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**The Application of Different Fresh Fish Handling Techniques on The Quality of Raw Ingredients of Producing Pindang Tongkol (Auxis thazard)**I Gede Suranaya Pandit<sup>1</sup>, I Wayan Parwata<sup>2</sup>, I Wayan Sudiarta<sup>3</sup><sup>1,3</sup> Faculty of Agriculture, Warmadewa University, Denpasar, Bali, Indonesia  
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E-mail: [parwata\\_iwayan67@yahoo.com](mailto:parwata_iwayan67@yahoo.com)**Abstract**

*Histamine poisoning can occur from consuming mackerel tuna fish that have undergone a process of decay. To avoid the process, the application of fresh mackerel tuna fish handling techniques required utilizing single factor completely randomized design. The treatment of fresh mackerel tuna fish handling techniques using room temperature as a treatment A. The applications of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1: 4) as treatment B. The application of fresh mackerel tuna fish handling techniques with the addition of 10% salt as treatment C, as well as fish the applications of mackerel tuna fresh handling techniques with 50% B and 50% C as a treatment D. Transportation starts from the fish handling sites in Seraya village Karangasem towards the fish auction in the village of Kusamba Klungkung Bali for ±3 hours. Results of analysis of variance showed significant differences. The applications of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1: 4) showed the best quality with high levels of histamine amounting to 11.30 mgN%, the water content of 74.53%, the levels of TVB 20.19 mgN%, salt 0:32% total of bacteria of 13.10 colonies/g, the amount of coliform is negative, as well as the organoleptic assessment of such as appearance 8.0 with a brilliant, powerful scacriteriales and thin mucus), eye 7.7 with convex criteria, with rather hazy cornea, rather dim pupil, the smell value of 7.8 with the criteria of soft fishy smell and texture value of 7.8 with an elastic texture criteria, other treatments still meet the criteria of fresh fish.*

*Keywords: Fresh fish, pindang, histamine*

**1. Introduction**

One of the fish consumed by many people is mackerel tuna, belonging to the family of scombroidae. The mackerel tuna fish if left at room temperature, then the process of deterioration will take place and be not fresh and will cause poisoning if consumed. One type of poisonings that often arise in mackerel tuna is histamine or often called scombroid fish poisoning because this type of fish contains the histidine amino acid that were contaminated by bacteria *Enterobacteriaceae aerogenes*, *Proteus morgani*, *Clostridium pefringens* and *Lactobacillus buchneri* by removing the enzyme histidine decarboxylase resulting histamine. Histamine forming bacteria are commonly found in human body parts that are not hygienic, dirt/feces, fish entrails and equipment that is not clean.

The applications of different fresh fish handling techniques on the quality of raw ingredients for making *pindang*, salted-boiled fish during storage and transportation with the use of low temperature with the addition of crushed ice and the addition salts need to be done. The applications of different fresh fish handling techniques on the quality of raw ingredients for making *pindang*, salted-boiled fish is very easy to apply by fishermen, fish processors, fish traders so that it can with stand or inhib-

iting the proliferation of spoilage bacteria and histamine forming.

## **2. Material and Methods**

Materials used are fresh mackerel tuna (*Auxis thazard*) with a total length of  $\pm 25$  cm and a weight of  $\pm 250$  g caught by traditional fishermen in the village of Seraya Bali Karangasem Karangasem Regency. PDAM-owned water taps and crushed ice and salt. Transportation is done for  $\pm 3$  hours starting from the fish landing sites in Seraya village Karangasem towards the fish auction in the village of Kusamba, Klungkung. Observations included the quality of such chemical histamine levels, water content, salts, levels of total volatile bases (TVB), microbiological quality such as the number of bacteria, coliform and organoleptic quality of the appearance of fresh mackerel tuna fish, eye, smell and texture.

The experimental research used completely randomized design (CRD) with a single factor, namely the treatment of different fresh mackerel tuna fish handling techniques consisting of: A = Application of fresh mackerel tuna fish handling techniques at room temperature (control), B = The applications of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4), C = The application of fresh mackerel tuna fish handling techniques with the addition of 10% salt, D = the applications of mackerel tuna fresh handling techniques with 50% B and 50% C.

