, namely the addition of probiotic supplements to feed. The use of probiotic supplements in the genus Haliotis has previously been carried out on several species with significant results in increasing disease resistance and growth (Macey & Coyne, 2005; Iehata et al., 2010; Jiang et al., 2013 ; Grandiosa et al ., 2018) . Obstacles in the application of probiotics actually exist namely how to prepare probiotics on a large scale and effective in its preparation so that technologies such as probiotic encapsulation must be developed in Indonesia.

CONCLUSION

Various challenges that are present for the abalone aquaculture sector will continue to be in the spotlight given the potential of Indonesia's relatively large area and the development of abalone aquaculture that is relatively left behind compared to neighboring countries (the Philippines). If Indonesia wants to become a well known country which supports sustainable aquaculture, the main problem of the infrastructure readiness must be provided to support production. The future of the marine and fisheries sector has been ordained by the world in the hands of the aquaculture sub-sector (FAO, 2016). This is based on the fact that capture fisheries are increasingly stagnant due to overfishing and damage to ecosystems. Indonesian aquacuture in general still holds the potential for very large production and development needs to better than now.

Acknowledgment

The authors wish to thank the Aquaculture Biotechnology Group of the Auckland University of Technology in providing insights of the world abalone aquaculture.

References

[1] S. Bachry, D. Solihin, R. Gustiano, K. Soewardi and N, Butet. "Morphometric Character and Morphology of Abalone *Haliotis squamata* Reeve 1864 In Coastal Southern Java and Bali." *Journal of Tropical Marine Science and Technology*, 11 (2), 273-284. 2019.

[2] J. Cai, Y. Han and Z. Wang. "Isolation of *Vibrio parahaemolyticus* from abalone (*Haliotis diversicolor supertexta* L.) postlarvae associated with mass mortalities." *Aquaculture*, 257 (1-4), 161-166. 2006.

[3] J.C. Chen and W.C. Lee. "Growth of Taiwan abalone *Haliotis diversificolor supertexta* fed on *Gracilaria tenuistipitata* and artificial diets in a multiple tier basket system." *Journal of Shellfish Research*, 18: 627–635. 1999.

[4] P.A. Cook. "Worldwide Abalone Production Statistics." *Journal of Shellfish Research*, 38 (2), 401-404. 2009

[5] A. Daniarsih, D.D. Solihin and R. Gustiano. "Biometric Characteristics and Variations of Abalone (*Haliotis asinina*) Phenotype in the Waters of the Western and Eastern Regions of Indonesia." *Proceeding of Biology* Education, 2 (1), 1-8. 2018

[6] L. Deni, Abdul Rahman and Abdul M. Balubi. "The Effect of Different Depths on Growth and Survival of Abalone (*Haliotis asinina*) Maintained in the Pipe Container System." Journal Media Akuatika, 3 (2018).

[7] M. De Zoysa. "Nutritional values, bioactive compounds, and health-promoting properties of abalone."Marine Nutraceuticals: Prospects and Perspectives, 57. 2013.

[8] B. Dharma. "Siput dan kerang Indonesia I (Indonesian shell I)." *PT. Sarana Graha, Jakarta*. 111 p. 1988.

[9] I.J. Effendi and A.M. Balubi, AM. "Pertumbuhan Populasi Abalon (*Haliotis asinina*) yang Dipelihara Menggunakan Drum Plastik Dengan Kepadatan Berbeda pada Kawasan Integrated Multi Trophic Aquaculture (IMTA)." *Jurnal Media Akuatika*, 1(2). 2016

[10] I.N. Giri, T. Sutarmat, H.T. Yudha, I. Rusdi and B. Susanto, B. "Grow-out of abalone Haliotis squamata in floating cages fed with different proportions of seaweed and with reduction of stocking density." *Indonesian Aquaculture Journal*, 9 (1), 15-21. 2014

[11] N. A. Giri, M. Marzuqi, N. Astuti, W. Andriyanto, I. Rusdi, and R. Andamari. "Evaluasi bahan baku pakan dan pengembangan pakan buatan untuk budidaya pembesaran abalon (*Haliotis squamata*)." *Jurnal Riset Akuakultur* 10(3), 379-388. 2015.

[12] R. Grandiosa, F. Mérien, T. Young, T. Van Nguyen, N. Gutierrez, E. Kitundu and A.C. Alfaro. "Multi-strain probiotics enhance immune responsiveness and alters metabolic profiles in the New Zealand black-footed abalone (*Haliotis iris*)." *Fish & Shellfish Immunology*, (82), 330-338. 2018.

[13] Hamka, Ije and Shearer, D. Abalone Industry Enhancement in Eastern Indonesia. 2009

[14] M.S. Hamzah, S.A.P. Dwiono and S. Hafid, S. "Studi pertumbuhan dan kelangsungan hidup anakan siput abalon tropis (Haliotis asinina) dalam bak beton pada kepadatan tebar berbeda." *J. Ilmu dan Teknologi Kelautan Tropis*, 4(2), 191-197. 2012.

