Eco. Env. & Cons. 27 (Special Issue of the 5 IBOC on Sustainability of Natural Resources, December, 2021) : pp. (S76-S83)

ISSN 0971–765X

Deterioration of the Quality Whiteleg Shrimp (*Litopenaeus vannamei*) Stored at Chilling Temperatures Harvested from Traditional Ponds and Intensive Ponds

Yuliati H. Sipahutar[1]*, Paulus P.R. Sitorus[2], M.G.E. Kristiany[1], D.H.G. Prabowo[1] and M.R. Suryanto[1]

[1]Jakarta Technical University Fisheries, Jakarta, Indonesia
[2]Postgraduate of MIPA, Universitas Indonesia, Pondok Cina, West Java, Indonesia

(Received 2 May, 2021; Accepted 15 June, 2021)

ABSTRACT

The research aims to differentiate the deterioration in quality of white shrimp (*Litopenaeus vannamei*) harvested from traditional and intensive ponds stored in chilling temperatures. Fresh white shrimp (*Litopenaeus vannamei*) used as sample harvested from intensive ponds and traditional ponds in Serang. This research were carried out for 5 days at chilling temperature using a randomized block design method with a treatment duration of 1,2,3,4 and 5 days in a cold box to test the organoleptic value and freshness of freshly harvested white shrimp (*Litopenaeus vannamei*). The test parameters were carried out by organoleptic test. Data analysis used non-parametric Kruskal wallis test and continued with multiple comparisons. Data were analyzed using ANOVA test, followed by HSD test if significant differences were found. Organoleptic test results of storage time treatment showed that shrimp in traditional and intensive ponds were significantly different ($p < 0.05$). Organoleptic test on storage on day 5 showed that traditional pond shrimp was still suitable for consumption with an appearance value of 7.4, an odor of 7.1 and a texture of 7.2. Whereas in intensive ponds it is not feasible to consume shrimp appearance 6.4, smell 5.2 and texture 6.3, so that the shrimp is rejected and does not comply with the standard organoleptic values that have been set, namely 7. The freshness test results of traditional ponds show the value on day 5, namely pH 7.21 and intensive 8.05. The TVB test results showed that the traditional pond showed 22.37 mgN/100g and the Intensive pond was 39.89 mgN/ 100g. The conclusion shows that the decline in quality of shrimp is faster in intensive ponds than in traditional ponds. Respectively, suggesting that the quality deterioration is faster for shrimp harvested from intensive ponds is than in traditional ponds.

***Key words:** Deterioration, Stored at chilling, Vanname shrimp*

Introduction

The northern part of Serang District has great potential for the development of aquaculture. One of the places for developing Vannamei shrimp cultivation in Serang is in the Subdistricts of Pontang, Tirtayasa, and Tanara (Pontirta). Serang District aquaculture production in 2017 from aquaculture and ponds has increased to reach five percent, namely a total of 47,544.29 tons. This fish farming is carried out in four districts with a land area of more than 5,000 hectares, namely in Pontang, Tirtayasa, Tanara and Kramatwatu Subdistricts (Dinas Ketahanan Pangan dan Perikanan Kabupaten

Serang, 2018).

Shrimp handling is carried out based on the origin of production, among others, from catches in the sea, public waters or from fishpond cultivation. Shrimp handling must be carried out quickly, carefully, and through the cold chain system while maintaining the temperature around 0 °C. Quality degradation occurs by autolysis, bacteriology, and oxidation (Purwaningsih, 2000).

The process of deteriorating quality can be caused by autolysis processes (enzymatic and chemical), oxidation processes, bacteriological processes, and due to dehydration processes (Nurjanah *et al.,* 2014). The process of chemical quality deterioration can be seen through the pH value and total volatile base (TVB) parameters (Sahubawa and Ustadi, 2019). Freshness of shrimp is the main indicator of shrimp quality, it can be seen from its appearance, texture and smell (Badan Standarisasi Nasional, 2006). The process of enzymatic deterioration of quality occurs by describing the chemical compounds present in shrimp body tissue (Suwetja, 2011). Enzymes can be said to trigger rotting shrimp naturally in the shrimp body. One of these enzymes is the catepsin enzyme. Catepsin enzymes are enzymes that are abundant in cell lysosomes and degrade myofibril proteins (Irianto and Giyatmi, 2015). The growth of blackspot in shrimp is a special characteristic when the shrimp has deterioration quality (Oehlenschläger, 1992). The perishability of the shrimp raw material is related to the high water content (80%) and the content of free amino acids which are excellent conditions and media for bacterial growth. Harvesting of shrimp in ponds is usually done at night so that the shrimp caught are not exposed to direct sunlight (Purwaningsih, 2000).