## **3. Results and Discussion**

### **3.1 Chemical Quality with The Applications of Different Fresh Mackerel Tuna Fish Handling Techniques**

The applications of different fresh mackerel tuna fish handlings on the quality of raw material for making salted-boiled fish, pindang in terms of chemical quality include histamine levels, moisture content, total volatile bases (TVB) and salinity indicate a divergence during transport from the handling of fish in Seraya Village, Karangasem District of Karangasem regency up at the fish auction in the village of Kusamba Dawan sub district, Klungkung regency and takes about 3 hours. Results of analysis of variance, Duncan test, the effect of treatment, between treatments, were significantly different ( $P < 0.05$ ) against histamine levels, moisture content, salinity and levels of TVB of fresh mackerel tuna.

### **3.2 Levels of Histamine**

There is a difference with the application of different fresh mackerel tuna fish handling techniques for  $\pm 3$  hours transportation to the fish auction in the village of Kusamba. Histamine formation is very closely linked to the development of bacteria (Table 1), especially the bacteria that secrete the enzyme histidine decarboxylase change the amino acid histidine into histamine. Delay in the form of histamine by bacteria is optimal at  $30^{\circ}\text{C}$  and a decline or slower in cold temperature  $0-5^{\circ}\text{C}$  [1]. Furthermore, [2] and [3], said that the formation of histamine from histidine which is toxic scombroid at a temperature range of  $20-30^{\circ}\text{C}$ . The production of histamine by  $80.96$  mgN/100 g in mackerel fish stored at a temperature of  $15^{\circ}\text{C}$ , 70% RH for 1 week. The quality of raw materials and hygienic conditions can affect the product, the histamine concentration is high and the possibility of histamine poisoning is becoming higher during handling.

Table 1.  
Chemical Quality With The Application of Different Fresh Mackerel Tuna Fish Handling Techniques

Treatment with the application of fresh mackerel tuna fish handling techniques	Histamine (mgN%)	Water Content (%)	Salt (%)	TVB (mgN%)
A. Room temperature ( $\pm 30^{\circ}\text{C}$ )	47.78 $\pm 4,15$ a	71.11 $\pm 1,10$	0.45 $\pm 0,03$	174.90 $\pm 7,30$
B. Addition of crushed ice (1:4)	11.30 $\pm 2,95$ d	74.53 $\pm 1,30$	0.32 $\pm 0,04$	20.19 $\pm 1,83$
C. Addition of Salt (10 % bb)	31.00 $\pm 5,40$ b	68.45 $\pm 1,10$	1.87 $\pm 0,10$	117.40 $\pm 6,65$
D. Addition of Crushed ice 50% B and 50% Salts C	21.45 $\pm 2,30$ c	72.99 $\pm 0,48$	1.25 $\pm 0,05$	88.07 $\pm 5,45$

Description: Duncan test, different letters indicate significant difference

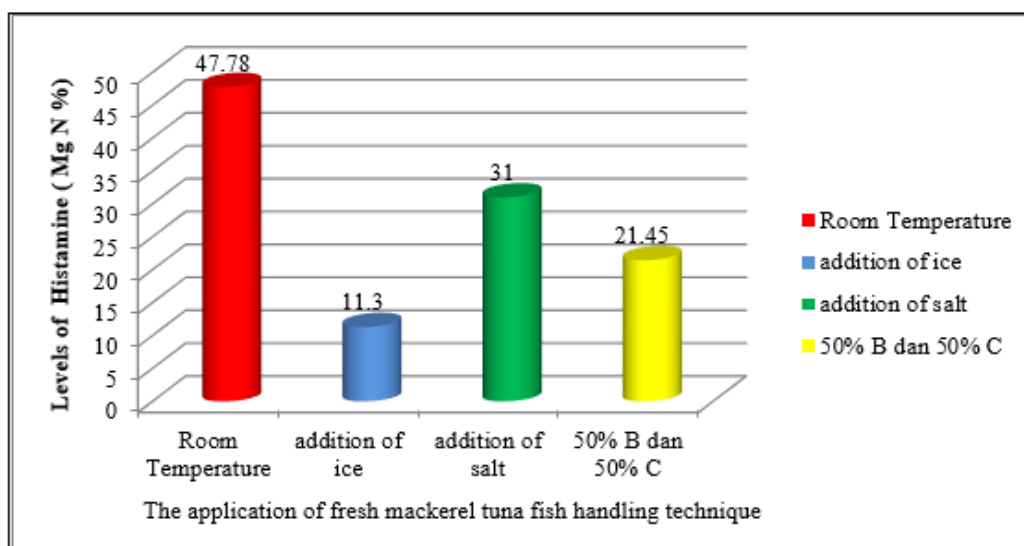


Figure 1

Histamine Levels With The Application of Different Fresh Mackerel Tuna Fish Handling Techniques

