Original Research Article

Moringa Leaf Extract as a Natural Preservative Against the Deterioration of Tilapia Fillet During Room Temperature Storage

ABSTRACT

This research was conducted to determine the percentage of moringa leaf extract to inhibit the deterioration of the quality of the tilapia fillet as a natural preservative against organoleptic characteristics during room temperature storage. This research was carried out at the Processing of Fishery Products Laboratory, the Aquaculture Laboratory of the Faculty of Fisheries and Marine Sciences, and the Central Laboratory of Padjadjaran University, Jatinangor. The research method used is experimental. Namely, a tilapia fillet soaked using different concentrations during room temperature storage. The organoleptic test (scoring test) was analyzed by Friedman's non-parametric statistical method consisting of 4 treatments and 20 semi-trained panelists as the number tests. In contrast, the pH testing of the tilapia fillet was analyzed by a descriptive method. Tilapia fillet with Moringa leaf extract soaking treatment consists of 0%, 4%, 8%, and 12% (v/v) for 30 minutes of soaking, then stored at room temperature (25°C-28°C). Observations occur once every 2 hours, namely at the 0, 2nd, 4th, 6th, 8th, 10th, 12th, 14th, and 16th hours. The parameters observed included organoleptic characteristics with 20 semi-trained panelists and a value of the tilapia fillet's degree of acidity (pH). The best use of moringa leaf extract at 8% appearance with an organoleptic value of 7.5, aroma of 7.7, and texture of 7.0 with a pH value of 6.8 to 16 hours storage.

Keywords: *Moringa leaf extract, organoleptic, pH, quality deterioration, tilapia fillet.*

1. INTRODUCTION

Tilapia is one of the fish consumed by people in Indonesia. This fish is a freshwater fish and an important global business commodity because it has a relatively high economic value [1]. In 2018, as many as 125 countries worldwide produced 6,882,202 tons of tilapia from the cultivation and catch of fishermen. Indonesia 2018 became the second largest tilapia producer after China, with a total production of 1,292,391 tons and a percentage of total world production of 18.76% [2].

Fish filet is a slice of meat without scales, bones, and sometimes without skin, and is one of the fishery products with high perishable properties, so good handling is needed [3]. Fish meat has a high water content with a percentage of as much as 80% with a pH close to neutral, making it easier for putrefactive bacteria to grow [4]. The decay in fish meat is one of the disadvantages for fisheries entrepreneurs, especially in the production of tilapia filets when fish production is abundant. Decaying in fish products can be inhibited by extending the shelf life of fish by lowering the moisture content and adding a preservative to fish [5].

The preservation of fish is needed to inhibit the decline in fish quality [6]. Plants are natural ingredients that are widely used in Indonesia as preservatives. Preservatives from plants can potentially inhibit the activity of putrefactive microbes caused by specific components. One of the plants that have active antimicrobial compounds that can be used to inhibit the deterioration of fish quality and has the potential to be a natural preservative is moringa leaves [7]. Moringa plants belong to the kingdom Plantae, division Spermatophyta, subdivision Agiosperms, class Dicotyledoneae. Order Brassicales, family Moringaceae, genus Moringa, species *Moringa oleifera* [8]. Moringa is a plant that can tolerate various environmental conditions. It is easy to grow even in extreme conditions such as very high temperatures, under shelter and can survive in light snowy areas. Moringa withstands long dry seasons and grows well in areas with annual rainfall ranging from 250 to 1500 mm.

The content of active compounds in moringa leaves that can inhibit the process of decay in fish includes steroids, triterpenoids, flavonoids, tannins, alkaloids, and saponins [9]. Antimicrobial compounds in Moringa leaves have an action mechanism that can damage bacterial cell membranes [6], and the content of flavonoids and essential oils in Moringa leaves can prevent the fat oxidation process in the fish decay process [10].

The process of decay in fish can be identified by organoleptic testing, which can provide indications of deterioration in the quality and other preferences of fishery products. Organoleptic is the assessment of food products using the human senses as the primary tool for measuring the acceptability of a product [11].

Based on the description above, there is a need for research to learn more about the use of Moringa leaf extract as a natural preservative for tilapia fillets during storage when viewed based on the organoleptic characteristics of fish. This research is expected to be applied by the community, especially in fishery products as natural preservatives.

2. MATERIALS AND METHODS

The research was carried out in July-August 2022 at the Fishery Products Processing Laboratory for organoleptic testing, the Aquaculture Laboratory of the Faculty of Fisheries and Marine Sciences acclimatised tilapia, and the manufacture of Moringa leaf extract was carried out at the Central Laboratory of Padjadjaran University.