[15] H. Hayati, I.G.N.P Dirgayusa and N.L.P.R Puspitha. Laju Pertumbuhan Kerang Abalon Haliotis squamata Melalui Budidaya IMTA (Integrated Multi Trophic Aquaculture) di Pantai Geger, Nusa Dua, Kabupaten Badung, Provinsi Bali." *Journal of Marine and Aquatic Sciences*, 4(2), 253-262. 2018.

[16] S. Iehata, T. Inagaki, S. Okunishi, M. Nakano, R. Tanaka and H. Maeda." Improved environment of abalone *Haliotis gigantea* through *Pediococcus* sp. Ab1 treatment. *Aquaculture*. (305) 59-65. 2010.

[17] E, Ishak, I. Setyobudiandi, F. Yulianda, M. Boer and B. Bahtiar. (2020). "Efek Keragaman Tipe Habitat terhadap Struktur Populasi dan Morfometrik Abalon *Haliotis asinina* Linnaeus, 1758". *Jurnal Biologi Tropis*. 20(1), 29-39. 2020.

[18] H, Jiang, X. Liu, Y. Chang, Y., M. Liu and G. Wang. "Effects of dietary supplementation of probiotic *Shewanella colwelliana* WA64, *Shewanella olleyana* WA65 on the innate immunity and disease resistance of abalone, *Haliotis discus* hannai Ino." *Fish & Shellfish Immunology*. (35) 86-91. 2013.

[19] M. Litaay, R. Agus and S. Ferawati. "Variasi genetik abalon tropis *Haliotis asinina* asal Sulawesi Selatan; prospek budidaya." 2012.

[20] N.A. Loekman, A. Manan, M. Arief & P, Prayogo. "Teknik Pendederan Kerang Abalon (*Haliotis squamata*) Di Balai Besar Penelitian Dan Pengembangan Budidaya Laut Gondol-Bali." *Journal of Aquaculture and Fish Health*. 7 (2), 78-83. 2018.

[21] B. Macey and V. Coyne. "Improved growth rate and disease resistance in farmed *Haliotis midae* through probiotic treatment." *Aquaculture*. (245) 249-261. 2005

[22] B. Mahardika and P. Danoedoro. Pemanfaatan Penginderaan Jauh Dan SIG Untuk Pendugaan Habitat Kerang Abalon (*Haliotis squamata* dan *Haliotis asinina*) Berdasarkan Kualitas Perairan Dengan Menggunakan Citra Landsat 8 Di Pantai Selatan Kabupaten Jembrana Provinsi Bali. *Doctoral dissertation*. Universitas Gadjah Mada. 2017.

[23] M. Marzuqi, I. Rusdi and B. Susanto. Aplikasi pakan buatan pada pemeliharaan benih abalon (*Haliotis* squamata). *Jurnal Riset Akuakultur*, 7(2), 237-245. 2012.

[24] K. Naidoo, G. Maneveldt, K. Ruck and J.J. Bolton. "A comparison of various seaweed-based diets and formulated feeds on growth rates of abalone in a land-based aquaculture system." *Journal of Applied Phycology*. 18 (3-5), 437-443. 2006.

[25] V.T. Nguyen, Z.J. Qian, B. Ryu, K.N. Kim, D. Kim, Y.M. Kim and J.Y. Je. "Matrix metalloproteinases (MMPs) inhibitory effects of an octameric oligopeptide isolated from abalone *Haliotis disc hannai*." *Food Chemistry*. 141 (1), 503-509. 2013.

[26] F.H. Khotimah, G.N. Permana, I. Rusdi and B. Susanto. "Pemeliharaan Larva Abalon Haliotis squamata Dengan Pemberian Jenis Pakan Berbeda Dalam Bentuk Tepung." *Jurnal Riset Akuakultur*. 13(1), 39-46. 2018

[27] D.A.A. Pebriani and A.P.W.K. Dewi. "Analysis of water carrying capacity based on water quality to the opportunities cultivation abalone (Haliotis sp.) In coastal kutuh, Bali." *Samakia: Jurnal Ilmu Perikanan*. 7(2), 66-71. 2016.

[28] D. Primaningsih, A.B. Patadjai, E. Ishak and I.J. Effendy. "Kualitas Pakan Formulasi dengan Binder Berbeda terhadap Pertumbuhan dan Sintasan Juvenil Abalon (*Haliotis asinina*) yang Dipelihara pada Sistem IMTA (Integrated Multi Tropic Aquaculture)". J*urnal Media Akuatika.* 1(4). 2016.

[29] T.H. Prihadi, I. Ardi, A. Widiyati and D.B. Wiyanto. "Potency of Different Seaweeds as Diets for Developing Abalone (*H. squamata*) Culture in Nusa Penida Island, Bali." In E3S Web of Conferences (Vol. 47, p. 02004). *EDP Sciences*. 2018.