The average levels of histamine in B treatment, the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4) produce a storage temperature of  $18^{\circ}\text{C} \pm 11.30$  mgN/100 g where as with the treatment D the applications of fresh mackerel tuna handling techniques with the addition of 50 % B and 50% C produce histamine levels of 21.45 mgN/100 g. This proves that the treatment of low storage temperature is more dominant, capable of restraining the growth of histamine forming bacteria compared with C treatment, the applications of fresh mackerel tuna fish handling techniques with 10% salt produce histamine levels of 31.00 mgN/100 g. The FDA has provided recommendations on the role of fish handling and refrigeration at a temperature of  $4^{\circ}\text{C}$  to suppress the growth of bacteria that produce histamine [4], [5]. The histamine and biogenic amine levels were lower in rainbow trout (*Onchorynchus mykiss*) which fillet compared with the intact form at the temperatures of  $5^{\circ}\text{C}$  storage after 12 days of storage. Furthermore, [6] indicate that the formation of histamine in fish is caused by bacterial contamination by removing the enzyme histidine decarboxylase during the handling, storage, processing, marketing, or during the process at restaurants and at home causing histamine-forming bacteria can grow by changing histidine into histamine. And thus the rapid cooling after catching can prevent the formation of histamine.

The average levels of histamine for all treatments during  $\pm 3$  hours transport have not passed the safe limits of histamine levels that were suitable for consumption that is equal to 50 mgN/100g. Increased levels of histamine is due to the growing environmental suitability of histamine forming bacteria. Histamine forming bacteria growth in tuna and mackerel are very rapid at a temperature of

±30°C within 24 hours of storage with the content of histamine that has reached 56.62 mgN/100g and 78.76 mgN/100g [7].

For the B treatment, the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4) produced a storage temperature of ±18°C can inhibit the formation of histamine levels. This is due to largely that the histamine-forming bacteria are not able to metabolize perfectly at low temperatures, but some bacteria are still able to perform minimal activity with low temperatures.

The A treatment with the applications of fresh tuna handling techniques to room temperature of ±30°C with B treatment, the applications of fresh tuna handling techniques with crushed ice (1: 4) temperature of ± 18°C, as well as C treatment, the applications of fresh tuna handling techniques with the addition of 10 % bb salt, as well as with treatment D the applications of fresh tuna handling techniques with 50% B and 50% C ± 20°C temperature. This is caused by bacteria that produce histamine requires optimal temperatures for growth, while the application of fresh fish handling techniques at low temperature to <20°C can inhibit the growth of bacteria and eventually inhibit the production of histamine. Temperature is one of the important environmental factors that affect the growth of bacteria, based on the temperature, the bacteria can be classified into three groups, namely: 1) thermophilic, that is, bacteria growth temperature ranges from 55° C to 75°C with an optimum growth at a temperature of 65°C. 2) mesophilic, that is a bacteria growth at a minimum temperature of 15°C and a maximum of 55° C with an optimum growth at a temperature of 25°C to 37°C. 3) psychrophilic is the area of bacterial growth between 0°C to 20°C [8]. According to [9], meat muscle of fish that are still alive are in a state of sterile, free of bacteria, but the bacterial population is concentrated in three places, namely on the skin surface amounting between 10<sup>3</sup> to 10<sup>4</sup> colonies/g, in the gills, the bacteria range from 10<sup>6</sup> to 10<sup>7</sup> colonies/g, and in the stomach contents, the bacteria between 10<sup>6</sup> to 10<sup>7</sup> colonies /g.

