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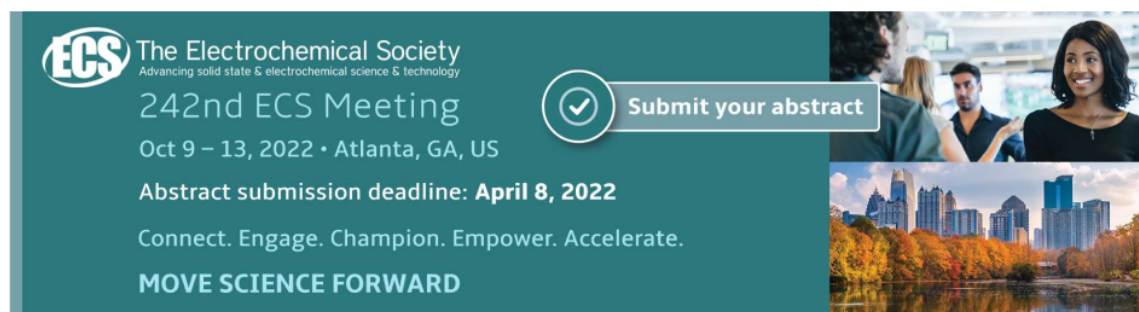
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The differences in the types of packaging and duration of storage on the quality of Tilapia (*Oreochromis niloticus*)

I G S Pandit^{1,2,*}, P A N K Permatananda³ and R Wulandari¹

¹Faculty of Agriculture, Universitas Warmadewa, Bali, Indonesia

²Postgraduate Program, Universitas Warmadewa, Bali, Indonesia

³Faculty of Medicine and Health Science, Universitas Warmadewa, Bali, Indonesia

*suranaya_pandit@yahoo.com

Abstract. One of the most popular types of tilapia dishes is *nila nyat nyat*, which is boiled with Balinese spices until the water runs out. This study aims to determine the interaction between the different types of packaging and the length of storage to the quality of tilapia boiled with Balinese spices and to know the differences in the type of packaging and the length of storage to the quality of tilapia boiled with Balinese spices. The method used in this study was a factorial complete randomized design with 2 factors, namely; factor A (type of packaging) which consists of 2 types: Styrofoam (A1) and mica (A2) and factor B (storage time) which consists of 3 types: 0 days (B1), 3 days (B2), and 6 days (B3). Observations include subjective and objective observations were done. The interaction between packaging type and storage time only affects the Total Plate Count (TPC) value of tilapia boiled with Balinese spices. The types of packaging, both Styrofoam and mica, have a significant influence on the value of TPC. Storage time in cold temperatures has a significant effect on the quality of tilapia boiled with Balinese spices.

1. Introduction

The province of Bali in Indonesia has enormous fisheries potential. Potential land for aquaculture in Bali is 1,667 hectares, but only has been utilized. Bali has potential land for freshwater cultivation in the form of rice fields, ponds and public waters covering an area of 27,410.57 hectares for the development of shrimp, goldfish, tilapia, catfish, carp, and ornamental fish [1]. One of the land for tilapia cultivation is the Sangeh Central Fish Cultivation Center located in Badung regency, precisely Sangeh village, Abiansemal District. Fish commodities developed at the Sangeh Fish Cultivation Center are tilapia, catfish and carp. Tilapia (*Oreochromis niloticus*) is a type of freshwater fish that is widely enjoyed by Balinese people. Tilapia has very good nutritional value for the body, including protein, fat, vitamins, minerals, and carbohydrates. By the community, tilapia is usually processed in various ways such as fumigation, frying, or other types of processed dishes. One of the most popular types of tilapia dishes is *nila nyat nyat*, which is boiled with Balinese spices until the water runs out [2].

So far, there are no traders who sell tilapia in the form of packaging so that it can be stored and resold. This study aims to determine the interaction between the different types of packaging and the length of storage to the quality of tilapia boiled with Balinese spices and to know the differences in the type of packaging and the length of storage to the quality of tilapia boiled with Balinese spices. The results of this study will be very useful in realizing a new product, which is boiled tilapia in Balinese



spices in the form of packaging. The packaging is believed to be able to maintain product quality and extend the shelf life of tilapia.

2. Method

The method used in this study was a factorial complete randomized design with 2 factors, namely; factor A (type of packaging) which consists of 2 types: Styrofoam (A1) and mica (A2) and factor B (storage time) which consists of 3 types: 0 days (B1), 3 days (B2), and 6 days (B3). Using the Ferderer formula, the number of replications in this study was 4 times, and the total number of experimental units was 4 units.