[30] S. Rejeki, S and R.W. Ariyati. "Pembesaran Siput Abalon (*Haliotis squamata*) Dalam Karamba Tancap Di Area Pasang Surut Dengan Padat Tebar Yang Berbeda." *Journal of Aquaculture Management and Technology*. 3(4), 214-221. 2014.

[31] M.U. Romdhini. "Strategi Optimalisasi Budidaya Abalon (*Haliotis asinina*) Di Pulau Lombok Menggunakan Matriks Leslie." Indonesia. 2010.

[32] I. Rusdi and M. Marzuqi. "Aplikasi pakan pada pemeliharaan benih abalon, *Haliotis squamata*." In *Prosiding Seminar Nasional Tahunan Hasil Perikanan dan Kelautan* (Vol. 15, No. 1, pp. 25-31). 2018.

[33] K.M. Setiawati, Y. Yunus, I. Setyadi and R. Arfah, R. Pendugaan Musim Pemijahan Abalon (*Haliotis asinina*) di Pantai Kuta, Lombok Tengah. *Jurnal Penelitian Perikanan Indonesia*, 1(3), 124-130. 2017.

[34] D. Setyono. "Abalone (*Haliotis asinina* L): 5. Early juvenile rearing and ongrowing culture." *Oseana*, 30(2), 1-10. 2005

[35] D. Setyono. "Stocking density for juvenile tropical abalone, *Haliotis asinina* reared in structures suspended offshore." *Oseanologi dan Limnologi di Indonesia*, 33(2), 213-226. 2007.

[36] D. Setyono. "Abalone (*Haliotis asinina* L): A Prospective Species For Aquaculture In Indonesia." *Oseana*, 29(2), 25-30. 2004.

[37] D. Setyono. "Culture techniques on the farming of abalone (*Haliotis* sp.), A perspective effort for aquaculture in Indonesia." *Oseana*, 32(1), 1-8. 1977.

[38] D. Setyono. "Reproductive aspects of the tropical abalone, Haliotis asinina, from southern Lombok waters, Indonesia." *Marine Research in Indonesia*, 30, 1-14. 2006

[39] D. Setyono and I. Aswandy. "Ongrowing techniques for juvenile donkey ear abalone (Haliotis asinina) at pemenang waters, North Lombok, Indonesia." *Marine Research in Indonesia*, 35(2), 15-22. 2010.

[40] D.T. Soelistyowati, A. Kusumawardhani and M.Z. Junior. "Karakterisasi fenotipe benih hibrida interspesifik abalon *Haliotis asinina* dan *Haliotis squamata*." *Jurnal Akuakultur Indonesia*. 12(1), 25-30. 2013.

[41] N.R. Sofyan. "Teknik Pemeliharaan Induk Dan Pembenihan Kerang Abalone (*Haliotis squamata*) Pada Bak Fiber Di Balai Perikanan Bududaya Laut Sekotong, Lombok Nusa, TENGGARA BARAT." 2017.

[42] B.S. Suriani, R. Kusmarwiyah and N. Cokrowati. "Laju pertumbuhan dan tingkat kelangsungan hidup abalon (*Haliotis squamata*) pada kombinasi jenls pakan yang berbeda." *Jurnal Perikanan Unram*. 3(2), 63-67. 2013.

[43] B. Susanto, I. Rusdi, S. Ismi and R. Rahmawati. "Pemeliharaan yuwana abalon (*Haliotis squamata*) turunan F-1 secara terkontrol dengan jenis pakan berbeda." *Jurnal Riset Akuakultur*. 5(2), 199-209. 2016.

[44] E. S. Syahrin, A.B. Patadjai, A. H. Sarita and I. J. Effendy. "Pengaruh Frekuensi Pemberian Pakan Formulasi terhadap Pertumbuhan dan Sintasan Juvenil Abalon Haliotis asinina yang dipelihara Pada Sistem IMTA (Integrated Multi-Tropic Aquaculture)". Jurnal Media Akuatika, 3(3). 2018

[45] C.H. Tung and A.C. Alfaro. Effect of dietary protein and temperature on the growth and health of juvenile New Zealand black-footed abalone (*Haliotis iris*). Aquaculture Research, 42(3), 366-385. 2011

[46] A. Yuniarti, Y. Kilawati and A.M. Hariati. Kajian heterogenitas genetik abalon (Haliotis asinina) di perairan Indonesia melalui metode Restriction Fragment Length Polymorphism (RFLP) mtDNA. Indonesia. 2009.

[47] https://www.cnnindonesia.com/gaya-hidup/20190822091453-262-423633/4-alasan-kerang-abalon-dikenal-dengan-harga-selangit

[48] https://www.antaranews.com/berita/1005774/kkp-kembangkan-benih-kerang-abalone-bernilai-ekonomi-tinggi

[49] https://finance.detik.com/berita-ekonomi-bisnis/d-4897318/target-ekspor-naik-250-di-2024-kkp-genjot-produktivitas-udang