### **3.3 Water Content**

The application of different fresh mackerel tuna fish handling techniques after ±3 hours transport to the fish auction in the village of Kusamba Klungkung there is a difference in water content produced (Table 1). In C treatment, the application of in fresh mackerel tuna handling techniques with the addition of 10% bb salt has the lowest water content: 68.45%, followed by a treatment of the application of fresh mackerel tuna fish handling techniques to room temperature of ± 30°C, water content of 71.11%, D treatment, application of in fresh mackerel tuna handling techniques with 50% B and 50% C amounted to 72.99% and the highest level of the water is treated and the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4) amounted to 74.53%. The water content is one of the parameters of the freshness of fresh fish with a content ranging from 70-80% [10], [11]. .

Differences in water content of fresh mackerel tuna are caused by the treatment of the applications of different fresh mackerel tuna fish handling techniques, because some of the water are used by the bacteria to metabolic processes and partly a process of evaporation of free water contained by tuna due to the storage room temperature of ± 30°C considerably higher than the fish temperature so that the water content is 71.11%. B treatment with the application of different fresh mackerel tuna fish handling techniques with the addition of crushed ice (1: 4) so that the storage temperature becomes ± 18°C which causes the fresh mackerel tuna can withstand dehydration of air and a balance of water ice with the free water available on the surface of the fish's body, causing water levels to be 74.53%, while the C treatment the application of different fresh mackerel tuna fish handling techniques with the addition of 10% bb salt lead free water drawn out so that the water content became 68.45%, then

treatment D the application of different fresh mackerel tuna fish handling techniques with 50% B and 50% C amounted to 72.99%. The difference is caused by the number and activity of bacteria that desperately need free water for growth. Besides, it is due to the storage temperature and the addition of salt. The growth and survival of bacteria is highly dependent on the free water which is expressed by the water activity ( $a_w$ ) and absolutely necessary for the survival of bacterial metabolism. The water content are important components of food because the water can affect appearance, texture and taste, so that the water content takes part in determining the freshness of food, but if the temperature is increased to exceed the balance of RH in the air, the water molecules will be to the surface and eventually evaporates. Besides, the water content expressed with free water could be used by the bacteria its growth [12].

### 3.4 Levels of Total Volatile Bases

The average of total volatile bases (TVB) of mackerel tuna fish treated with the applications of different fresh mackerel tuna fish handling techniques indicated differences in levels of TVB as presented in Table 1. The highest levels of TVB are in the treatment A, the applications of different fresh mackerel tuna fish handling techniques with room temperature of  $\pm 30^\circ\text{C}$  in the amount of 174.90 mgN%, followed by C treatment, the applications of different fresh mackerel tuna fish handling techniques with the addition of salt of 10% bb in the amount of 117.40 mgN%, followed by treatment D the applications of handling techniques, the applications of different fresh mackerel tuna fish handling techniques fresh mackerel tuna with 50% B and 50% C amounted to 88.07 mgN% and the lowest on the treatment and application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4) TVB content of 20.19 mgN%. For more details, differences in the levels of TVB for each treatment are presented in Figure 2.