2.1 Tools and Materials

The tools used in this research consisted of fish handling equipment, making filets, making Moringa leaf powder, making Moringa leaf extract, organoleptic, and pH tests. The equipment used is a fibre tub measuring 1 m 3 with a capacity of 1,000 litres, pump air atman AT-106, airstone size 3 x 2, hose aerator size 3/16 inches, fishing net, hose water size 5/8 inches, plastic PE size 80 x 50 cm, cool box, cutting board, knife, receptacle plastic, ice shovel, receptacle plastic perforated, large tray, large sieve, blender, sieve (40 mesh), jerrycan, paper filter, analytics scales, measure glass, funnel plastic, Buchi rotavapor R-220 pro, spatula, vials, beaker glass size 1000 ml, pipet measure and rubber bulb, strainer plastic, tissue towels, plastic perforated, cling wrap, scissors, plate styrofoam, stationary, handphone, score sheet of 20 sheets, digital balance, beaker glass volume 100 ml, pH meter, mortar and pestle. The ingredients used in this research were moringa, 60 tilapia fish from BRPI Subang, alcohol, hand sanitiser, aquades 5 litres, ethanol 70% 9.1 litres, ice

2.2 Research Methods

The experimental research method is a tilapia filet that is soaked using different concentrations during room temperature storage. The organoleptic test (scoring test) was analyzed by Friedman's non-parametric statistical method consisting of 4 treatments and 20 semi-trained panelists as the number tests. In contrast, the pH testing of the tilapia fillet was analyzed by a descriptive method. Soaking in tilapia filets is carried out for 30 minutes. The treatment used is as follows:

A : no treatment (control)
B : tilapia fillet with moringa leaf extract soaking 4%
C : tilapia fillet with moringa leaf extract soaking 8%
D : tilapia fillet with moringa leaf extract soaking 12%

Observations were made on the pH and organoleptic of tilapia fillet meat that had been soaked using a moringa leaf extract for 30 minutes. Observations were made at the 0, 2nd, 4th, 6th, 8th, 10th, 12th, 14th, and 16th hours. Friedman's test data analysis was carried out in every observation [12].

2.3 Research Stages

The research procedure consists of five stages, first the manufacture of moringa leaf powder [13]. Second is the manufacture of moringa leaf extract [14]. The third is the procedures for handling live tilapia. Fourth is the process of making tilapia fillets [15]. Fifth is the applications of moringa leaf extract to tilapia fillets [16].

2.4 Observed Parameters

The parameters to be observed in the research include organoleptic tests and pH values [17]. The organoleptic test is a scoring test that observes tilapia fillets appearance, aroma, and texture. Fish will be said to have good quality if it has an organoleptic value of 7 to 9, a value of 5 to 6 if it has medium quality, and a value of 1 to 4 if it has less quality [18].

2.5 Data Analysis

The pH observation data were analyzed descriptively based on the average pH of the filet to see changes in the decrease and increase in the pH of the filet during storage. The results of scoring tests conducted hourly on observations were analyzed with Friedman's non-parametric statistics with the Chi-squared test. Friedman test was carried out to determine the effect of tilapia fillet soaking using moringa leaf extract based on organoleptic characteristics. *The Friedman* test was carried out to determine the effect of soaking indigo filets using Moringa leaf extract based on organoleptic characteristics stored at room temperature.

3. RESULTS AND DISCUSSION

3.1 Organoleptic characteristics

Organoleptic testing of tilapia fillets was carried out using scoring tests with parameters that include appearance, aroma, and texture, with a scoring limit of 1 to 9. Organoleptic values of 9 indicate fish in very fresh condition, organoleptic values with values of 7-8 indicate fresh fish conditions, organoleptic values of 5-6 indicate threshold between fresh and non-fresh states, and organoleptic values of 1-4 filets of fish are declared rotten and unfit for consumption [19]. Based on BSN [16], tilapia fillet quality and food safety requirements in the fresh state have an organoleptic value of at least 7.

3.1.1 Appearance

Appearance is the leading indicator of freshness that consumers can see when buying fishery products because appearance is closely related to the quality of a food product [20].

The average appearance of tilapia fillets stored in room (25°C-28°C) temperatures is presented in Fig 1.

Based on the panelists assessment of the appearance of tilapia fillets, all average appearance values decreased along with the length of storage for 16 hours. The highest average has a value of 9 of storage 0 hours on all treatments, which means that the fish in the category is very fresh and there is no difference from live fish because organoleptically, the fish has a brilliant meat colour, clean, whole meat incisions, and bright red linea lateralis. The lowest average appearance value at 16-hour storage, namely in treatment A (control) was 1.6 with an appearance of a greyish-brown meat incision, clean, not whole, and dull brown lateral linea.

Changes in the appearance of tilapia fillets treated with soaking moringa leaf extract, in addition to experiencing changes in appearance during room temperature storage (25°C-28 °C), also shared a shift in intense green colour to yellow to brown. Changes to the appearance of 16 hours of storage are presented in Fig 2. Changes in appearance are caused by the content of flavonoids that function as anti-viral and antimicrobial [21]. The chlorophyll content causes the green colour of moringa leaf extract. Moringa leaves contain high chlorophyll, which is 6,890 mg/kg of dry matter, and moringa leaves contain 4x more chlorophyll content than wheatgrass plants [22]. So that the higher the concentration of moringa leaf extract used, the colour produced will be more concentrated. The colour of Moringa leaf extract is getting thicker because the evaporation process is carried out so that it produces a darker colour [23]. Suppose the tilapia fillet treated with moringa leaf exrak soaking is cut on the sample. In that case, it will appear brilliant milky white, meaning that the green colour that turns into fawn-colored is only found on the surface of the tilapia filet and does not penetrate the filet meat.