This research was conducted to determine the deterioration quality of whiteleg shrimp (*Litopenaeus vannamei*) stored in cold temperatures harvested from traditional and intensive ponds, so that both producers and consumers know that they are doing cultivation, processing, and consuming these shrimp.

Materials and Methods

The research was conducted from February to May, 2019 at traditional and intensive ponds in Serang District, Banten.

Vannamei shrimp samples were taken from traditional ponds in Pontang Subdistrict, and intensive ponds BAPPL Serang, Serang District, Banten Province. Shrimp samples were taken from intensive ponds and traditional ponds with a harvest age of ± 90 days with a size of 50 -60 meat/kg. Shrimp is taken intact according to the organoleptic requirements of SNI 01-2346-2006. The washed shrimp are put in a fiberglass tub and added with ice in a ratio of 2: 1. First the fiberglass is coated with ice, then arranged with the shrimp that have been put in plastic on top and covered again with a layer of ice. Samples were tested and stored for 0, 1, 2, 3, 4 and 5 days to be observed with organoleptic test parameters, and the freshness of pH and TVB shrimp.

The experimental design was carried out with a randomized block design (RBD) with treatment of pond type and storage time. Variable types of ponds are traditional ponds and intensive ponds and variable storage time is 0, 1, 2, 3, 4, and 5 days. Organoleptic tests were carried out by non-standard panelists to determine deterioration of shrimp quality, using fresh shrimp scoresheets according to the SNI 01-2728.1-2006 criteria regarding Fresh Shrimp Specifications 1 (Badan Standarisasi Nasional, 2006). Testing for TVB numbers was carried out using the Conway method based on the procedures listed in SNI 2354.8-2009 (Badan Standardisasi Nasional, 2009). pH measurement using a pH meter is carried out according to the SNI 06-6989.11-2004 procedure (Badan Standardisasi Nasional, 2004).

Organoleptic test data analysis was carried out with the non-parametric Kruskal wallis test and continued with multiple comparisons (Sugiyono, 2007). Organoleptic test of shrimp with organoleptic scoresheet SNI 01-2728.1-2006 by non standard panelis (Badan Standardisasi Nasional, 2006). Data analysis test pH dan TVB was analyzed by ANOVA, with a confidence limit of 95% ($p < 0.05$). If it is significantly different, it is continued with the HSD test (Hanafiah, 2010).

Results and Discussion

Organoleptic Testing of Vaname Shrimp at Chilling Temperature

Organoleptic properties related to physical characteristics is a very important role, especially in determining fresh or rotten commodities (Muchtadi, 2013) . Organoleptic assessment has an important role in the application of quality as it can provide an indication of rot and other damage to the product

(Soekarto, 2008), (De Man, 2010) adding that the organoleptic test aims to determine the nature or factors of taste and acceptance of food. Organoleptic determination of deterioration of shrimp quality was carried out using a score sheet in accordance with SNI 01-2346-2006 including parameters of shrimp appearance, smell, and texture.

Appearance Test

The appearance criteria is an organoleptic parameter which is quite important to be assessed by the panelists. This is because if the appearance is good and liked, the panelists will see other parameters (aroma, smell and taste) (De Man, 2010). Appearance also affects consumer acceptance, although appearance does not determine the level of consumer preference absolutely.

This appearance test was carried out on intensive ponds and traditional ponds at storage of 0, 1, 2, 3, 4, 5 days. Table 1 shows the appearance results for traditional and intensive ponds.

Table 1. Test results of the appearance on traditional and intensive pond shrimp

Day Storage	Traditional	Intensif
Day 0	9 ± 0.05^{a}	8.8 ± 0.02^{a}
Day 1	8.7 ± 0.6^{a}	8.5 ± 0.04^{a}
Day 2	8.5 ± 0.5^{a}	8.1 ± 0.1^{ab}
Day 3	8.3 ± 0.9^{b}	7.8 ± 0.3^{b}
Day 4	8.1 ± 0.4^{bc}	7.2 ± 0.1^{c}
Day 5	7.4 ± 0.1^{c}	6.4 ± 0.9^{d}

Note: the numbers in the same column are followed by different superscrip letters (a, b, etc.) which are significantly different

The organoleptic value test results of the appearance of vanamei shrimp at storage with chilling temperature at 5 days of storage from traditional ponds with a value of 7.4 are still acceptable, while those from intensive ponds with a value of 6.4 are not accepted. According to the SNI 01-2346-2006 standard, the quality requirements for food safety, the minimum organoleptic value limit is 7, with the specification of whole shrimp, the transparency is a bit lost, a little dull and the inter-sections are less sturdy.