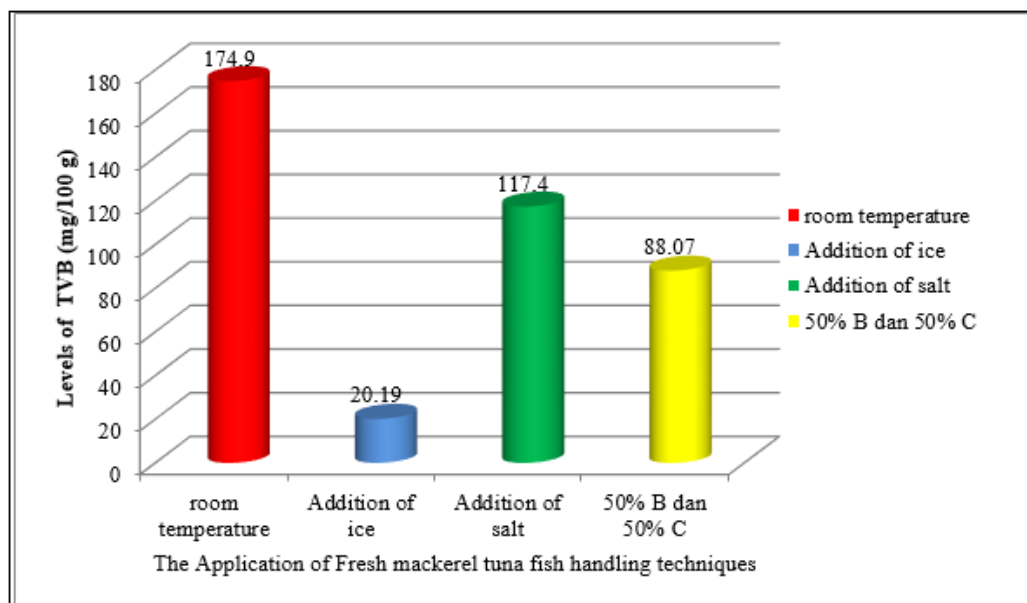


Figure 2  
TVB With The Application of Different Fresh Mackerel Tuna Fish Handling Techniques

TVB levels are influenced by a number of bacteria that are resistant to live after being given treatment of the application of different fresh mackerel tuna fish handling techniques so that the bacterial metabolism results in the form of TVB are also different in each treatment. According to [13], [14]. TVB is an indicator of the quality of fish, including trimethylamine, dimethylamine, ammonia and other nitrogen bases which is the result of bacteria and autolytic enzymes during decomposition. TVB as an indicator of the quality of fish with a maximum of 200 mgN/100 g is the limit for consumption of fish freshness. Based on Table 1 The treatment with the application of different fresh mackerel tuna fish handling techniques are still suitable for consumption because the levels of TVB is <200 mg N/100 g.

Differences in the levels of TVB is caused by the difference in the population of bacteria that grow on each treatment, thus the amount of metabolism in the form of TVB is also different. TVB is the result of decomposition of proteins by bacteria and enzyme activity. Protein breakdown can produce 95% ammonia and CO<sub>2</sub>, in addition to the direct result of protein break down into total N non-protein fish body into the base with a pH of 7.1 to 7.2.

### **3.5 Salt with the application of different fresh mackerel tuna fish handling techniques**

Salt due to the treatment of the application of different fresh mackerel tuna fish handling techniques that produce also different salt. C treatment, namely the application of fresh mackerel tuna fish handling techniques with the addition of 10% bb salt is the highest salt content amounting to 1.87%, followed by the treatment D, the applications of fresh mackerel tuna handling techniques with 50% B and 50% C with a salt of 1,25%, followed by a treatment of the application of fresh mackerel tuna fish handling techniques to room temperature of  $\pm 30^{\circ}\text{C}$  amounting to 0.45% and treatment B, the applications of fresh mackerel tuna handling techniques with the addition of crushed ice (1:4) of 0.32% (Table 1). Salt is a natural preservative potential to kill spoilage bacteria; according to [15] the addition of salt in small quantities, <3% bb can trigger the growth of bacteria, but the number of >5% will serve as a preservative and flavor of the product.

### **3.6 Microbiological Quality with the the Applications of Different Fresh mackerel tuna Fish Handling Techniques**

Applications of different fresh mackerel tuna fish handling techniques in terms of microbiological quality include the amount of bacteria, coliform number. The number of bacteria due to the treatment given indicates differences in the number of bacterial colonies during 3 hours transport at the fish auction in the village of Kusamba Klungkung, while the number of coliform is negative.

### **3.7 Number of Bacteria**

The average number of bacteria in the application of fresh mackerel tuna fish handling techniques during  $\pm 3$  hours transport showed different numbers of colonies. Colony countis The highest number of colony was found in the application of fresh mackerel tuna fish handling techniques with room temperature of  $\pm 30^{\circ}\text{C}$ , followed by the application of fresh mackerel tuna fish handling techniques with the addition of 10% bb salt, treatment D, the application of fresh mackerel tuna fish handling techniques with 50% B and 50% C and the lowest is the treatment with the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1: 4) as shown in Table 2.

Table 2.