Based on the results of research that the low value of organoleptic quality of appearance in tilapia fillets can be caused by prolonged storage time. Changes in the appearance of tilapia fillet meat are caused by the growth of putrefactive bacteria that change cell membranes. The permeability of cell membranes in fish meat is disturbed due to the presence of phenol compounds in moringa leaves, causing the appearance of fish filets to change [21]. The lack of inhibitory effect of antimicrobial compounds is caused by chemical changes in the active substance during room temperature storage, especially polyphenol compounds such as flavonoids and tannins that are damaged during the oxidation process due to oxygen stored at room temperature [21]. The longer the room temperature storage time (20 °C-25 °C) in all treatments of the concentration of basil solution, the appearance of the colour of fish meat will decrease [24]. The duration of storage using moringa leaf extract cannot inhibit microbial activity, so it cannot maintain the appearance of the tilapia fillet colour [21]. When compared to treatments A (control), B (4%) and D (12%), the tilapia fillet of treatment C (8%) can maintain its freshness for up to 12 hours, which means that treatment C has a greater organoleptic final value compared to other treatments at the end of storage.

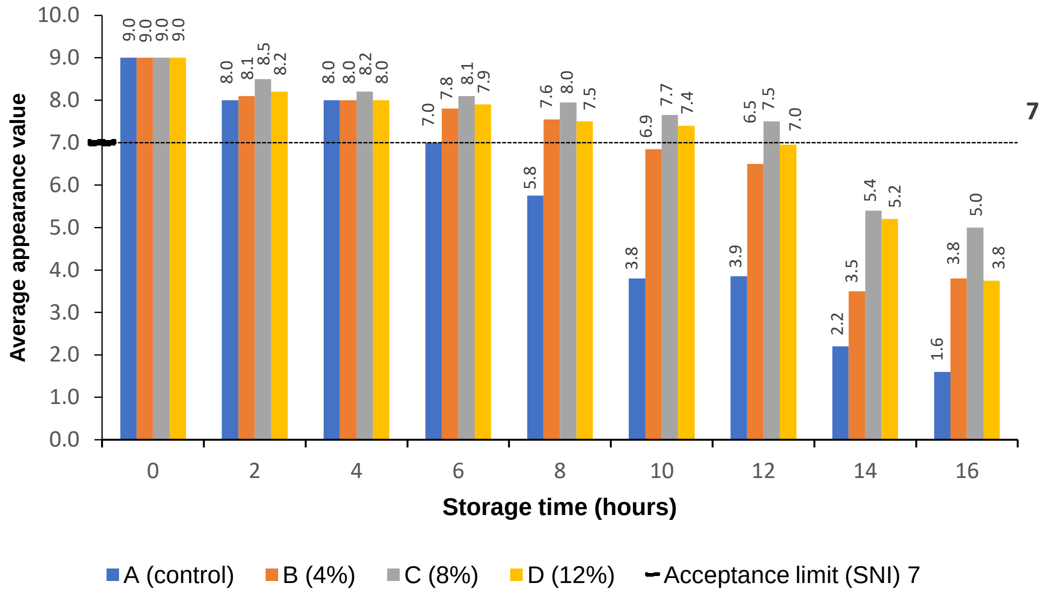

Fig 1. Average appearance of tilapia fillets stored in room (25°C-28°C) temperatures

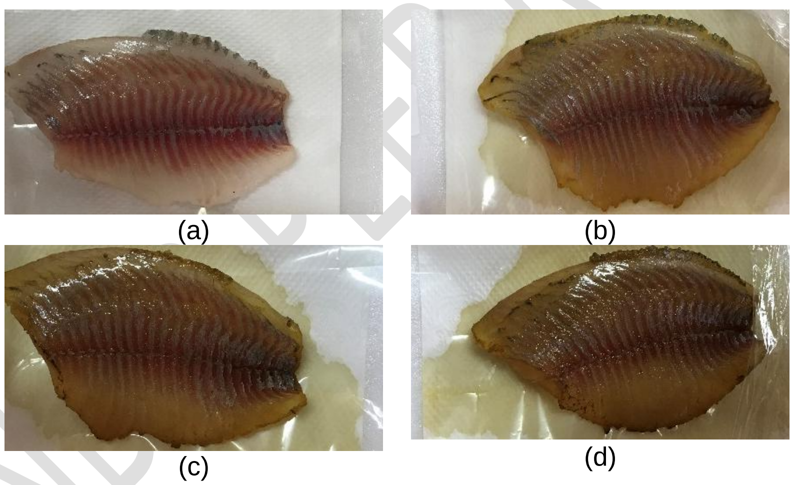

Fig 2. Appearance of tilapia fillet with moringa leaf extract soaking treatment during 16-hour storage at room temperature (25°C-28°C)

(a) A = Control; (b) B = 4%; (c) C = 8%; (d) D = 12%

Friedman's test results on organoleptic values statistically showed that the length of time observed had a marked effect on several long deposits on the appearance of tilapia fillets treated with moringa leaf extract soaking treatment. Friedman's test results against organoleptic tilapia fillets are presented in Fig 3.

