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Research Paper

The Effect of *Pindang* Frigate Mackarel Vacuum Packaging On Quality and Storage at 5°c and -18°c

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ABSTRACT
Processing of fishery products have an important role in post-harvest activities considering that fishery products are perishable goods. The current vacuum packaging technique is a packaging technique that is currently well-known among the public. The purpose of this study was to determine the effect of pindang frigate mackarel vacuum packaging on the quality and shelf life at temperatures of 5°C and -18°C. This research is a comparative experimental study that compares the quality of vacuum frigate mackarel pindang at storage times of 0, 7, 14, 21, and 28 days at storage temperatures of 5°C and -18°C. Parameters evaluated include chemical, microbiological and organoleptic parameters.
The results showed that the quality of vacuum frigate mackarel pindang stored at a temperature of 5°C with -18°C for up to 28 days still had decent quality and was not significantly different. This is because the vacuum packaging and storage temperature of 5°C and -18°C spoilage microbes are not able to grow and develop. There was a slight difference in quality degradation at 5°C and -18°C storage temperatures, especially in the number of bacteria and a slightly brownish appearance at 5°C vacuum frigate mackarel. However, until the end of the 28th day of storage, the vacuum frigate mackarel pindang product at storage temperatures of 5°C and -18°C still met the SNI requirements.
Keywords*: Quality and Shelf Life of Pindang Frigate Mackarel Vacuum,*

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I. INTRODUCTION

The demand for food products derived from fish for local and export needs is increasing from year to year. In addition to being the main source of food (nutrition), fish is a commodity that is a source of livelihood for fishermen and fishery product processing business actors [1]. Processing of fishery products plays an important role in post-harvest activities considering that fishery products are perishable goods. Fast and precise handling is needed to maintain the quality of fishery products in the hands of consumers. Fish processing processes and techniques that are well known to the public, both traditional and modern, are pemindangan. In principle, pemindangan is done to inhibit the growth of microorganisms or enzyme activity in the fish body that can cause damage [2].

The largest transfer center in Bali Province is in Kusamba village, Klungkung, Bali. Every day this milling center is able to produce up to 20 tons of pindang per day. Based on production data from the Kusamba Fish Processing Place (TPI), it was found that the production of pindang in June 2018 totaled 522,200 kg including tuna, tuna, lemuru, barramundi, and so on, with tuna occupying the highest position, which was 468,200 kg [3]. TPI Kusamba is a fish processing place that still uses simple equipment, the production of pindang is solely intended to meet the needs of the local market. The finished pindang is only packaged using bamboo baskets, which is very lacking in terms of aesthetics and safety because it is not able to maintain the quality of the pindang to remain good, especially at room temperature [3, 4].

The current vacuum packaging technique is a packaging technique that is currently well-known among the public. Food products packaged under vacuum become free of gas and water vapor so as to reduce the amount and growth, inhibit changes in smell, taste, and appearance during storage [5]. There are many food products on the market that are packaged by vacuum method, but there is no pindang *Frigate Mackarel* that is packaged in a vacuum and researched. This research is a basic research to produce quality betel products that are able to compete in the global market. How is the effect of vacuum packaging products on the chemical, microbiological, and organoleptic quality at storage temperatures of 5°C and -18°C. How is the influence of

vacuum packaging products on the quality of shelf life at 5°C and -18°C storage temperatures. Specific Research Objectives To examine the effect of vacuum packaging products on the chemical quality, microbiological quality, on the organoleptic quality, at storage temperatures of 5°C and -18°C, as well as analyzing the shelf life of vacuum-packed pindang *Frigate Mackarel* products at storage temperatures of 5°C and -18°C.

II. METHODOLOGY

This research is a comparative experimental study that compares the quality of vacuum *Frigate Mackarel* pindang products at shelf life of 0, 7, 14, 21 and 28 days at storage temperatures of 5°C and -18°C. Pindang products produced by the Kusamba Fish Center, whole, without defects, were selected as research materials. The head of the Pindang *Frigate Mackarel* is removed, split into two (2) parts, then the entrails and bones of the vertebrates are removed, put in a polyethylene vacuum plastic, for a vacuum process to become a vacuum *Frigate Mackarel* pindang product.