The results of Kruskall Wallis organoleptic analysis showed that traditional and intensive ponds had a significant effect ($p < 0.005$) on shrimp appearance. The overall organoleptic test results during storage can be concluded that shrimp from traditional storage ponds up to day 5 are still fit for consumption, because the value is more than 7. Shrimp from storage intensive ponds on day 5 can no longer be consumed.

One of the parameters of deterioration of quality is a change in color in foodstuffs. (Niamnuy *et al.*, 2008) explain that this is due to the oxidation of astaxanthin (red pigment) so that the red color which is a characteristic of astaxanthin disappears and turns dull. The color change of the shrimp depends on the crustacyanin protein molecule that binds to astaxanthin. Research (Sipahutar *et al.*, 2019) shows that there is a decline in the quality of the organoleptic value of appearance specifications on shrimp along with the increase in storage days. The color becomes dimmer and turns pink, the transparency of the lenders gets duller, and the inter-segmentation becomes less and less solid, as a result of further biochemical processes and the development of microbes.

According to (Murniyati dan Sunarman, 2000) the minimum threshold for organoleptic value of fresh shrimp is 7, so that the product is declared fit for consumption. The application of handling and storage in chilling temperatures can prevent deterioration of the shrimp during the process. This is consistent with research (Azizah, 2015) that the organoleptic value of the appearance of white shrimp (Paneus merguiensis) decreased in value during cold storage. on the 6th day of storage shows a slightly dull color and between segments is less sturdy. The deterioration rate of shrimp quality can be inhibited by chilling temperature (4 ^{o}C) where enzyme activity and bacterial growth can be inhibited.

(Winarno, 2007) explained that the appearance of food is an important indicator in determining the quality of food. According to the organoleptic test assessment, the minimum threshold for fresh fish is 7, so that the product is declared fit for consumption (Susiwi, 2009). In accordance with SNI 01-2728.1-2006, shrimp with this value are not elastic, not compact, and not dense (Badan Standarisasi Nasional, 2006).

Smell Test

Odors are chemicals that are mixed in the air, generally in very low concentrations, that humans perceive with the sense of smell. Odors can be either good or bad odors. Smell is one of the parameters that affects the taste of good taste, one of the parameters that affects the perception of the good taste of a food. In the food industry, the test of aroma is considered important because it can quickly provide an assessment of the results of production, whether the production is liked or not by consumers (Soekarto, 2008). The smell of a product is determined when volatile substances enter the nasal passages and are responded to by the olfactory system.

Odor or aroma is a parameter that affects the quality of a processed product. The aroma or smell of food can determine the delicacy of these food ingredients (De Man, 2010). In general, the smells received by the nose and brain is mostly a combination of four main smells, namely fragrant, sour, rancid, and charred (Farber, 2005). This odor test is carried out to determine the value in intensive ponds and traditional ponds from 0, 2, 4, 6, and 8 days storage. Table 2 presents the odor test results in intensive and traditional ponds.

Organoleptic value test results The odor of vaname shrimp at storage at chilling temperature at 5 days of storage from traditional ponds with a value of 7.1 is still acceptable while from intensive ponds with a value of 5.2 is not accepted. According to the SNI 01-2346-2006 standard, food safety quality requirements, the minimum organoleptic value limit is 7, with a specific neutral odor.