The Number of Bacteria With The Application of Different Fresh Mackerel Tuna Fish Handling Technique

Treatment with the application of fresh mackerel tuna fish handling techniques	Total bacteria (colony/g)	Total coliform (colony/g)
A. Room temperature ( $\pm 30^{\circ}\text{C}$ )	$163.10^3$	Negative
B. The addition of bulk ice (1:4)	$13.10^1$	Negative
C. The addition of salt (10 % bb)	$15.10^2$	Negative
D. The addition of crushed ice of 50% B and salt 50% C	$24.10^1$	Negative

The number of bacterial colonies strongly determine the quality of fresh mackerel tuna, such as chemical quality as the result of bacterial metabolism such as histamine and TVB. Like wise on the organoleptic quality such as appearance, eye, smell and texture. The use of low temperature of 0-20° C in the preservation process, can slow the growth of bacteria, even some bacteria undergo death and several others still grow slowly by forming spores. Furthermore, the use of low temperature results in a decrease in chemical and bacterial processes associated with damage or decay, but the use of low temperatures can not be used to kill all bacteria [16]. Based on the maximum temperature and optimal growth of bacteria were divided into 3 groups: thermophiles, mesophiles and psychrophiles. Thermophiles microbes are bacteria that can grow well at a temperature of 40-65°C. Mesophiles where most microbial spoilage bacteria grow in the temperature range of between 15-45°C growth, while psychrophiles microbes are bacteria that grow at low temperature of 0-20°C, with the types of bacteria that are often found in products stored at low temperatures among other *Pseudomonas*, *Aerobacter*, *streptococcus* and *Proteus*.

### 3.8 Number of Coliform

*Coliform* is relatively heterogeneous bacteria belonging to the family of Enterobacteriaceae. Based on the results of qualitative analysis, *Coliform* with the application of different fresh mackerel tuna fish handling techniques no bubbles are found in the Durham tube. The fresh mackerel tuna fish produced by the fishermen from the catch in the waters of Seraya Village, Karangasem District of Karangasem Regency are uncontaminated, free from dirt, so it does not identify the presence of *coliform*. So is the case with the application of different fresh mackerel tuna fish handling techniques is negative too.

The application of fresh mackerel tuna fish handling techniques with the storage temperature of  $\pm 30^{\circ}\text{C}$  is the range of good growth temperature for optimal growth of *coliform* bacteria at 37°C [8], but it turns out that coliform was not found on the application of different fresh mackerel tuna fish handling. Based on SNI [11] declared that the security boundary of *coliform* bacteria contamination of fresh fish is  $1.10^4$  colonies/g. *Coliform* is a heterogeneous group of bacteria, rod-shaped, gram-negative and are facultative anaerobic, or aerobic, fermenting lactose, forming acid and gas within 24 hours at a temperature of 37°C [8]. The group is classified as the family of Enterobacteriaceae such as *Escherichia*, *Edwardsiella*, *Citrobacter*, *Salmonella*, *Shigella*, *Klebsiella*, *Enterobacter*, *Hafnia*, *Serratia*, *Proteus*, *Yersinia* dan *Erwinia* [16].

### 3.9 Organoleptic quality with the application of different fresh mackerel tuna fish handling technique

The applications of different fresh mackerel tuna fish handling techniques will produce different organoleptic quality (Table 3). The organoleptic quality includes appearance, eye, smell and texture. Differences in the value of appearance, eye, smell and texture of fresh mackerel tuna fish is the impact of differences in the number of bacteria. Results of analysis of variance, Duncan test, treatment

effects, between treatments, were significantly different ( $P < 0.05$ ) on appearance, eye, smell and texture of the fresh mackerel tuna fish.

### 3.10-Appearance

Average appearance with the treatment of the application of fresh mackerel tuna fish handling techniques for the transport of  $\pm 3$  hours resulted in differences in the appearance of the value of the fresh mackerel tuna fish as shown in Table 3.

Table 3  
The Average Value of The Appearance of The Application of Different Fresh Mackerel Tuna Fish Handling Techniques

Treatment with the application of fresh mackerel tuna fish handling techniques	Appearance	Eyes	Odor/Smell	Texture
A. Room temperature ( $\pm 30^{\circ}\text{C}$ )	6.1 $\pm$ 0,5	6.0 $\pm$ 0,3	5.8 $\pm$ 0,3	5.8 $\pm$ 0,6
B. The addition of bulk ice (1:4)	8.0 $\pm$ 0,0	7.7 $\pm$ 0,5	7.8 $\pm$ 0,2	7.8 $\pm$ 0,2
C. The addition of salt (10 % bb)	6.8 $\pm$ 0,1	6.4 $\pm$ 0,5	6.7 $\pm$ 0,5	6.7 $\pm$ 0,5
D. The addition of crushed ice of 50% B and salt 50% C	7.6 $\pm$ 0,3	7.4 $\pm$ 0,3	7.6 $\pm$ 0,5	7.6 $\pm$ 0,5

