The Effect of Differences in Temperature and Storage Time on Characteristics of Vannamei Shrimp (*Litopenaeus vannamei*) Intensive Pond

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Abstract

Indonesia has great potential in the development of the fisheries sub-sector consisting of capture fisheries and aquaculture. Shrimp is Indonesia's main export commodity in the fisheries sector. One type of shrimp, namely, vannamei shrimp. Vannamei shrimp have the characteristics of being able to live in the salinity range of 5-45 ppt with optimal salinity of 10-30 ppt; temperature range of 24° - 32°C with an optimal temperature of 28° - 30°C; The protein requirement is low, namely 32% with an FCR of 1.5 and the percentage of meat is 66 – 68%, higher than tiger prawns which is only 62%. The principle of freezing shrimp is one way to slow down the process of quality degradation, either by autolysis, bacteriology, and oxidation. This research is an experimental study that consists of the main parameters, namely the value of protein content, Total Volatile Base, and supporting parameters of organoleptic test values (color, aroma, texture) in vannamei shrimp with differences in temperature and shelf life. Consisting of independent variables, namely shelf life and temperature, dependent variables, namely protein, organoleptic, and TVB, as well as control variables of vannamei shrimp size 100 with an age of 2 months, and storage media. A completely Randomized Design (CRD) was used as the experimental design. Data were analyzed using Analysis of Variance (ANOVA) and continued with Duncan Multiple Range Test (DMRT). The results showed that the effect of shelf life and differences in freezing temperature of vaname shrimp, on protein and TVB levels of white vaname shrimp had met the quality requirements so that it was suitable for consumption and obtained the highest average value for each parameter of texture, color, and odor, namely 7 in the shrimp freezing treatment for 1 day at a temperature of -5°C.

Keywords: *Litopenaeus vannamei*, protein, TVB

Introduction

Indonesia has great potential in the development of the fisheries sub-sector which consists of capture fisheries and aquaculture. Shrimp is Indonesia's main export commodity in the fisheries sector. Shrimp contributed the largest figure to the export value of fishery products with the export volume of fishery products reaching 1.26 billion kilograms in 2020, the volume of shrimp increased by 28.96% compared to 2019 which was 207.70 million kg, or as much as 18.95% in last year. (Ministry of Maritime Affairs and Fisheries 2021).

However, shrimp and other fishery products are known as perishable products because they contain very high protein levels, so they have a short shelf life (Litaay, 2017). The decay of fishery commodities begins when the product dies which causes chemical, physical, microbiological, and histological changes that occur in muscle fibers. This process usually coincides with the gradual loss of nutritional content which impacts the quality of fishery commodities, changes in quality are influenced by several factors, especially temperature. If the temperature is not properly controlled it will have an impact on the decline in the quality of fisheries commodities (Badrin, 2019).

Freezing is one of the treatments that can be done to extend the shelf life of shrimp. The principle of freezing shrimp is by slowing down the degradation process, both autolysis, bacteriology, and oxidation. The level of freshness of shrimp is a benchmark for distinguishing quality shrimp, so research is needed on the effect of temperature and long shelf life on the quality of vaname shrimp. Shrimp quality degradation is caused by factors originating from the shrimp body

itself or environmental factors. Therefore, good handling is needed so that the quality of the shrimp can be maintained until the shrimp is consumed by consumers.

Methods

The research method used in this study is experimental.

a. Protein Testing (SNI 01-2354.4-2006)

The first stage is destruction. The sample is mashed, then 2 g is weighed, put into a Kjeldahl flask, add 2 catalyst tablets or 3.5 g catalyst mixture, add 15 ml H_2SO_4 and 3 ml H_2O_2 (let stand 10 minutes). Destruct at 415°C, cool. The next stage is distillation. The results of the digestion are added to 50-70 ml of distilled water, add 50-70 ml of NaOH. Distillation, tamping the distillation results with Erlenmeyer containing 25 ml of 4% H3BO3 which has been added Methyl Red indicator and Bromcresol green, do the distillation until the distillation volume reaches 150 ml. Next is the titration stage. Titrate with 0.2 N HCL until the color changes from green to neutral gray, then work on the blank. Protein Test Determinant Formula:

$$\text{Protein content} = \frac{(VA - VB)\ HCl \times N\ HCL \times 14.007 \times 6{,}25 \times 100\%}{W}$$

Information:
VA = Milliliters of sample titration HCL
VB = Milliliter of HCL blank titration
N = HCL concentration
14.007 = Atomic weight of nitrogen
6.25 = Fish protein conversion factor
W = sample weight

b. TVB (Total Volatile Base) Testing

The first stage is extraction. 10 g of sample is weighed and homogenized. Added 90 ml of 6% PCA, homogenized the sample with a homogenizer for 2 minutes, then filtered the sample with filter paper. Next is the distillation stage. 50 ml of fish extract was added to the distillation tube, added 3-5 drops of phenolphthalein indicator then added 2-3 drops of silicon anti-foaming added 10 ml of 20% NaOH. The reservoir is prepared in an Erlenmeyer containing 100 ml of H3BO3 and 3-5 drops of Tashiro indicator. Steam distillation for ± 10 minutes until 100 ml of distillation is obtained so that the final volume contains ± 200 ml of green solution. Next is the titration stage. The distillate results were titrated using a 0.02 N HCl solution that had been frozen. Titrate until the distillate changes from green to purple again.