Table 2. Test results of the smell on traditional and intensive pond shrimp

Day Storage	Traditional	Intensif
Day 0	8.8 ± 0.05^{a}	8.7 ± 0.1^{a}
Day 1	8.5 ± 0.1^{a}	8.4 ± 0.04^{a}
Day 2	8.2 ± 0.3^{a}	7.9 ± 0.2^{ab}
Day 3	7.5 ± 0.5^{b}	7.4 ± 0.04^{b}
Day 4	7.3 ± 0.1^{bc}	7.1 ± 0.1^{c}
Day 5	7.1 ± 0.1^{c}	5.2 ± 0.5^{d}

Note: the numbers in the same column are followed by different superscrip letters (a, b, etc.) which are significantly different

The Kruskall Wallis organoleptic analysis results showed that traditional and intensive ponds had a significant effect (p <0.005) on the smell of shrimp. The overall organoleptic test results during storage can be concluded that shrimp from traditional storage ponds up to day 5 are still fit for consumption, because the value is more than 7. Shrimp from storage intensive ponds on day 5 can no longer be consumed.

According to (Pardio *et al.,* 2011), that after 15 days of storage, the aroma of shrimp will show a clear change with an organoleptic value of 5.4, in which the aroma of ammonia increases. According to (Jaffrès *et al.,* 2011) *Serratia liquefaciens* as one of the shrimp rot bacteria shows symptoms of deterioration of quality by producing the smell of amines or urine. This odor is related to the presence of several volatile compounds produced by bacteria, including TMA, which is responsible for the appearance of fishy and ammonia odors, as well as ethyl acetate and 2-butanol which are associated with pungent solvent odors and smell like glue. According to (Winarno, 2014), the aroma of food is an important indicator in determining the quality of foodstuffs.

Texture Test

Texture is one of the quality characteristics that influence consumer perception. Texture assessment aims to determine the panelist's acceptance of the level of elasticity or resilience of a product which can be assessed using the sense of touch, namely through touch stimulation (De Man, 2010). This texture test was carried out in intensive ponds and traditional ponds at storage of 0, 1, 2, 3, 4, 5 days. Table 3 shows the appearance results for traditional and intensive ponds.

The organoleptic value test of the texture of vannamei shrimp at storage at chilling temperature at 5 days of storage from traditional ponds with a value of 7.2 is still acceptable, whereas from intensive ponds with a value of 6.3 it is not accepted. According to SNI 01-2346-2006 standards, the quality requirements for food safety, the minimum organoleptic value limit is 7, with the criteria that the

Table 3. Test results of the tekstur on traditional and intensive pond shrimp

Day Storage	Traditional	Intensif
Day 0	9 ± 0.03^{a}	9 ± 0.04^{a}
Day 1	8.6 ± 0.1^{a}	8.6 ± 0.03^{a}
Day 2	8.2 ± 0.2^{ab}	7.8 ± 0.04^{ab}
Day 3	7.9 ± 0.7^{b}	7.4 ± 0.08^{b}
Day 4	7.6 ± 0.1^{b}	7.0 ± 0.2^{c}
Day 5	7.2 ± 0.08^{c}	6,3 ± 0.7^{d}

Note: the numbers in the same column are followed by different superscrip letters (a, b, etc.) which are significantly different shrimp body is less elastic, compact and dense.

The results of Kruskall Wallis organoleptic analysis showed that traditional and intensive ponds had a significant effect (p <0.005) on shrimp texture. The overall organoleptic test results during storage can be concluded that shrimp from traditional storage ponds up to day 5 are still fit for consumption, because the value is more than 7. Shrimp from storage intensive ponds on day 5 can no longer be consumed.

This is in accordance with research conducted by (Jannah *et al.,* 2014), on the organoleptic of white shrimp during cold storage which shows that the longer it is stored, the more damaged the texture of the shrimp will be. The texture on days 0 to 3, the texture is compact and dense, but on days 6 to 9, the compactness of the shrimp meat is reduced. Microbial activity can cause damage to the constituent components of the binding tissue and the threads of shrimp meat so that they lose strength to support the structure of the meat to make it compact (Suwetja, 2013). Damage to the structure of the meat tissue will cause the meat to lose its flexibility and elasticity so that it becomes soft, this is in accordance with the study of (Sipahutar *et al.,* 2020) that the texture value continues to decline during storage where the inelastic texture is not compact and soft.

The difference in the pattern of organoleptic deterioration of the two ponds could be caused by extrinsic and intrinsic factors (Sipahutar *et al.,* 2020). Several factors that influence the rate of change are grouped into two factors, namely intrinsic factors such as shrimp species, size, sex and maturity level. Extrinsic factors such as type of fishing gear, weather conditions, geographic location, method of handling. The rough way of handling shrimp due to pressure (squeezing) will cause bruises or wounds on the meat so that it will accelerate the rate of penetration of bacteria and unsanitary conditions will also contaminate the shrimp meat (Masengi, 2018).