The lowest appearance value obtained in treatment A, of the application of fresh mackerel tuna handling technique with room temperature of  $\pm 30^{\circ}\text{C}$  with an average value of 6.1 (the criteria began to dim, scales rather easily detached), followed by treatment C the application of fresh mackerel tuna handling technique with the addition of 10% salt bb with an average value of 6.8 (criteria begin to get a bit dim redness, scales begin to fall off), followed by treatment D the application of fresh mackerel tuna handling technique with 50% B and 50% C with an average rating of 7.6 (brilliant reddish criteria, scales rather strong, thin mucus), and the average value of the appearance of fresh mackerel tuna highest is obtained at treatment B with the application of fresh mackerel tuna handling technique with the addition of crushed ice (1:4) of 8.0 (brilliant criteria, powerful scales and thin mucus). Impairment of the appearance of fresh mackerel tuna during a  $\pm 3$  hour transportation can not be avoided, however, because the appearance of the impairment is caused by the different treatment of the application of fresh mackerel tuna fish handling techniques. The appearance of fresh mackerel tuna is the determining factor before other factors considered. The appearance can be used as the indicator of freshness of food. The appearance of mackerel tuna fish is affected by the water content in each treatment, mackerel tuna fish with a lower water content with treatment A appears drier as compared to treatment B, The mackerel tuna fish water content are important components of food because the water can affect the appearance, so the content of water also determines the appearance of foodstuffs. Besides, the high number of bacteria (Table 2) will change proteins into simpler compounds by utilizing the free water content contained in mackerel tuna. In line with the ongoing activity of the bacteria can change the appearance of bright fresh mackerel tuna fish to become dim.

### 3.11 Eyes

The average value of the fresh mackerel tuna fish during  $\pm 3$  hours transport already has shown a difference value of eyes as a result of different treatment of the application of fresh mackerel tuna fish handling techniques, but the average value of eyes is still acceptable by the panelist or not yet passed the acceptance of panelists limit. The lowest eye average value is obtained in treatment A with the application of fresh fish handling techniques with room temperature of  $\pm 30^{\circ}\text{C}$  with an average value of 6.0 (criteria slightly sunken, cloudy cornea, grayish pupils and dim), followed by treatment C with the application of fresh fish handling techniques with the addition of 10% bb salt with an average value of 6.4 (criteria slightly concave, slightly cloudy cornea, gray pupil and somewhat dim), followed by treatment D with the application of fresh fish handling techniques with 50% B and 50%



C with an average value of 7.4 (criteria flat eyes, hazy cornea, grayish pupil and dim), and the highest average value of the appearance of fresh mackerel tuna is obtained at treatment B with with the application of fresh fish handling techniques with the addition of crushed ice (1:4) amounted to 7.7 (convex criteria, some what hazy cornea, pupil some what dim). The eyes of fresh mackerel tuna are givrn treatment B not much different from the characteristics of freshly caught mackerel tuna, so the application of fresh fish handling techniques with the addition of crushed ice (1:4) is able to maintain the curvature of the fresh tuna eyes during transport. The number of bacterial colonies are relatively less in treatment B, that the process of protein reform around the muscles of tuna eyes is slower than other treatments.

### **3.12 Odor/ Smell**

All the applications of different fresh fish handling techniques after  $\pm 3$  hours transport to the fish auction site in the village of Kusamba Klungkung can still be accepted by the panelists. The lowest average value of odor obtained in the treatment A with the application of fresh fish handling techniques with room temperature of  $\pm 30^{\circ}\text{C}$  with an average value of 5.8 (criteria rather neutral odor), followed by treatment of C with the application of fresh fish handling techniques with the addition of 10 % bb salt with an average value of 6.7 (neutral odor criteria), followed by treatment D with the application of fresh mackerel tuna fish handling techniques with 50% B and 50% C with an average value of 7.6 (nearly neutral criteria fishy smell), and the highest average value of appearance of fresh mackerel tuna is obtained at treatment B with the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1: 4) of 7.8 (soft fishy smell criteria).