Stages of research include preparation of raw materials, namely tilapia which is still intact and fresh, cleaned, then fried half-cooked. Balinese spices that have been prepared sautéed until fragrant. The previously fried fish is then boiled with Balinese spices until all the spices and gravy are absorbed. Cooked fish are packed with mica and Styrofoam then stored in cold temperatures of 9°C. Observations include subjective and objective observations. Subjective observations consisted of organoleptic tests including appearance, taste, odor, and texture by using 15 panelists. Objective observations include chemical tests, namely analysis of water content, protein, and total volatile bases (TVB), and microbiological tests including total plate count (TPC) analysis. All data obtained were analyzed statistically. To see the effect of packaging, ANOVA test was carried out. The degree of significance is set to $\alpha = 0.05$.

3. Results

3.1. Results of objective assessment

Table 1 shows the average value of the objective test results of tilapia boiled with Balinese spices. The average value of water content in all types of packaging used decreased during storage. The results of ANOVA analysis showed that the type of packaging did not significantly affect the moisture content of tilapia, while the storage time showed very significant effect. Furthermore, the interaction between the types of packaging with the length of storage shows effect that is not significant. For protein levels, the average value in all types of packaging used decreased during storage. Based on the results of ANOVA analysis, it was found that the type of packaging did not significantly affect the protein content of tilapia, while the storage time showed significant effect. The interaction between the type of packaging and the storage time showed no significant results on protein content.

Table 1. Average value of objective test result of tilapia fish boiled with Balinese spices.

No	Treatment	OBJECTIVE			
		Water (%)	Protein (%)	TVB (mgN/100%)	TPC (colony/gr)
1	A1B1	73.870	25.51	7.73	2.27
2	A2B1	73.967	25.57	7.47	3.56
3	A1B2	71.855	24.03	13.26	3.69
4	A2B2	71.907	23.86	13.75	4.79
5	A1B3	70.754	22.59	17.85	4.91
6	A2B3	70.409	22.46	17.97	5.29

It also can be seen from table 1 that TVB values for all types of packaging have increased during storage. Through the ANOVA test, the type of packaging showed a non-significant effect, while the storage time showed very significant influential results. The interaction between the type of packaging and the length of storage showed insignificant results. As with the TPC value, which also showed in table 1 that the average value of TPC in all types of packaging has increased during storage. ANOVA test shows that the type of packaging has a significant effect, as well as the length of storage. The interaction between types of packaging with storage time shows results that have a significant effect on the value of TPC.

3.2. Subjective test result

From table 2, we can see the result of subjective measurement into tilapia fish that is boiled with Balinese spices. The average value of appearance on all types of packaging has decreased during storage. The results of ANOVA analysis indicate that the type of packaging has a non-significant effect, while the storage time has a significant effect on the appearance of tilapia. The interaction between the type of packaging and the length of storage shows the effect that is not real. Whereas for odor, the average value in all types of packaging has decreased during storage. Based on the results of ANOVA analysis, it shows that the type of packaging had an unrealistic effect, while the storage time had a significant effect. Furthermore, the interaction between the type of packaging and the length of storage shows an unrealistic influence on the smell of boiled tilapia with Balinese spices.

Table 2. Average Value of Subjective Test Result of Tilapia Fish Boiled with Balinese Spices

No	Treatment	ORGANOLEPTIC			
		Appearance	Odour	Texture	Taste
1	A1B1	7.95	7.48	7.45	7.63
2	A2B1	7.88	7.43	7.28	7.33
3	A1B2	7.45	7.23	7.18	7.18
4	A2B2	7.16	7.13	7.05	7.13
5	A1B3	6.17	6.19	6.08	6.02
6	A2B3	6.13	6.12	6.04	6.00

Table 2 also point out a decrease in the value of tilapia textures on all types of packaging during storage. When tested with ANOVA, the type of packaging has an unrealistic effect, while the storage time has a significant effect. The interaction between the type of packaging and the length of storage obtained results that are not significant. Taste value also decreases in all types of packaging during storage, as seen in table 2. ANOVA analysis shows that the type of packaging has no significant effect, while storage time has a significant effect. Then, the interaction between the type of packaging and the storage time significantly affected the taste of tilapia.