Further test results showed that significant differences began to occur in the 3-day storage treatment at chilling temperature, it is better if the vaname shrimp was not stored at chilling temperature (4°C) for more than 5 days because shrimp in cold storage occurred activity and growth of psychotropic bacteria, the presence of psychotropic bacteria in the cold storage. large quantities can cause various kinds of odors and physical damage to food (Badrin, 2019).

Cooling is the storage of foodstuffs above the freezing temperature of 2-10 °C. Typical chilling in the refrigerator is generally 4-8 °C. Storing meat at cold temperatures can extend the durability of meat because at cold temperatures the activity of microorganisms can be inhibited and suppressed (Estiasih and Ahmadi, 2016). The storage process at chilling temperatures can inhibit the deterioration of shrimp quality. (Sipahutar *et al.,* 2020), stated that the accumulation of volatile nitrogen was slower than shrimp stored at ambient temperature. Enzyme activity in shrimp meat runs more slowly so that the shrimp remains fresh for a long time (Tam *et al.,* 2019).

Freshness Shrimp Parameter

Freshness of shrimp is a measure of whether it is good or bad. Fish is said to be fresh if the biochemical, microbiological and physical changes have not caused serious damage to the fish (Effendi, 2015). Good handling and sanitation is very necessary to maintain the freshness of the fish, the longer it is in the open air, the less fresh it is. Cooling which is usually done in a refrigerator refrigerator generally reaches 4-8 ° C. Shrimp storage in cold temperatures can extend the durability of meat because at cold temperatures the activity of microorganisms can be inhibited and suppressed.

pH Test

The value of the degree of acidity (pH) is one of the indicators measured to determine the level of chemical freshness of fishery products. The pH value of fish meat that is still alive is neutral (Eskin, 1990). (Suwetja, 2013) explains that after fishery products die, there will be biochemical changes and a deterioration or deterioration process will occur due to autolysis, chemistry and bacteria. Determination of the deterioration phase of shrimp quality is carried out to determine the condition and level of freshness of shrimp.

Table 4 shows that the pH value for the two ponds experienced the same change, namely the longer the storage time, the pH of the shrimp will also increase. The pH range of shrimp for traditional ponds on day 0 to day 5 is 6.43 - 7.21 and in intensive ponds on day 0 to day 5 are 6.57 and 8.05.

ANOVA test results showed that the pH value of traditional ponds was significantly different (p <0.05) with intensive ponds, in the long storage treatment. The results of further tests showed that significant differences began to occur at 2 days of

Table 4. Test results of the pH on traditional and intensive pond shrimp

Day Storage	Traditional	Intensif
Day 0	6.43 ± 0.5[a]	6.57 ± 0.2[a]
Day 1	5.85 ± 0.08[a]	5.80 ± 0.5[ab]
Day 2	6.92 ± 0.2 [b]	6.88 ± 0.3[b]
Day 3	6.90 ± 0.04[c]	7.06 ± 0.05[c]
Day 4	7.07± 0.7[cd]	7.16 ± 0.18[c]
Day 5	7.21 ± 0.05[d]	8.05 ± 0.04[d]

Note: the numbers in the same column are followed by different superscrip letters (a, b, etc.) which are significantly different

storage at chilling temperature.

According to (Kamila *et al.,* 2006) who conducted pH testing on fresh giant prawns stored at room temperature showed a pH range of 6.65-6.79 at storage 3 hours-9 hours at room temperature. Changes in the pH value of fishery meat have an effect on the spoilage of fishery products. Changes in pH value occur due to the autolysis process and bacterial activity. Changes in the pH value in the deteriorating quality phase can be caused by the production of lactic acid from the breakdown of glycogen in shrimp meat (Riyanto *et al.,* 2006). The pH value of Vaname shrimp continues to increase along with the long storage time at cold temperatures (Sipahuntar *et al.,* 2019). Increasing the pH value during cold storage is thought to be due to the formation of amines by decarboxylated amino acids.