TVB calculation formula:

$$TVB = \frac{(Vc - Vb) \times N \times 14{,}007 \times 2}{w} \times 100\ \%$$

Information:
Vc = Volume of sample titrated HCl solution
Vb = Volume of blank titration HCl solution
N = Normality of HCl solution
W = Sample weight (g)
14.007 = Weight of nitrogen atoms
2 = Dilution factor

c. Organoleptic Testing (SNI 01-2346-2006)

Sensory testing is a method of testing using the human senses as the main tool for assessing the quality of fishery products that have undergone processing (Mulyana et al., 2018). Vannamei shrimp organoleptic testing was carried out based on SNI 01-2346-2006 concerning organoleptic testing. The organoleptic assessment included the texture, color, and smell of frozen shrimp to determine the panelists' preferred frozen shrimp products. This organoleptic test used 30 untrained panelists.

Results and Discussion

a. Protein Test Results

The results of protein analysis aim to determine the amount of protein content in shrimp meat which is related to the shelf life of shrimp. The higher the protein content, the shorter the shelf life of the shrimp. High protein content in a food will affect its physical, chemical, and biological properties.

The results obtained from the ANOVA (Analysis of Variance) test showed that there was an interaction effect between shelf life and temperature on the protein content of vannamei shrimp with a sig. 0.047 so H1 is accepted. Calculation of the highest protein content value was obtained from the 1-day storage period at -5°C, which was 23.84 mg, then the lowest protein content was obtained from the 6-day storage period at -22°C, which was 15.11 mg.

Based on the results of Duncan's multiple range test (Duncan Multiple Range Test) it is known that the 1-day shrimp storage period at -5°C showed a significant difference ($p<0.05$) with the 6-day storage period at -5°C, the shelf life of 3 days at -5°C, shelf life of 3

days at -17°C, the shelf life of 1 day at -22°C and shelf life of 6 days at -22°C. The 6-day shrimp storage period at -5°C showed no significant difference ($p>0.05$) with the 3-day storage at -5°C and 1-day storage at -17°C. The 3-day shrimp storage at -5°C showed no significant difference ($p>0.05$) with the 1-day storage at -17°C and the 3-day storage at -17°C. As for the treatment of the shrimp storage period of 6 days at -22°C, there was a significant difference ($p<0.05$) in all other treatments.

The results of protein analysis aim to determine the amount of protein content in shrimp meat which is related to the shelf life of shrimp. Based on the calculation of the average protein content, the highest yield was obtained from the 1-day storage period at -5°C, which was 23.84 mg, and the lowest protein content was obtained from the 6-day storage period at -22°C, which was 15.11 mg. The highest yield of protein content in this study complied with SNI 01.2728.1.2006 regarding shrimp as a raw material, namely 18.0-22.0 mg (BSN, 2006).

According to Hadiwiyoto (1993), deterioration in quality is generally associated with the decomposition of macromolecular compounds into simple macromolecular compounds, in the form of foul-smelling gases. Compounds that Protein plays a major role in the process of decomposing fishery products, but components of fat, carbohydrates, and other compounds are also disassembled and contribute to the spoilage of fish meat. Microbes Bacteria that play a dominant role in damage (decomposition) are bacteria. The speed of spoilage is influenced not only by the ambient temperature, but also by the nature of the meat, especially water activity, pH, and its oxidation-reduction potential.

The process of fish spoilage by bacteria and fungi can be inhibited by storing fish at 0°C or even lower. Storage at cold temperatures can maintain quality for several days or in the short term and when stored at frozen temperatures can last for a period of up to one year. Storage with cold and freezing temperatures can also destroy spoilage microbes.

b. TVB (Total Volatile Base) Test Results

The results obtained from the ANOVA (Analysis of Variance) test showed that there was an interaction effect between shelf life and temperature on the TVB value of vannamei shrimp with a sig. 0.002 so that H1 is accepted. Calculation of the highest TVB value was obtained from the 1-day storage period at -22°C, which was 8.705 mg, then the lowest TVB value was obtained from the 1-day storage period at -22°C.

Based on the results of Duncan's multiple range test (Duncan Multiple Range Test) it was found that the 6-day shrimp storage period at -5°C showed a significant difference ($p<0.05$) with all other treatments. The 3-day shrimp storage period at -5°C showed no significant difference ($p>0.05$) with the 1-day shrimp storage at -5°C. The 3-day shrimp storage period at -17°C showed no significant difference ($p>0.05$) with the 6-day shrimp storage period at -17°C and the 1-day storage period at -17°C. As for the treatment of 1 day of shrimp storage at -17°C, there was no significant difference with the 3-day treatment at -22°C, 6 days of storage at -22°C, 6 days of shrimp storage at -22 °C and the shelf life of shrimp is 1 day at -22°C.

