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Food Safety Test of Salted Fish from the Traditional Markets of Kapuas Regency Indonesia and Control Efforts

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ABSTRACT

Salted fish in traditional markets contains a lot of formalin and is consumed by the public due to a lack of knowledge about which salted fish are safe for consumption. The aim of this research was to test the food safety of several salted fish sold in traditional markets in Kapuas Regency, Central Kalimantan, Indonesia, and identify control efforts. This research was carried out in two steps. The first step tested the qualitative presence of formalin in five types of salted fish: selar, squid, gulama, anchovies, and cottonfish. The second step focused on control efforts for the salted fish with the highest formalin content using four soaking treatments: plain water, rice washing water, salt water, and tamarind water at a concentration of 50%, each with 600mL for 3 hours and three replications. The parameter in the first step was the qualitative formalin test on five types of salted fish samples using a test kit. The parameters in the second step were formalin levels, total plate count (TPC), and moisture content in the salted fish with the highest formalin level compared to the first step. The results of the first step showed that salted anchovies had the highest formalin content. The second step showed that tamarind water was able to reduce formalin and moisture in salted anchovies after being soaked for 3 hours, but was not able to reduce TPC. The food safety test results of salted anchovies from traditional markets in Kapuas Regency, Central Kalimantan, showed the highest formalin content. The control effort using 600mL of tamarind water at a 50% concentration was able to reduce formalin levels and total plate count in salted anchovies soaked for 3 hours, but recorded no potential to reduce moisture content to meet SNI standards. Through this study, it is hoped that tamarind water as a natural ingredient can be used to reduce formalin levels in salted fish in general.

INTRODUCTION

The traditional fish processing process has an important role in Indonesia, especially for traditional fishermen. Almost 50% of the caught fish is traditionally processed, with salted fish being one of the most widely produced and consumed products in the community **(Ramlah *et***

***al.*, 2018)**. Salted fish is made by preserving fish meat with added salt, aiming to extend its shelf life. To make processed fish products last longer, some manufacturers, in addition to using salt, also use chemical preservatives. One of the preservatives often used by manufacturers is formalin.

Consumers in Indonesia come from various social levels, but not all of them understand the consequences of consuming food or other products that contain harmful preservatives **(Rumape *et al.*, 2020)**. **Poernomo *et al.* (2021)** and **Rovita and Wulandari (2022)** stated in their research that although salted fish is very popular among the community, public knowledge about safe and proper salted fish consumption is still lacking. This is proven by the continued presence of formalin-containing salted fish in circulation and consumption. In practice, many business actors still do not understand the difference between preservatives used for food and those for non-food purposes.

Formalin is one of the harmful preservatives if found in food, yet it is still widely used to preserve it **(Shao *et al.*, 2022)**. Formalin is a mixture of formaldehyde, methanol, and water **(Siddhartha *et al.*, 2020)**, with formaldehyde content varying between 20–40%. In Indonesia, several laws prohibit the use of formalin as a food preservative, including the Regulation of the Minister of Health No. 722/2021, Regulation of the Minister of Health No. 1168/Menkes/PER/X/2021, Law No. 7/2021 concerning Food, and Law No. 8 concerning Consumer Protection. The danger lies in the residues that formalin leaves behind, which are carcinogenic to the human body **(Permenkes, 2012)**.

The research by **Niswah *et al.* (2016)** in five traditional markets in Palembang found that out of 25 salted fish samples tested, 8 were positive for formalin. The low price of formalin is one factor that encourages producers and traders to use it as a food additive, allowing them to gain greater profit and produce more durable products. This practice is supported by consumer behavior that favors long-lasting and inexpensive products. The main dangers of formalin to health include severe effects if inhaled, harmful effects if in contact with skin or ingested, skin blisters, burns on mucosal membranes, respiratory tract irritation, severe eye irritation, allergic reactions, and an increased risk of cancer **(Siddhartha *et al.*, 2020; Saktiningsih *et al.*, 2023)**.