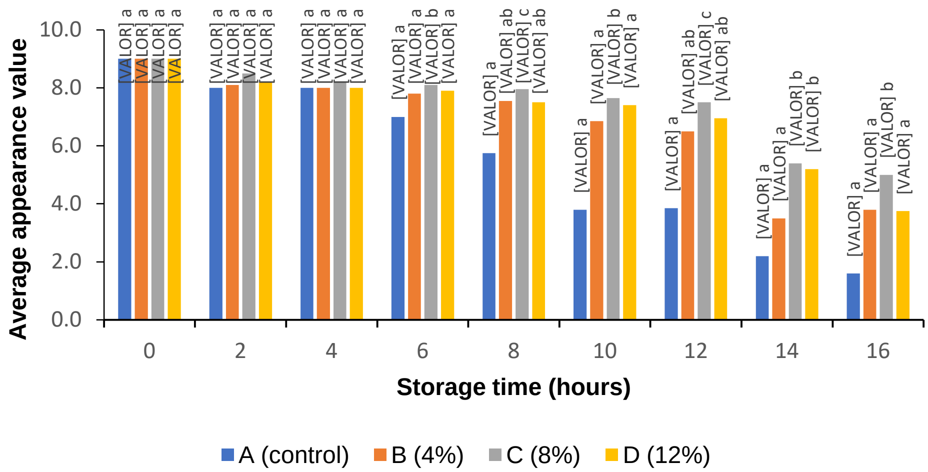

Fig 3. Friedman test results in organoleptic analysis of the appearance tilapia fillets

Description: Numbers followed by different letter notations mean markedly other treatments (α = 0.05)

Based on Fig 3, the results of Friedman's test analysis showed that at observations of 0, 2, and 4 hours, there was no discernible effect on the appearance value of tilapia fillets at a 95% confidence level. The results of observations of 6-hour storage of treatments A (control), B (4%), and D (12%) did not differ markedly, while treatment C (8%) differed dramatically. The 8, 10- and 12-hour observations of only the C (8%) treatment differed markedly, while the A, B, and D treatments did not. The statements of 14-hour storage of treatments A (control) and B (4%) did not vary markedly, and observations at the end of the 16-hour storage of treatments A, B, and D did not differ markedly, whereas treatment C differed dramatically. Based on the results of the Friedman test analysis, it was seen that the administration of moringa leaf extract treatment C (8%) showed significantly different results when compared to other treatments in each observation and could maintain its freshness for up to 12 hours.

3.1.2 <u>Aroma</u>

Aroma or bau results from a nasal responsecaused by the evaporation of soluble substances in a product into the air so that it will be recognised as a specific aroma [25]. Aroma testing is essential in the food or fishery products industry because it can provide direct assessment results regarding products that are more in demand by consumers [26]. The average aroma value is presented in Fig 4.

Based on the panelist's assessment of the aroma of tilapia fillets, all average aroma values decreased along with the length of storage for 16 hours. The highest average has a value of 9. 0 0 hours storage on all treatments, which shows that the fish in the category is very fresh. There is no difference from live fish because organoleptically, the aroma of tilapia filet is very fresh and has a specific type of smell. The lowest average appearance value at 16-hour storage, namely in treatment A (control) was 2.3, with an appearance with aroma characteristics with characteristics of foul smell and ammonia, and had the impression of being rejected by the panelists. Treatments B and D have an average value of 3.8 and 4.2, which have an organoleptic ammonia aroma that is quite strong and already smells sour, as a result of treatment C (8%) has an average value of 5.3 with organoleptic characteristics of ammonia aroma getting smelled and a slightly sour aroma.