Vacuum *Frigate Mackarel* pindang products were divided into two groups, namely group A (temperature 5°C) and group B (temperature -18°C), with a shelf life of 0, 7, 14, 21 and 28 days, with 3 replications. Vacuum *Frigate Mackarel* pindang products were stored in a refrigerator at 5°C and in a freezer at -18°C for storage. Observation parameters include chemicals such as histamine levels, moisture content, total volatile bases levels; microbiology such as the number of bacteria, the number of coliforms, and the number of *Escherichia coli*; and organoleptic parameters such as appearance, texture, and smell. The data from the analysis were statistically tested using paired t-test, with the difference being significant if $P < 0.05$

III. RESULTS AND DISCUSSION

The quality of vacuum *Frigate Mackarel* pindang that had been stored for 0 days, 7 days, 14 days, 21 days and 28 days at temperatures of 5°C and -18°C (Table 1) had a quality that was still suitable for consumption and did not differ in quality, starting from storage day 0 to day 14, this is because storage temperatures at low temperatures or cold, even frozen can reduce or inhibit the growth of microbes in food and can reduce the microbial population (kill some). Biochemical reactions in fresh food can be inhibited by cooling which causes a reduction in the rate of enzymatic changes and slows the rate of respiration and aging of fresh food. Refrigeration can prevent the growth of mesophilic microorganisms and all thermophilic microorganisms, whereas freezing can preserve foodstuffs for several months or sometimes years [11]. Differences in the quality of vacuum *Frigate Mackarel* pindang can be seen after the 21st day of storage at a temperature of 5°C, namely in the observation of the total bacteria $67{,}10^1$ colonies/g to $186{,}10^3$ coloni/g on the 28th day. Changes were also seen in the observations of the panelists, namely the appearance of a brownish color change from a score of 8, 7 to 7.73 compared to the storage of pindang *Frigate Mackarel* in vacuum at -18°C. However, according to SNI, the two vacuum-*Frigate Mackarel* pindang products until the end of the 28th day of observation were still suitable for consumption. A similar statement based on the results of research [12] showed that the best treatment for storage of skipjack tuna was obtained in the vacuum packaging treatment at freezing temperatures compared to cold temperatures. Research [13] stated that vacuum and non-vacuum packaging methods had no significant effect on the total microbes of banana heart meatballs and catfish. This occurs due to the lack of oxygen availability in vacuum packaging which causes aerobic bacteria to be unable to live, while in non-vacuum packaging the growth of bacteria is slowed by cold temperature treatment.

Table 1. Chemical, microbiological and organoleptic quality as well as further tests of vacuum *Frigate Mackarel* roasting at 5°C and -18°C storage temperatures.

Quality Parameters	Temperature (°C)	Day Observation				
		0	7	14	21	28
Water content (%)	5	64.61 [a]	65.46 [a]	62.44 [a]	62.05 [b]	62.29 [a]
	-18	64.13 [a]	63.30 [a]	59.76 [a]	63.32 [a]	59.24 [b]
Histamine (mgN%)	5	4.18 [a]	4.24 [a]	4.47 [a]	6.78 [a]	7.02 [a]
	-18	1.56 [b]	2.36 [b]	3.40 [b]	4.51 [b]	4.96 [b]
TVB (mgN%)	5	7.20 [a]	8.00 [a]	8.90 [a]	10.00 [a]	10.20 [a]
	-18	4.35 [a]	6.10 [a]	6.50 [a]	7.20 [a]	7.50 [a]
Total bacteria (coloni/g)	5	0 [a]	76 [a]	89 [a]	146 [a]	168000 [a]
	-18	0 [a]	32 [b]	34 [a]	40 [b]	6700 [b]
Coliform (coloni/g)	5	0 [a]	<3 [a]	<3 [a]	<3 [a]	<3 [a]
	-18	0 [a]	<3 [a]	<3 [a]	<3 [a]	<3 [a]
E, coli (coloni/g)	5	0 [a]	<3 [a]	<3 [a]	<3 [a]	<3 [a]
	-18	0 [a]	<3 [a]	<3 [a]	<3 [a]	<3 [a]
Appearance	5	9.00 [a]	9.00 [a]	8.70 [b]	8.70 [b]	7.73 [b]
	-18	9.00 [a]	9.00 [a]	9.00 [a]	9.00 [a]	8.70 [a]
Smell	5	9.00 [a]	9.00 [a]	8.00 [b]	8.00 [b]	7.00 [b]

	-18	9.00 [a]	9.00 [a]	9.00 [a]	9.00 [a]	8.00 [a]
Texture	5	9.00 [a]	9.00 [a]	9.00 [a]	8.00 [b]	8.00 [b]
	-18	9.00 [a]	9.00 [a]	9.00 [a]	9.00 [a]	9.00 [a]