According to **Lubis *et al.* (2021)**, the side effects of formalin use may not appear immediately but can accumulate over time unless a person experiences acute formalin poisoning at high doses. The potential acute health effects of formalin exposure include irritation, while excessive exposure can lead to death. The potential chronic effects include cancer and cellular function changes. In addition, formalin is also teratogenic in humans.

The visual appearance of food containing borax and formalin is often indistinguishable. Foods containing these substances generally have characteristics such as being easily crushed, very crispy, chewy, brighter in color, resistant to spoilage for more than three days, and not easily approached by flies or ants **(Hastuti, 2020)**.

Several studies have examined formalin content in processed fish or food products and explored ways to reduce it. These include efforts to lower formalin levels in anchovies using rice washing water **(Marpaung, 2021; Canti *et al.*, 2022)**, using tamarind solution to reduce formalin in food, and utilizng salt solution to lower formalin levels in white tofu **(Sebayang *et al.*, 2020; Guo *et al.*, 2024)**. It is hoped that the use of tamarind water can reduce formalin levels in the five types of salted fish studied.

The purpose of this study was to test the food safety of several processed salted fish obtained from traditional market sellers in Kapuas Regency, Central Kalimantan, by analyzing their formalin content and applying methods to reduce formalin levels in samples tested positive.

MATERIALS AND METHODS

1. Material

This research was carried out from March-August 2024 at the Labotarium of the Fish Quarantine Station for Quality Control and Safety of Fishery Products (SKIPM) Palangka Raya. In the first step of the research, five (5) types of salted sea fish were studied: selar, squid, gulama, anchovies, and the cottonfish, each weighing 10g. The samples were purchased from traders in two (2) traditional markets in Kapuas Regency, Central Kalimantan, namely the Morning Market and the Pure Market. Fish samples suspected of containing formalin were tested qualitatively using a test kit.

The salted fish samples from traditional markets in Kapuas Regency (Fig. 1).

1.1. Salted selar (*Selaroides leptolepis*) fish

1.2. Salted squid (*Loligo* sp.)

1.3. Salted gulama (*Johnius carouna*) fish

1.4. Salted anchovies (*Stolephorus indicus*)fish

1.5. Salted cotton (*Gerres filamentosus*) fish

Fig. 1. 5 (five) salted fish samples from traditional markets in Kapuas Regency

The materials used for the second step of the research included: rice (900 g), tamarind (150 g), salt (15 g), water (2.4 L), 5 drops of Fo-1 reagent (NaOH), 1 teaspoon of Fo-2 reagent (chromotropic), 1,8-dihydroxynaphthalene-3,6-disulfonate, and 72% H_2SO_4. The tools used for the formalin test were the Merck MColortest Formaldehyde test kit, ACAS WH-B28 digital scale (10 kg), EcoBlue Series EC 1152 binocular microscope, knife, clear plastic, pipette, test tubes, measuring spoon, and aquadest.

2. Methods

The research method carried out in this study was sampling by the sampling technique method, where the sampling method used was purposive sampling. The advantage of using the purposive sampling technique method is that the sample is selected in such a way so that it is relevant to the research design, and also the sample selected is an individual who, according to the research considerations, can be approached. The drawback is that there is no guarantee that the sample used is representative. The determination of the sample count used is that the researcher takes 50% or all samples from the total population as a representative sample. The analysis carried out is a qualitative analysis of the formalin content in salted fish product samples, and if there are samples indicated to contain formalin, quantitative tests are implemented (**Sugiyono, 2020**).