4. Discussion

This study aims to look at the effect of packaging type and storage time on the quality of boiled tilapia with Balinese spices. The quality in question is assessed subjectively and objectively. Objective assessments included water content, protein content, and total volatile bases (TVB). In this study, it was found that the value of moisture content has decreased in all types of packaging during storage. This is in accordance with previous studies which indicated that the longer the storage time is, the faster the binding capacity of water will decrease which is indicated by the increase in the amount of free water [3]. Decreased water levels are caused by the degradation of the myofibrils protein (actin and myosin) so that the protein cannot bind the water properly again. Storage of cold temperatures causes a decrease in water content due to desiccation or withdrawal of water by the evaporator, so that the water content will decrease with increasing storage time for cold temperatures [4].

Storage duration has an effect on protein content, that there is a tendency of decreased protein levels due to the longer storage time. The decrease was allegedly due to bacterial activity that could digest proteins [5]. It was mentioned in a study that microorganisms can grow optimally at room temperature, but can still grow and develop with increasing time at cold temperatures, which ultimately results in protein degradation [6]. Therefore, a decrease in protein content in cold temperatures is only able to slow down product damage.

Based on the Indonesian National Standard (SNI no 2354.8: 2009) the value of the TVB standard ranges from 25-30 mgN/100%. If associated with the results of this study, then the storage of cold temperatures of 9oC for 0-6 days in all types of packaging still meets Indonesian national standards [7]. According to previous research, the deterioration in the quality of fish is caused by enzymatic and

bacterial action. Both of these actions break down the constituent components of the fish's body tissue so as to produce physical changes such as soft meat and chemical changes that produce volatile and foul-smelling compounds [8]. Increased levels of TVB are caused by an increase in the number of bacteria due to the continuing process of deterioration in quality by microorganisms that produce volatile base compounds, such as ammonia [9]. A study showed that TVB values did not increase during initial storage, but increased at the end of storage along with increased bacterial activity [10].

Based on the Indonesian National Standard (SNI no 4106.1-2009) the TPC standard value threshold is 5.0×10^5 colonies / gram. If it is associated with the results of the study, then for storing cold temperatures 9°C for 0-6 days the quality value of boiled tilapia with Balinese spices in all types of packaging still meets Indonesian national standards [11]. Bacteria are able to grow at a temperature range of 15°C - 55°C so that the longer the storage, the more bacteria will be involved, even bacterial spores are very resistant to heat to reach a temperature of 121°C [12].

From the results of this study, Styrofoam packaged tilapia has a lower total microbial than those packed with mica because Styrofoam has lower permeability to gas and water vapor so it is better in preventing microorganism contamination while mica has high gas transmission properties. One of the properties of Styrofoam is that it can prevent contact between material and oxygen so that it can protect material from contamination, while mica has a slightly high permeability to oxygen so it easily absorbs oxygen from the outside and causes the availability of sufficient oxygen to spur bacterial growth [13,14]. The amount of bacteria in this study can be caused by contaminated products during processing and packaging. In air it is known that there are many microorganisms such as protozoa, algae, fungi, bacteria, viruses, and various forms of spores that can contaminate food [15]. The increase in the number of bacteria during storage is due to high water content and the availability of sufficient nutrients for bacterial growth as well as environmental temperature factors [16].

Subjective assessments included appearance, texture, odor, and taste assessed using organoleptic score sheets. Based on Indonesian national standards, the standard organoleptic test score is a minimum of 7 [11]. If associated with this study, tilapia is still suitable for consumption at 0-3 days of storage for all types of packaging, while for storage of 6 days all types of packaging either mica or Styrofoam have not met the standards set.

A decrease in the value of appearance during storage is thought to be due to the water content of the product which also decreased during storage [17]. It can also be caused by changes that can occur physically or chemically. The physical and chemical behavior of food which is influenced by the growth of an organism can cause damage to the structure of the food and make it soft and runny so that the appearance is not brilliant [18]. Decrease in odor value in tilapia during storage at cold temperatures is a result of decomposition (decomposition), especially ammonia, various sulfur compounds and chemicals called amines derived from decomposition of amino acids. The smell of tilapia, which all characterizes the aroma of fish, turns into a rancid aroma typical of ammonia [19]. It also has an effect on taste value, a decrease in taste value during storage is also caused by bacterial activity that produces secondary metabolites and the role of enzymes that produce unpleasant taste that affects the panelist's assessment of the taste of a product [20]. As for texture, changes in the texture properties of fish muscles can result from aggregation and denaturation of proteins, especially myofibril proteins which cause a decrease in protein solubility during cold storage [21].

5. Conclusion

The interaction between packaging type and storage time only affects the TPC value of tilapia boiled with Balinese spices. The types of packaging, both styrofoam and mica, have a significant influence on the value of TPC. Storage time in cold temperature has a significant effect on the quality of tilapia boiled with Balinese spices.

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PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6