The smell of fresh mackerel tuna given the treatment B do not differ much from the characteristics of freshly caught tuna fish that is fishy smell of sea water, so that the application of fresh fish handling techniques with the addition of crushed ice (1:4) was able to maintain the stench of fresh tuna during transport.

Changes in the value of a very sharp odor on treatment A with the application of fresh fish handling techniques with room temperature of  $\pm 30^{\circ}\text{C}$  that is caused by the decay process is running very fast and effective at room temperature  $\pm 30^{\circ}\text{C}$ , where bacteria and enzymes parse the macro components in fish, especially protein into simple compounds and ultimately become foul-smelling compounds such as ammonia, histamine,  $\text{H}_2\text{S}$ , indole, skatol and others until these materials completely decomposed. In the treatment B the decay process is in the form of slow changes, but some psychrophilic bacteria are still able to perform minimal activity at low temperature of  $0\text{-}20^{\circ}\text{C}$ .

### **4.3 Textures**

The average value of the texture of fresh mackerel tuna fish after  $\pm 3$  hours transport up to the fish auction in the village of Kusamba Klungkung indicates a difference in the values of smell, but still within the limits of acceptance of the panelists. The lowest average texture value is obtained in treatment A with the application of fresh fish handling techniques with room temperature of  $\pm 30^{\circ}\text{C}$  with an average value of 5.8 (texture criteria starts to soft), followed by treatment C with the application of fresh fish handling techniques with the addition of 10 % bb salt with an average value of 6.7 (mushy texture criteria), followed by treatment D with the application of fresh fish handling techniques with 50% B and 50% C with an average value of 7.6 (slightly mushy texture criteria), and the highest average appearance value of fresh mackerel tuna is obtained at treatment B with the application of fresh fish handling techniques with the addition of crushed ice (1:4) amounted to 7.8 (elastic texture criterion). The average difference in the texture value of each treatment is caused by the treat-

ment effect of the application of different fresh fish handling techniques during transport. Changes in the texture from the compact, elastic into mushy is caused by bacteria and enzymes works, especially bacteria that secrete proteolytic enzymes and parse proteins that are gradually able to reduce the elasticity of the meat muscle of fish until the fish meat texture becomes brittle.

The texture of fresh mackerel tuna given the treatment B do not differ much from the characteristics of freshly caught tuna fish, that is elastic texture, so that the application of fresh fish handling techniques with the addition of crushed ice (1: 4) is able to maintain the elastic texture of fresh tuna during transport. The texture of the still fresh mackerel tuna meat with panelists assessment is 8 showing that the mackerel tuna has just undergone reform process of fish meat protein by bacteria and enzymes. In this condition, the fish is still at the stage of rigormortis towards postrigor stage. Once this stage is passed, then when the temperature reaches the optimal conditions for the growth of bacteria, the bacteria found in 3 centers, namely the gills, guts and fish body surface, is growing very rapidly towards a process of decay. In treatment B, rigormortis process is running slow, because the rigormortis process ia a natural process that always happens after the fish undergo the process of death. The rigormortis process is a process of glycogen change into lactic acid, the process continues until the content of glycogen depleted. This process is an enzymatic process that is strongly influenced by temperature. In this situation the texture of mackerel tuna is still elastic during transportation to the place of the fish auction in the village of Kusamba Klungkung.

#### 4. Conclusion

Based on the results of the study it could be concluded that the application of fresh mackerel tuna fish handling techniques with the addition of crushed ice (1:4) produced  $\pm 18^{\circ}\text{C}$  temperature on the chemical quality that is histamine levels of 11.30 mgN%, water content 74.53%, salt 0.32% and TVB content is 20.90% mgN%, the microbiological quality, i.e number of bacteria,  $13.10^1$  colonies/g, the amount of *coliform* is negative, while the organoleptic quality includes the appearance is 8.0, the eyes 7.7 smell, 7.8 and texture, 7.8 with the conclusion this is still very fresh as raw material for producing *pindang*, salted-boiled fish, followed by the treatment with the addition of crushed ice and salt of 50%, the addition of 10% bb salt.

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