Research procedure

This research is carried out in 2 (two) steps. The 1st step is a qualitative formalin test on 5 (five) types of salted fish: selar, squid, gulama, anchovies, and cottonfish. The procedure for testing salted fish formalin is as follows, according to the method of **Putri *et al.* (2024)**: preparation of tools and materials and test media: Prepare 100mL of aquadest and smooth the sample by chopping it using a knife for each sample to be tested. Every time a sample is smoothed, all tools are washed first so that the next sample is not contaminated with the previous one. Then, weigh each crushed sample at 10g followed by placing it in plastic. Add 20mL of prepared aquadest to the plastic sample, then squeeze until the extract comes out. Take 5mL of sample liquid (sample extract) using a syringe and put it into a sample bottle. Then, add 5 drops of Fo-1 and stir, and add 1 measuring spoon of Fo-2 and stir for 1 minute. After stirring, let it sit for 5 minutes. Observe the color change that occurs in each sample tested; if there is a change to purple, it indicates a positive formalin content, and if there is no change and the color remains the same as the initial sample, indicating a negative formalin content.

In the 2nd step of the study, a follow-up test was carried out on salted fish samples with the highest levels of formalin compounds, namely by conducting an experiment to reduce the formalin level in the salted fish using four soaking treatments: ordinary water, rice washing water, salt water, and tamarind water for 3 hours each. The test parameters are the formalin content test, TPC test, and moisture test.

The TPC test method based on **Puspitasari *et al.* (2022)** is as follows: all tools and materials are prepared and sterilized. Next, the dilution stage is carried out for each sample. Each sample is taken as much as 1 g and then diluted. The dilution factor used is 1×10^{-1} to 1×10^{-3}. Next is the media preparation stage. Nutrient agar media is weighed as much as 13g, then dissolved in 1,000mL of aquadest. Furthermore, the media are sterilized using an autoclave at a temperature of 121°C and pressure of 1atm for 15 minutes. Each diluted sample is then implanted in nutrient agar media by the pour plate method, incubated at room temperature for 24 hours, and then observation and calculation of the Total Plate Count (TPC) are carried out.

The analysis of the moisture of salted fish according to **Pumpente *et al.* (2023)** refers to the gravimetric method according to SNI 01-2354.2-2015. The principle of this method is based on the evaporation of water present in the sample by heating, then weighing until a constant weight is reached. The weight reduction that occurs represents the moisture contained in the sample. The empty container is heated in the oven at 105°C for 2 hours, then cooled in a desiccator until it reaches room temperature, and the container is weighed (A). Afterward, the mashed salted fish is weighed at 2g and is put in the container (B). Then, it is placed in a non-vacuum oven at 105°C for ±20 hours. It is then cooled in a desiccator for ±30 minutes and weighed again (C). The moisture of salted fish was calculated using the equations:

$$\text{Moisture (\%)} = \frac{B-C}{B-A}\times100\%$$

Where: A = weight of empty container (g)

B = container weight + initial sample (g)
C = container weight + dry sample (g)

The procedure for making rice washing water based on **Marpaung (2021)** is as follows: prepare 900g of rice, then add 600mL of water; stir for 2 minutes, and strain to separate the rice from the solution.

The procedure for making salt water according to **Tane *et al.* (2023)** is as follows: prepare 15g of salt, then add 600mL of water, followed by stirring for 1 minute until well mixed.

The procedure for making tamarind water based on **Guo *et al.* (2024)** is as follows: prepare 150g of tamarind at a concentration of 50%, then add 600mL of water. Then, stir for 2 minutes, and strain to separate the tamarind seeds from the solution.

Statistical analysis

The data obtained in the 1st step of the research were analyzed qualitatively and descriptively, while the data obtained from the 2nd step of the research were analyzed using one-way analysis of variance (ANOVA).

RESULTS

Step 1 research

The results of the formalin test are qualitatively based on color changes in 5 (five) types of salted fish (Fig. 2).