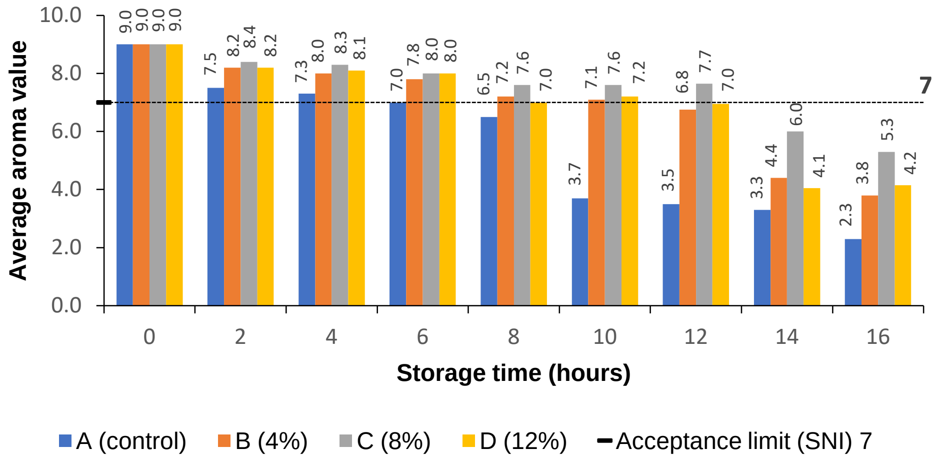

Fig 4. Average aroma of tilapia fillets stored in room (25°C-28°C) temperatures

Based on the results of organoleptic observations, the aroma can be known, and organoleptic values continue to decrease along with the length of storage time. The decreased aroma value is due to the activity of putrefactive bacteria. The organoleptic value of the specific aroma of fish decreased from the observation time at room temperature (25°C-28°C), which is caused by putrefactive bacteria [28]. Decay and lam storage time will trigger the growth of putrefactive microbes [29]. The putrefactive microorganism is caused by the production of volatile content [29].

The results of the observation of the aroma of tilapia fillets with a treatment of 4% and 8% have a scent that does not interfere with the odour character of the tilapia fillet. In comparison, in soaking with a concentration of 12%, the smell of moringa is more smelly. Moringa leaf extract solution can give an authentic aroma to fish [21]. This is because the essential oil compounds contained in moringa leaves are included in the group of volatile compounds such as the monoterpene and sesquiterpene groups which belong to the group of antimicrobial compounds that are easily subject to evaporation. In addition, the aroma of tilapia fillets soaked in a solution of moringa leaf extract has a distinctive aroma caused by the presence of terpenoid compounds. The terpenoid content in moringa leaves provides aromatic properties that include aroma, taste, and texture [30].

Changes in aroma in tilapia fillets during room temperature storage (25°C-28°C) are influenced by the product's fat content, which affects the durability due to the formation of oxidation [31]. Fat content is degraded along with protein denaturation, which will experience an increase in pro-oxidant activity, loss or inactivation of antioxidants, enzyme activity and splitting of cell membranes which can result in the occurrence of fat oxidation [32]. Fish storage at room temperature (25°C-28°C) has a sharp change in aroma value caused by the decay process running very quickly and effectively, where bacteria and enzymes decompose macro components in fish, especially proteins, into simpler compounds and eventually into compounds that smell unpleasant such as ammonia, H_2S, histamine, skatol, indole, etc [33]. until these compounds decompose entirely. The decrease in the organoleptic value of aromas is thought to be due to the formation of volatile bases resulting from protein degradation by proteolytic enzymes as well as microbial activity [34]. Volatile component constituents in fishery products include 3-methyl-1-butanal; 2,3-butanedione; 2-methyl-1-butanal; 2,3-heptanedione, and trimethylamine [35].

The panelist's acceptance threshold for tilapia fillet scent in treatment A (control) to 6-hour storage with an average of 7.0, treatment B (4%) to 10-hour storage with an average of 7.1, treatment C (8%) to 12-hour storage with an average of 7.7, and treatment D (12%) to 12-hour storage with an average of 7.0. The organoleptic value requirement is considered fresh if it has tilapia >7 [16]. Kite fish soaked in moringa leaf extract solution can improve the quality of its aroma until storage at the 12th hour at room temperature (25°C-28°C) and meet the quality standards of fresh fish set by SNI (2729-2013) [21].

The difference in the effect of using moringa leaf extract solution can be known by testing the aroma value of the tilapia fillet using Friedman test statistics and then continuing with the multiple comparison test. Friedman's test results of the importance of aroma tilapia fillet are presented in Figure 5.

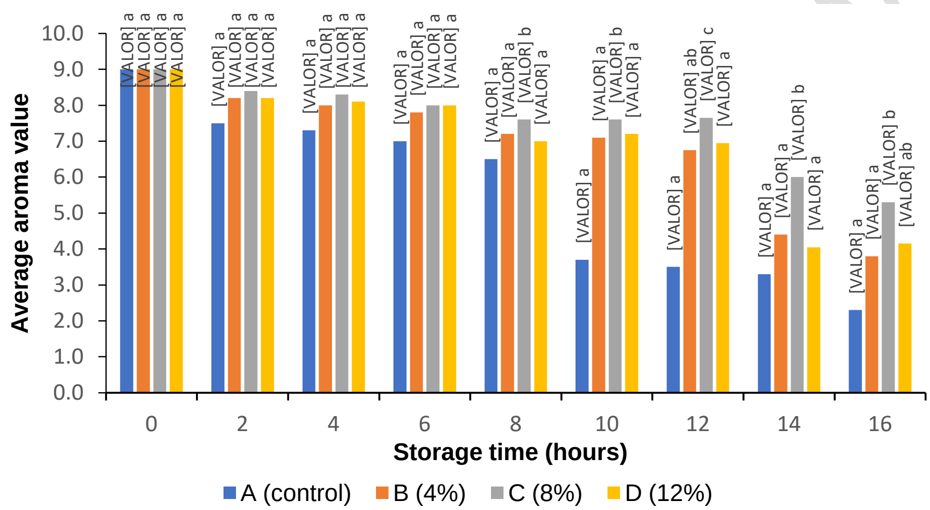

Fig 5. Friedman test results in organoleptic analysis of the aroma tilapia fillets