*) *Notations with different letters show a significant difference*

WATER CONTENT

The chemical quality of vacuum *Frigate Mackarel* pindang on the 0th day of storage shows the quality of fresh *Frigate Mackarel* pindang as Table 1, because it has a moisture content of 64.61% for vacuum *Frigate Mackarel* pindang at 5°C and 64.13% for vacuum *Frigate Mackarel* pindang at -18°C , this still meets the maximum moisture content required by SNI of a maximum of 70% [14]. This water content is not much different from the water content of pindang tuna research results [15] which is 64.19–65.17%, pindang layang tuna by 68.82% [16] and pindang lisong fish which ranges from 56.69–66,45% [17]. After storage at a temperature of 5°C for the 7th day shelf life of vacuum *Frigate Mackarel* pindang has a water content of 65.46%, then the 14th day shelf life the water content becomes 62.44%, then decreases to 62.29%, while the storage is -18°C the water content of vacuum *Frigate mackarel* pindang decreased to 63.30% and continued to decrease to 59.24% on day 28. This was due to the effect of vacuum packaging with storage at cold temperatures and freezing temperatures which caused the water content to decrease, when compared between cold temperatures 5°C with -18°C there is no real difference. Products packaged by vacuum technique at a frozen storage temperature of -18°C have a lower moisture content than a cold storage temperature of 5°C [18] and it is further stated that vacuum packaging is more effective and can reduce the rate of increase in water content during storage because vacuum treatment can reduce evaporation.

Based on the results of statistical tests using paired t-test, it was found that the water content ($P<0.05$) for both treatments on day 0, both storage temperature of 5°C and storage temperature of -18°C was not significantly different, while for the shelf life of day 21 and day 28 there was real difference. This is due to vacuum *Frigate Mackarel* with a frozen storage temperature of -18°C, the water decreases 63.32% faster to 59.24% compared to a relatively stable cold temperature of 5°C. The water content of vacuum *Frigate mackarel* pindang at both storage temperatures, namely 59.24% and 62.29%, was still able to support microbial growth. This also happened in research on the water content of yellow spiced pindang fish products that occurred on the 14th day of storage with a range between 64.58-66.28% which could support microbial growth. The increase in water content has an effect on increasing Aw so that it supports microbial growth [11].[12].

Histamine levels

Based on the results of statistical tests using paired t-test, it was found that the histamine levels ($P<0.05$) for the two treatments on day 0 were significantly different (Table 1), while the effect of shelf life on the 7th day of the 14th, 21st and There was no significant or significant difference on the 28th day of shelf life in the two treatments. Based on the results obtained from the histamine test of 1 mg/kg and the TPC test of 370 coloni/g, based on these results it can be concluded that frozen black marlin loin has met the SNI standard for frozen marlin loin, the fish has good quality so it is safe for consumption. and fit to be marketed [20]. The increase in histamine levels was caused by histamine-forming bacteria that were still able to grow and reproduce at storage temperatures of 5°C and -18°C in minimal conditions. The growth of histamine-forming bacteria in tuna and tuna was very rapid at a temperature of 30°C in a 24-hour storage time with histamine content reaching 56.62 mg/100 g and 78.76 mg/100 g [21]. [22] reported histamine levels in tuna (*Katsuwonus pelamis*), mackerel (*Scomberomorus commersonii*) and sardines (*Sardinella gibbosa*) which had been pre-boiled and then stored at 30°C for 6 hours, the histamine levels were 17, 14, respectively. and 8 mg/100 g. The content is still categorized as safe and can be used as raw material for canned fish products in accordance with FDA standards, which are below 50 mg/100 g and [23] FDA has set a critical temperature limit for histamine formation in fish centers, which is 4.4ºC.

Total Volatile Bases

Based on the results of statistical tests using paired t-test, it was found that the levels of TVB ($P<0.05$) for all treatments on the shelf life of day 0, shelf life of day 7 and shelf life of 14, 21 and 28 days did not significantly different are indicated by the same letter notation. TVB levels are used to measure the level of freshness of fish and as an appropriate limit for consumption. Fish are at the limit of freshness that can still be consumed with TVB-N levels of 20-30 mgN/100gr [23]. Based on Table 1, the use of cold temperatures of 5°C and freezing temperatures of -18oC was able to inhibit microbial growth, so that the results of microbial metabolism in the form of TVB did not increase significantly. The results of the study [25] on pindang tuna (*Euthynnus affinis*). This is indicated by the lowest average value found on day 0 with an average TVB value of 17.02 mgN/100g. While the highest average value is on day 9 with an average TVB value of 36.82 mgN/100g.