Fig. 2a. Salted selar fish formalin test results

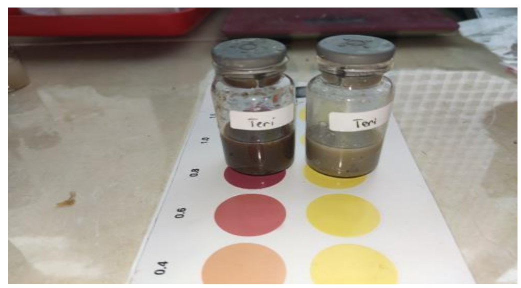

Fig. 2b. Salted squid formalin test results

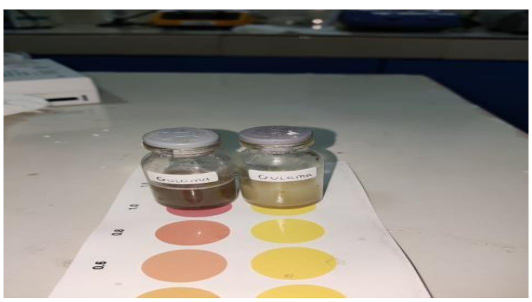

Fig. 2c. Results of the salted gulama fish formalin test

Fig. 2d. Results of salted anchovy formalin test results

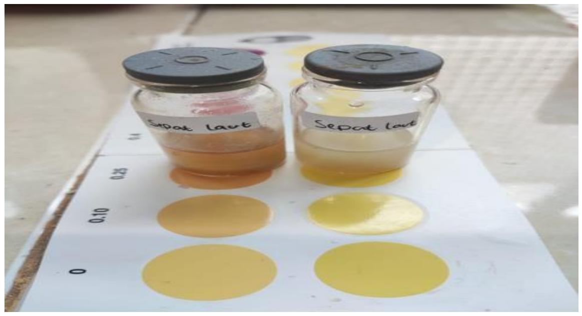

Fig. 2e. Salted cotton fish formalin test results

Fig. 2. Qualitative formalin test results based on color changes in 5 (five) types of salted fish

The results of the formalin content test based on the test kit on 5 (five) types of salted fish are shown in Table (1).

Table 1. Results of formalin compound content test based on test kits on 5 (five) types of salted fish

No.	Salted fish name	Test results	mg/l
1.	Salted selar fish	Positive (+)	0.10
2.	Salted squid	Positive (+)	1.00
3.	Salted gulama fish	Positive (+)	0.80
4.	Salted anchovy fish	Positive (+)	1.50
5.	Salted cotton fish	Positive (+)	0.25

The results of the formalin test in Table (1) show that all the salted fish samples were positive (+) for formalin, with the highest value of 1.50mg/ L found in salted anchovies and the lowest value of 0.10mg/ L in the salted cotton fish. It can be concluded that the highest formalin compound content was found in salted anchovies.

Step 2 research

Furthermore, in the 2nd step of the study, salted anchovies containing the highest formalin levels were treated to reduce the formalin compound content by soaking them in 600 mL of different solutions: plain water (A), rice washing water (B), salt water (C), and tamarind water at a concentration of 50% (D), each for 3 (three) hours. The results of all treatments in the 2nd phase of the study were tested quantitatively using the parameters of formalin, total plate count (TPC), and moisture (Table 2).

Table 2. Recapitulation of test results on salted anchovies

Treatments	Test		
	Formalin (mg/l)	TPC (cfu/g)	Moisture (%)
A	0.73±0.115[d]	$1.77x10^2$±0.153[a]	64.28±0.060[c]
B	0.35±0.087[b]	$3.10x10^2$±0.100[bc]	64.18±0.035[bc]
C	0.53±0.115[c]	$3.80x10^2$±0.200[b]	63.15±0.025[b]
D	0.15±0.087[a]	3.87 $x10^2$±0.252[c]	61.20±0.025[a]
SNI 8273:2016	Max. 1.5 m/l	Max. 1×10^5	Max. 40%

Different superscripts in the same column show very noticeable differences.

Description:

A: salted anchovies in 600mL of plain water soaking (control)
B: salted anchovies in 600mL of rice water soaking
C: salted anchovies in 600mL of salt water soaking
D: salted anchovies in 600mL of tamarind water soaking

Formalin

The average value of the formalin test in salted anchovies (*Stolephorus* sp.) (Fig. 3).