Description: Numbers followed by different letter notations mean markedly other treatments (α = 0.05)

Based on Figure 6, the results of Friedman's test analysis showed that at observations of 0 hours to 6 hours, all treatments did not have a noticeable impact on the aroma of tilapia fillets. 8-hour, 12-hour, and 14-hour statements of C (8%) treatment differed, while treatments A (control) B (4%), and D (12%) had unreal differences. The 16-hour treatment of A, B, and D did not differ markedly, while the treatment of C (8%) differed dramatically. This is because the C treatment has a higher aroma value score compared to others and can maintain its freshness for up to 12 hours.

3.1.3 <u>Texture</u>

Texture testing is done by hand by touching it directly. This aims to feel the texture of a product being tested [26]. Fresh fish fillets will show elastic fish meat textures, while inelastic fish fillet textures show that fish fillets have decreased in quality [36]. The average texture values are presented in Fig 6.

Based on the panelists assessment of the texture of tilapia fillets, all average aroma values decreased along with the storage time for 16 hours. The highest average has a matter of 9.0

0 hours of storage on all treatments, which means that the tilapia fillet is very fresh, and there is no difference because organoleptically, the texture is dense, elastic when pressed fingers and compact. Fresh fish has the same meat texture as live fish: chewy, adaptable and flexible [36]. The average appearance of the lowest value at 16-hour storage, namely in treatment A (control) had an average of 2.1, which had a very soft organoleptic texture. Finger brushes did not disappear when pressed and were less compact. The B and D treatments have average values of 3.4 and 3.7, with the surface of the tilapia fillet already soft, finger marks visible when pressed, and the meat less compact. While the C treatment has an average value of 5.4, which has a dense meat texture, is less tight, and, when pressed with fingers, is less elastic.

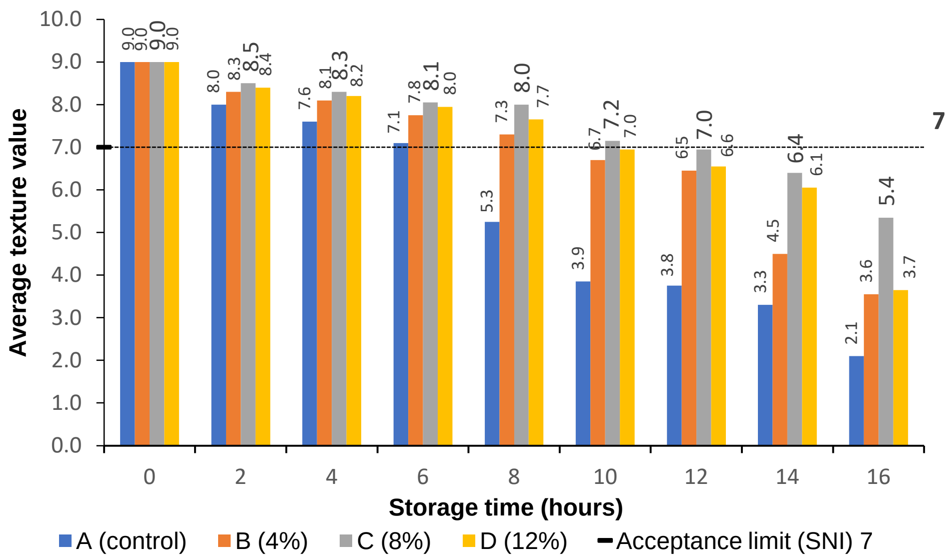

Fig 6. Average texture of tilapia fillets stored in room (25°C-28°C) temperatures

Based on the average texture value according to BSN [16], that fish is said to be fresh if it has an organoleptic value of at least 7, meaning that treatment A (control) can maintain its freshness for up to 6 hours. Treatment B (4%) to 8 hours storage, treatment C (8%) up to 12 hours, and treatment D (12%) up to 10 hours. Treatment C has the most extended shelf life, with the highest average texture value. It is suspected that C treatment is an optimum concentration of moringa leaf extract as an effective antibacterial compound to inhibit bacterial growth so that damage in meat can still be inhibited [21]. The flavonoid content in moringa leaves has antibacterial activity that inhibits the formation of bacterial cell membranes [37]. The cell membrane serves to control the entry and exit of various substances. It is the location of the system, and the transportation of active substances, so the occurrence of bacterial inhibition can be caused due to damage that occurs to the structural components of the bacterial cell membrane.