According to (Surasani and Patange, 2012) states that all samples of tiger prawns that are packed either vacuum or non-vacuum and stored in cold storage show an increase in pH during storage at a temperature of 0-4 °C with a value early on day 0 starting from 7.11 and reaching 7.81 and 7.78 on days 17 and 27. According to (Azizah, 2015) changes in pH value occur due to the autolysis process. According to (Sipahuntar *et al.,* 2020). At 8 days of storage, the pH value of intensive pond shrimp is higher than that of traditional pond shrimp, this shows deterioration of the quality of intensive pond shrimp is faster from traditional pond shrimp. The results of research conducted on vannamei shrimp are in accordance with the explanation (Leitão and Rios, 2000), the longer the storage time the resulting pH value increases along with the deteriorating phase of shrimp quality. This is presumably due to the action of the fast metabolic enzymes in shrimp and the glycogen content in shrimp meat due to the death process in shrimp

Total Volatile Base (TVB) Test

The principle of determining TVB is to determine the freshness of shrimp chemically by evaporating the compounds formed due to the breakdown of amino acids found in fish meat (Suwetja, 2011).

Table 5 shows that the TVB value for shrimp from the two ponds experienced the same change, namely the longer the storage time, the TVB for shrimp will also increase. The TVB value of shrimp in traditional ponds and shrimp in intensive ponds until the end of storage was 22.37 mgN /100 g for intensive ponds and 39.89 mgN/100 g for shrimp in intensive ponds. This shows that based on the TVB value at the storage of chilling temperatures up to day 5, shrimp from traditional ponds are still safe for consumption, and incentive pond shrimp are no longer acceptable.

Table 5. Test results of the TVB on traditional and intensive pond shrimp

Day Storage	Traditional	Intensif
Day 0	5.96 ± 0.7[a]	11.77 ± 0.38[a]
Day 1	9.05 ± 0.28[b]	15.67 ± 0.5[ab]
Day 2	12.33 ± 0.5[b]	18.57 ± 0.08[b]
Day 3	15.63 ± 0.04[bc]	23.24 ± 0.1[c]
Day 4	19.94 ± 0.1[c]	28.74 ± 0.32[cd]
Day 5	22.37 ± 0.08[d]	39.89 ± 0,4[d]

Note: the numbers in the same column are followed by different superscrip letters (a, b, etc.) which are significantly different

ANOVA test results showed that the TVB value for shrimp from traditional ponds at storage chilling temperature was significantly different ($p < 0.05$) with the TVB value for shrimp from intensive ponds. chilling.

According to (Ozogul, 2010), the increase in TVB value was caused by autolysis activity and the activity of putrefactive bacteria during the storage process. In the enzymatic process, protein will be broken down into simpler compounds, such as peptides, amino acids and ammonia. According to (Surasani and Patange, 2012), at the beginning of shrimp storage at a temperature of 0-4 °C, the TVB value was 8.92 mgN/100 g which gradually increased to 26.33 mgN/100 g. According to (Sipahuntar *et al.,* 2019) TVB of shrimp from traditional ponds at the end of Day 8 storage was 24.75

mgN/100 g and shrimp from intensive ponds with a value of 32.87 mgN/100 g. This TVB value will increase with the longer storage time due to degradation by enzymes in the shrimp body to produce simple compounds which are components of volatile base compounds (Sipahuntar *et al.,* 2019). Increasing the value of TVB during storage due to degradation of proteins and their derivatives produces a number of volatile bases such as ammonia, histamine, H2S, trimethyl amines which smell foul.

Conclusion

Traditional and intensive ponds have a significant effect on the organoleptic test of vanname shrimp. Shrimp quality deterioration occurs more rapidly in intensive ponds than in traditional ponds. Consecutively, it shows that quality deterioration is faster for shrimp harvested from intensive ponds than in traditional ponds with organoleptic, pH and TVB parameters.

References

Azizah, L. H. 2015. Analisis Kemunduran Mutu Udang Vaname (*Litopenaeus vannamei*) Secara Kimiawi dan Mikrobiologis, Institut Pertanian Bogor.

Badan Standardisasi Nasional, 2004. *Air dan Air Limbah - Bagian 11: Cara Uji Derajat Keasaman (pH) dengan Menggunakan Alat pH Meter*. Indonesia: BSN.

Badan Standardisasi Nasional, 2006. *Petunjuk Pengujian Organoleptik dan atau Sensori*. Indonesia.

Badan Standardisasi Nasional, 2009.*Penentuan Kadar Total Volatil Base Nitrogen (TVB-N) dan Trimetil Amin Nitrogen (TMA-N) pada Produk Perikanan SNI 2354.8:2009*. Indonesia: BSN.