TVB analysis results aim to determine the decline in quality or the level of shrimp spoilage. Based on the calculation of the average protein content, the highest yield was obtained from the 1-day storage period at -5°C, which was 23.84 mg, and the lowest protein content was obtained from the 6-day storage period at -22°C, which was 15.11 mg. The highest yield of protein content in this study complied with SNI 01.2728.1.2006 concerning shrimp as a raw material, namely 18.0 – 22.0 grams (BSN, 2006). Limitation of TVB content for fishery products, namely very fresh criteria if the value of TVB content is less than 10 mg N/100 g, fresh ranges from 10-20 mg N/100 g, while not fresh ranges from 20-30 mg N/100 g, and unfit for consumption greater than 30 mg N/100 g. TVB content limit for edible shrimp is not more than 30 mg N/100g. The thing that needs to be considered in maintaining the quality of shrimp is the cold chain. The cold chain or cold chain is a supply chain system that in the process considers the temperature level to maintain

The product remains frozen or chilled in an environment with a certain temperature during production, storage, distribution, and the sales process. The matter is intended to maintain product quality. If the cold chain is interrupted, the quality of the product will

likely decline. Therefore, every place related to the handling and distribution of shrimp must be equipped with facilities and infrastructure to keep the shrimp fresh, such as ice water, and containers for handling and storage (Larasati, 2011).

c. Organoleptic Test Results

Organoleptic assessment includes several test aspects including texture, color, and odor. The results obtained from the Kruskal-Wallis test showed that there was an interaction effect between shelf life and temperature on the organoleptic test values of vannamei shrimp with a sig. 0.00 so that further Mann-Whitney tests are needed to find out significant differences between treatments.

Each texture, color, and odor parameter at P1, P2, P3, P4, P5, P6, P7, and P8 are known to show no significant difference with the sig value. > 0.05 but for each texture, color, and odor parameter at P9 showed a significant difference with a sig value <0.05.

Based on the calculation of the average organoleptic test, the highest results were obtained from the freezing treatment of vannamei shrimp with a shelf life of 1 day at -5 temperature with an average value of 7.70 for the texture parameter, 7.37 for the color parameter and 7.73 for the odor parameter. According to Roiska et al., (2020), the organoleptic value of shrimp as a raw material must meet the freshness requirements, namely a minimum of 7, with intact and solid specifications and texture, clean or brilliant white appearance, and fresh smell.

The texture preference test for the highest panelist acceptance of the average vannamei shrimp texture value was 7.70 ± 1.39 in treatment P1 or freezing vannamei shrimp for 1 day at -5oC and panelist acceptance with the lowest average value of 2.93 ± 1.28 or freezing vannamei shrimp for 6 days at -22oC. The characteristics of the shrimp that the majority of the panelists liked were less elastic, compact, and dense.

The color preference test for the highest panelist acceptance of the average vannamei shrimp color value was 7.37 ± 1.45 in treatment P1 or freezing vannamei shrimp for 1 day at -5oC and panelist acceptance with the lowest average value of 3.23 ± 1.45 or freezing vannamei shrimp for 6 days at -22oC. The characteristics of the shrimp that the majority of the panelists liked were intact, translucency had somewhat disappeared, and between segments were less sturdy.

The shrimp color parameter is one of the organoleptic qualities of shrimp quality decline. The color of the shrimp when it is still fresh when pre-rigor looks clear. This color changes during the rigor mortis phase, the shrimp becomes yellowish and black spots begin to form. The next change is a pink color and many black spots are formed during post rigor, and the appearance of the shrimp then becomes red and forms a lot of black color (Nurhayati et al., 2018)

The odor preference test for the highest panelist acceptance of the average vannamei shrimp odor value was 7.73 ± 1.20 in treatment P1 or freezing vannamei shrimp for 1 day at -5oC and panelist acceptance with the lowest average value of 3.673 ± 1, 88 or freezing vannamei shrimp for 3 days at -22oC. The characteristics of the shrimp that the majority of the panelists liked were the specific smell and neutral or typical of the shrimp.

Conclusion

The conclusions of this study are:

1. The effect of differences in temperature and long shelf life of shrimp in vannamei shrimp intensive ponds on protein content and TVB (Total Volatile Base) have met the quality requirements so that they are suitable for consumption with a protein value of 23.84 and a TVB value of <30 mg.

2. The effect of differences in temperature and long shelf life of shrimp in vannamei shrimp intensive ponds on organoleptic values is known to have the highest values for each of the texture, color, and odor parameters, namely with a value of 7 in the 1-day shrimp freezing treatment at -5ºC.

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