Based on the average texture value, the appearance of tilapia fillets decreased from 2-hour to 16-hour observations. Organoleptic values decline due to during storage changes in the texture of fish meat will change due to the growth of bacteria which results in fish meat no longer being good [38]. The bacteria decomposition begins to occur intensively after the rigor mortis stage has passed, and the fish meat is no longer compact [18]. The length of storage time makes a significant difference in fish stored at room temperature (25°C-28°C). The characteristics of the decline in the quality of fresh fish based on texture are not chewy and elastic, mushy, and high water content [39]. While the characteristics of the texture of fish that have good quality are flexibility, density, and elasticity when pressed with fingers—the elastic texture of fish meat is due to the uninterrupted binding tissue in the core [40].

During storage, fish meat will gradually begin to experience a decrease in organoleptic value at 5 hours of storage [35]. This is due to the activity of the enzyme cathepsin, which damages the structure of fish meat to become less elastic and soft. Reported in the results of their research that the activity of the enzyme cathepsin dramatically affects the texture of fish meat because cathepsin can decrease flexibility (suppleness) so that fish meat becomes inelastic and fish meat tissue softens (mushy) [41]. Characteristic changes in fish are due to low ATP residue to remodel actomyosin into actin and myosin, so the fish muscles become stiff and rigid [41].

The difference in the effect of using moringa leaf extract solution can be known by testing the texture value of the tilapia fillet using Friedman test statistics and then continuing with multiple comparison tests. Friedman's test results show the importance of texture tilapia fillet in Fig 7.

Based on Fig 7, the results of Friedman's test analysis showed that the 0 and 2-hour alterations of all treatments had an unreal difference in the texture of tilapia fillets. The 4-hour observations of treatments A, B, and D did not differ markedly, and the C treatment differed dramatically. The 6-hour statement of treatments A and B did not differ markedly, while treatments C and D differed dramatically. The 8, 10, 14 and 16-hour excitations of treatments A, B, and D did not differ markedly, while the C treatments differed dramatically. The 12-hour observation of treatments A, B, and D did not differ markedly. Still, it was significantly different from treatment C. Friedman's test results carried out could be seen that the administration of moringa leaf extract in treatment C (8%) showed very different results in each observation and could maintain its freshness for up to 12 hours and had a higher texture value score compared to other treatments.

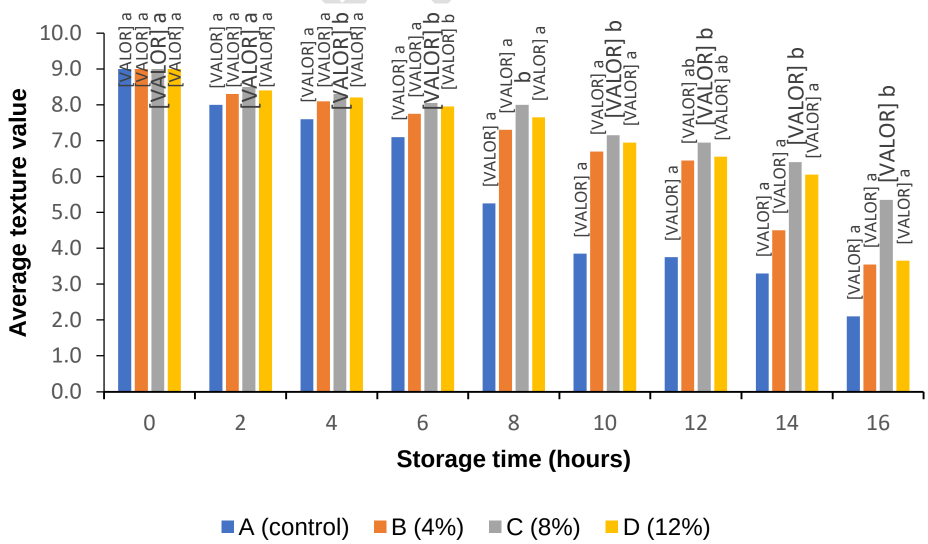

Fig 7. Friedman test results in organoleptic analysis of the texture tilapia fillets

Description: Numbers followed by different letter notations mean markedly other treatments (α = 0.05)

3.2 Degree of Acidity (pH)

Indicators for measuring the level of freshness of fish can be determined through a test of the value of the degree of acidity (pH). The pH is calculated to determine the pH change in the tilapia fillet for 16 hours of storage at room temperature. The results of observations on the average pH of tilapia fillets are presented in Fig 8.

The average value of tilapia fillets during storage (25°C-28°C) ranged from 6.2 to 7.4. During storage, there was a change in pH value. In the early storage stages, the 2nd hour for the control tilapia fillet and the 4th hour for the tilapia filet treated with soaking moringa leaf extract decreased the pH value. Still, as time increased, the pH value increased. Tilapia fillet with soaking treatment of moringa leaf extract solution has a lower pH value compared to the pH of the control, and this is suspected to be due to the influence of moringa leaf extract antimicrobial substances, namely tannins and flavonoids which can slow down the growth rate of bacteria [24].