Badan Standarisasi Nasional, 2006. Udang segar - Bagian 1: Spesifikasi: *Standar Nasional Indonesia*. BSN, Indonesia, pp. 1–10.

Badrin, T. A., Patajai, A. B. and Wirayatno, S. 2019. Studi perubahan Biokimia dan Mikrobial Udang Vanname (*Litopenaceus vannamei*} selama proses rantai dingin di Perusahaan Graha Makmur Cipta Pratama, Kabupaten Konawe. 2(1) : 59–68.

de F. Leitão, M. F. and de P. A. Rios, D. 2000. Microbiological and Chemical Changes in Freshwater Prawn (*Macrobrachium rosembergii*) Stored Under Refrigeration. *Brazilian J. Microbiol.* 31(3) : 178–183.

De Man, J. M. 2010. *Kimia Makanan*, 2nd ed. Bandung: Institut Teknologi Bandung

Dinas Ketahanan Pangan dan Perikanan Kabupaten Serang, 2018. Statistik Dinas Ketahanan Pangan dan Perikanan Kabupaten Serang," Serang

Effendi, M. S. 2015. *Teknologi Pengolahan dan Pengawetan Pangan*, 3rd ed. Bandung: Alfabeta.

Eskin, N. A. M. 1990. *Biochemistry of Foods*, 2nd ed. New York: Academic Press

Estiasih, T. and Ahmadi, K. 2016. *Teknologi Pengolahan Pangan*, 2nd ed. Jakarta: Bumi Aksara.

Farber, L. 2005. *Freshness Test. In: Fish as Food*, 4th ed. New York: Academic Press.

Hanafiah, K. A. 2010. *Rancangan Percobaan Teori & Aplikasi*,. Palembang: Universitas Sriwijaya palembang

Irianto, H. E. and Giyatmi, S. 2015. *Teknologi Pengolahan Hasil Perikanan*, vol. 2. Jakarta.

Jaffrès, E. 2011. Sensory Characteristics of Spoilage and Volatile Compounds Associated with Bacteria Isolated from Cooked and Peeled Tropical Shrimps using SPME-GC-MS Analysis. *Int. J. Food Microbiol.* 147(3) : 195–202 doi: 10.1016/j.ijfoodmicro.2011.04.008.

Jannah, M., W. ruf, and Surti, T. 2014. Efektivitas Lengkuas (Alpinia Galanga) Sebagai Pereduksi Kadar Formalin Pada Udang Putih (*Penaeus merguiensis*) Selama Penyimpanan Dingin. *J. Pengolah. dan Bioteknol. Has. Perikan.* 3(1) : 70–79.

Karnila, R. Suparmi, and Romaida, M. 2006. Kajian Sifat Mutu Udang Galah (*Macrobrachium rosenbergii*) Segar pada Penyimpanan Suhu Kamar. *Berk. Perikan. Terubuk*. 33(2) : 121–125.

Karungi, C., Byaruhanga, Y. B. and Muyonga, J. H. 2004. Effect of Pre-icing duration on Quality Deterioration of Iced Nile Perch (Lates Niloticus). *Food Chem.* 85(1): 13–17.

Masengi, S., Sipahutar, Y. H. and Sitorus, A. C. 2018. "Penerapan Sistem Ketertulusuran (Traceability) Pada Produk Udang Vannamei Breaded Beku (Frozen Breaded Shrimp) di PT. Red Ribbon Jakarta. *J. Kelaut and Perikan. Terap.* 1(1) : 46–54.

Muchtadi, T. R. 2013. *Ilmu Pengetahuan Bahan Pangan*. Bandung: Alfabeta

Murniyati and Sunarman. 2000. *Pendinginan, Pembekuan dan Pengawetan Ikan*. Yogyakarta: Kanisius

Niamnuy, C., Devahastin, S. Soponronnarit, S. and Vijaya Raghavan, G. S. 2008 . Kinetics of Astaxanthin Degradation and Color Changes of Dried Shrimp During Storage. *J. Food Eng.* 87(4) : 591–600 doi: 10.1016/j.jfoodeng.2008.01.013.

Nurjanah, Abdullah, A., Sudirman, S. and Tarman, K. 2014. *Pengetahuan dan Karakteristik Bahan Baku Hasil Perairan*. Bogor.

Oehlenschläger, J. 1992. *Evaluation of Some Well Established and Some Underrated Indices for The Determination of Freshness and/or Spoilage of Ice Stored Wet Fish*. Elsevier Science Publishers B. V.