Total bacteria

Based on the results of statistical tests using paired t-test, it was found that the number of bacteria (P<0.05) in the two treatments of day 0 storage did not differ between the two treatments of 5°C and -18°C with the number empty. This means that the vacuum *Frigate Mackarel* pindang is really fresh, while the 7th day shelf life and 14th day, 21st day to 28th day there are significant differences, indicated by different letter notations with storage temperatures of 5°C to -18°C. Vacuum packaging of pindang *Frigate Mackarel* with a cold temperature of 5°C during storage day 28 resulted in a total of 168,103 coloni/g microbes, while frozen storage at -18°C with a shelf life of 28 days resulted in a total of 67,101 coloni/g bacteria. the number of bacteria is still very feasible according to SNI 2717.1:2009 with a total microbe of 10.10^5 Coloni/g [11].

In vacuum packaging, the growth of existing aerobic spoilage bacteria will be inhibited by anaerobic environmental conditions, namely vacuum packaging. In products that have been packaged using a vacuum, the remaining oxygen is used by the existing aerobic bacteria to produce carbon dioxide and suppress the growth of aerobic spoilage bacteria. While the highest average value was found on day 9 with the number of colonies as many as 8,103 colonies/g. At a cold storage temperature of 5°C is not suitable which is able to inhibit the development of microorganisms so that fish are not easily decomposed. This is in accordance with the statement [25] that one of the factors that affect the deterioration of quality in fish is caused by temperature.

Coliform

Based on the results of the study in Table 1 regarding the number of coliforms, it turns out that the results in all treatments, both pindang *Frigate Mackarel* vacuum at 5°C and -18°C, resulted in the number of 0 colonies/g on day 0. This shows that it is true that pathogenic bacteria have not grown and developed, but on the 7th day the number of coliform bacteria colonies <3 colonies/g, coliform bacteria contamination may occur during the handling of fresh fish, during the transfer process the coliform bacteria contamination occurs. However, during storage day 0, coliform bacteria were not able to reproduce and grow at temperatures of 5°C and -18°C until the end of the 28th day of the study. The number of coliforms still met the SNI criteria.

Escherichia coli (E. coli)

the number of bacteria e, coli, was less than <3 coloni/g at a temperature of 5°C and -18°C (Table 1) until the end of the 28th day of the study, so it still met the SNI criteria.

Appearance

Based on the results of statistical tests using paired t-test, it was found that the appearance (P<0.05) had a shelf life of 14 days, 21 days to 28 days, especially changes in appearance (Figure 1) and smell while the texture was still intact. This is due to the influence of vacuum packaging and storage temperatures of 5°C and -18°C. These differences are indicated by different letter notations.

The decrease in the appearance value from 8.7 on the 14th day, decreased to a value of 7.73 on the 28th day in the 5°C vacuum treatment of pindang *frigate mackarel* can not be avoided, as well as the freezing temperature treatment of -18°C on the 28th day. The appearance of vacuum *frigate mackarel* pindang is a determining factor before other factors are considered. Appearance can be used as an indicator of food quality. The appearance of pindang tuna is influenced by the water content contained in each treatment.

Figure 1. Changes in appearance and texture at the end of storage

Smell

The change in smell score was very sharp in the 5°C vacuum treatment of pindang *frigate mackarel* with a 28th day shelf life, namely a score of 7, compared to the -18°C storage temperature with a score of 8. This was due to the very slow decay process at 5°C cold and freezing temperature -18°C. At a temperature of 5°C and -18°C bacteria and enzymes are still able to very slowly decompose macro-components in fish, especially proteins into simple compounds and finally into foul-smelling compounds such as ammonia, histamine, H_2S, indole, skatole and others. [29].

Texture

The difference in the average texture value in each treatment was caused by the vacuum condition of the frigate mackarel pindang with a storage temperature of 5°C and a temperature of -18°C. Changes in texture are slightly brittle due to the work of bacteria and enzymes, especially bacteria that secrete proteolytic enzymes that break down proteins so that they are gradually able to reduce the cohesiveness of fish meat muscles until the texture of fish meat becomes brittle on the 21st and 28th days of storage. The vacuum which was still fresh on day 0, when assessed by the panelists, showed that the texture of the tuna fish was still compact and intact, and after storage on the 21st day of storage, there was a slight change, namely the reshuffling of fish meat protein by bacteria and enzymes.

IV. CONCLUSION

The quality of vacuum *frigate mackarel* pindang at a temperature of 5°C can be stored for up to 28 days with chemical quality microbiological quality and organoleptic quality. Likewise, the quality of vacuum *frigate mackarel* pindang at a temperature of -18°C can be stored for up to 28 days with better quality and meets the Indonesian National Standard.

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