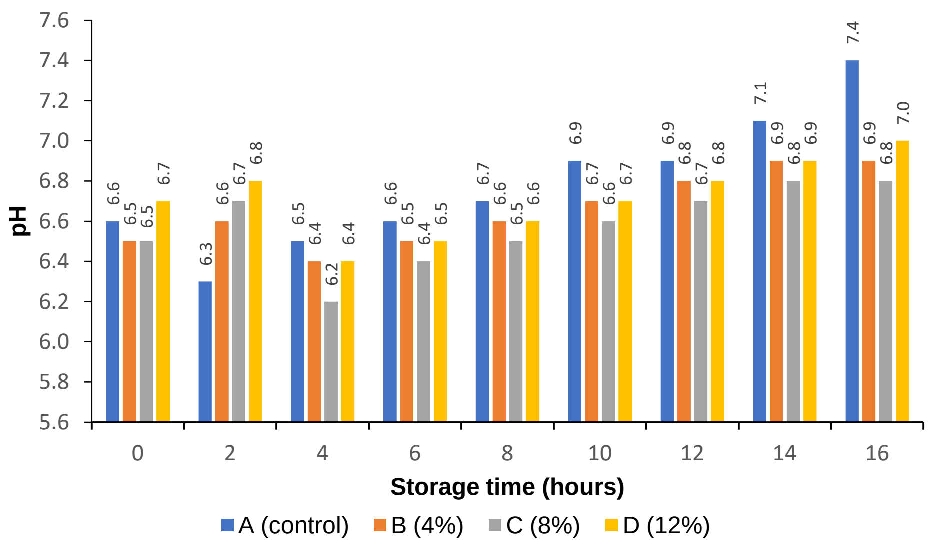

Fig 8. Average pH value of tilapia fillet with moringa leaf extract soaking treatment at room temperature storage (25°C-28°C)

The pH of the tilapia fillet tends to increase until the last observation, which is at the 16th hour. The tilapia fillet of treatment A (control) had a final pH value of 7.4, treatment B (4%) had a pH value of 6.9, treatment C (8%) of 6.8, and treatment D (12%) had a pH value of 7.0. The amount of concentration used can affect the pH value in tilapia meat. The change in pH value that occurs in the tilapia fillet with the soaking treatment of moringa leaf extract solution is suspected to be due to the influence of the moringa leaf extract solution, which can keep the tilapia filet fresh. Using moringa leaf extract can maintain the pH value of kite fish meat until the 18th hour of storage, with a pH value of 6.52 [21]. Based on the results of observations of the resulting pH value, the control tilapia fillet is still categorised as fresh until the storage of 0-12 hours with a pH value of tilapia meat of 6.6-6.9. Meanwhile, tilapia fillets with a concentration of 4% storage of 0-16 hours with a pH value of 6.5-6.9, a concentration of 8% storage of 0-16 hours with a pH value of 6.5-6.8, and a concentration of 12% storage of 0-14 hours with a pH value of 6.7-7.0. The pH value is still fresh because it ranges from 6.2 to 7.0 [42].

A decreased pH in fish meat occurs due to the formation of lactic acid due to the breakdown of glycogen under anaerobic conditions [43]. When fish die, adenosine-triphosphate (ATP) will be synthesised mainly from glycogen and small parts of keratin phosphate (in fish) under anaerobic conditions [44]. The process of glycolysis (glycogen reduction process) will continue until lactic acid is formed. As the final result, the final product of this glycolysis process will cause the pH of fish meat to decrease. The increased pH value is due to the presence of volatile compounds due to the activity of bacteria and proteolytic enzymes [45]. The increased pH in fish meat can be caused by the presence of alkaline compounds, such as trimethylamine, ammonia, and other volatile compounds [48]. This alkaline component of the combination is caused by the activity of bacteria that can decompose components in meat [46]. Live fish have a pH value of about 7.0 [47], and fresh fish has a pH value ranging from 6.2 to 7.0 [44]. If the fish has a pH value of >7, then the fish is less fresh [48], and if the pH value is >8, then the fish is not fresh (rotten) [45].

The pH value is closely related to the growth rate of bacteria. The higher the pH value or the more alkaline, the higher the ability of bacteria to grow and develop, which can cause a decrease in the quality of fresh fish meat and vice versa. The pH value is closely related to the growth rate of microorganisms [52]. The lower the pH, the lower the ability of a microorganism to grow, except for bacteria resistant to low pH (*Achidophilic*). Microorganisms can grow in the pH range of 6.0 to 8.0 or alkaline [53]. When viewed from the results of the research in Fig 8. antibacterial compounds contained in moringa leaves, such as saponins, tannins, and flavonoids, have antimicrobial activity [21]

4. CONCLUSION

Based on the results of research, it can be concluded that the use of moringa leaf extract as a natural preservative to inhibit the decline in the quality of tilapia fillet based on organoleptic characteristics at room temperature (25°C-28°C), which has the longest quality deterioration, namely in the C treatment (8%) shelf life up to 12 hours, the average organoleptic value of an appearance was 7.5, the aroma was 7.7, the texture was 7.0. It was still accepted by the panelists, and the pH value was 6.8.

The cost required to apply Moringa leaf extract as a natural preservative is only required to make the extract which is US$77,00. Perhaps the price for each country can be different and the extraction method used can affect the costs incurred

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