Ozogul. 2010. *Methods for freshness quality and deterioration In: Handbook of Seafood and Seafood Product analysis. Edited*. USA.: CRC Press. Taylor and Francis Group. Boca Rato.

Pardio, V. T., Waliszewski, K. N. and Zuñiga, P. 2011. Biochemical, Microbiological and Sensory Changes in Shrimp (*Paneus aztecus*) Dipped in Different Solutions Using Face-Centred Central Composite Design. *Food Sci. Technol.* 46(2).

Purwaningsih, S. 2000. *Teknologi Pembekuan Udang*. Jakarta: Penebar Swadaya.

Riyanto, R., Kusmarwati, A. and Dwiyitno, 2006. Pembentukan Formaldehid pada Ikan Kerapu (*Epinephelus fuscoguttatus*) selama Penyimpanan pada Suhu Kamar. *J. Pascapanen dan Bioteknol. Kelaut. dan Perikan.* 1(2) : 111–116.

Sahubawa, L. and Ustadi, 2019. *Teknologi Pengawetan dan Pengolahan Hasil Perikanan*. Gajah Mada University Press.

Sipahutar, Y. H., Ramli, H. K., Kristiani, M. G. E. and Prabowo, G. 2019. Quality of Consumer on Vannamei Shrimp (*Litopenaeus vannamei*) from Intensive Addition and Traditonal Pond Bulukumba District, South Sulawesi. *Pros. Simp. Nas. Kelaut. dan Perikan. VI Univ. Hasanuddin*, pp. 359–366

Sipahutar, Y. H., Ramli, H. K., Kristiani, M. G. E., Prabowo, D. H. G., Suryanto, M. R. and Pratama, R. B. 2019. Chemical Composition of Whiteleg Shrimp (*Litopenaeus vannamei*) Cultivated from Intensive Farming and Traditional Farming at Bulukumba Regency, South Sulawesi. In: *IOP Conference Series: Earth and Environmental Science*. 399. doi: 10.1088/1755-1315/399/1/012125.

Sipahutar, Y. H., Suryanto, M. R., Ramli, H. K., Pratama, R. B. and Panjaitan, T. F. 2020. Organoleptic Quality of Whiteleg Shrimp (*Litopenaeus vannamei*) Cultivated from Intensive and Traditional Pond at Bulukumba District, South Sulawesi." doi: 10.1088/1755-1315/564/1/012040.

Sipahutar, Y. H., Suryanto, M. R., Ramli, H. K., Pratama, R. B. and Irsyad, M. 2020. Melanosis rate of whiteleg shrimp (*Litopenaeus vannamei*) from intensive pond and traditional pond at Bulukumba Regency, South Sulawesi," in *Prosiding Simposium Nasional VII Kelautan dan Perikanan 2020 :* pp. 31–42.

Soekarto, T. S. 2008. *Penilaian Organoleptik: untuk Industri Pangan dan Hasil Pertanian*. Jakarta: Bhrata Karya Aksara

Sugiyono, 2007. *Statistik non parametrik untuk penelitian*. Bandung: Alfabeta.

Surasani, V. K. R. and Patange, S. B. 2012. Melanosis Inhibition and SO2 Residual Levels in Farmed Tiger Shrimp (*Penaeus monodon*) following Different Sulfite-Based Treatments. *J. Aquat. Food Prod. Technol.* 21(4) : 330–337. doi: 10.1080/10498850.2011.601537.

Susiwi, S. 2009. Penilaian Organoleptik Regulasi Pangan. Universitas Pendidikan Indonesia, Bandung

Suwetja, I. K. 2011. *Biokimia Hasil Perikanan*. Jakarta: Media Prima Aksara. 2011.

Suwetja, I. K. 2013. *Indeks Mutu Kesegaran Ikan*. Malang: Bayumedia Publishing

Tam, L. N., Anh, T. H. and Van Hei, C. 2019. The shel-life Black Tiger Shrimp (penaeus Monodon) treatd wiyh the different condition. *Vietnam J. Sci. Technol.* 57(4) : 401. doi: 10.15625/2525-2518/57/4/12764.

Winarno, F. 2007. *Teknologi Pangan*. Bogor: Mbrio Press

Winarno, F. 2014. *Kimia Pangan and Gizi*. Jakarta: Gramedia