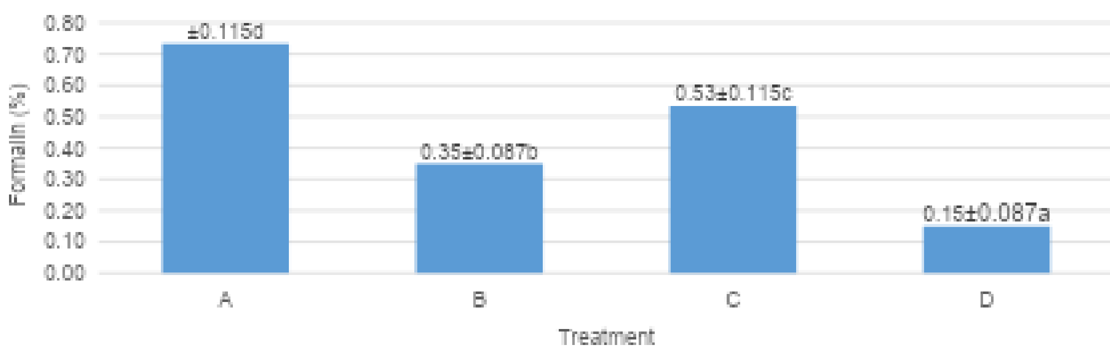

Fig. 3. Graph of the average value of formalin content in salted anchovies (*Stolephorus* sp.)

Based on the graph in Fig. (3), the highest average formalin content was obtained in treatment A (salted anchovies soaked in 600mL of plain water as a control) at 0.73mg/ L, followed by treatment B (salted anchovies soaked in 600mL of rice washing water) at 0.35mg/ L, then treatment C (salted anchovies soaked in 600mL of salt water) at 0.53mg/ L, and the lowest formalin content was found in treatment D (salted anchovies soaked in 600mL of tamarind water at a concentration of 50%) at 0.15mg/ L.

The data were then analyzed using analysis of variance (ANOVA). Based on the results of the ANOVA, the formalin levels in salted anchovies (*Stolephorus* sp.) were obtained with an F-count value of 17.95, which was greater than the F-table values at 5% (4.07) and 1% (7.59) significance levels, indicating that the treatments were significantly different.

Total plate count (TPC)

The average value of the total plate count (TPC) of salted anchovies (*Stolephorus* sp.) fish is shown in Fig. (4).

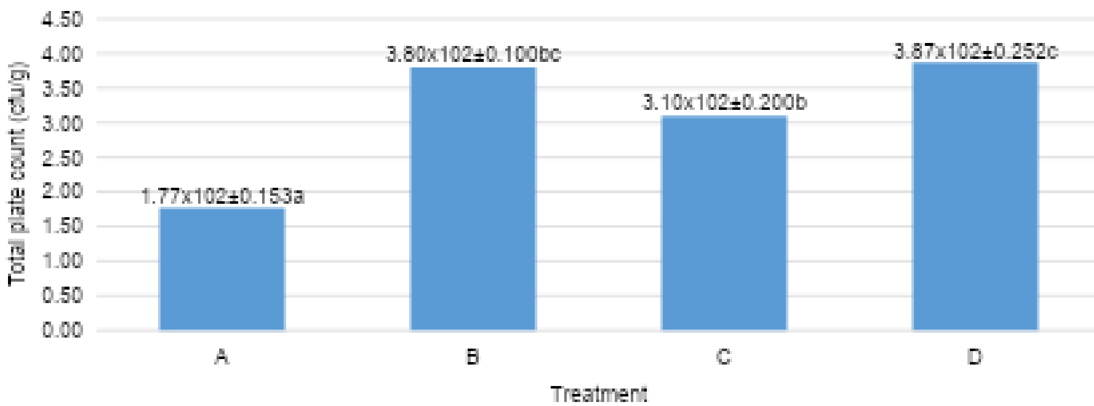

Fig. 4. Graph of the average value of the total plate count (TPC) of salted anchovies

Based on Fig. (4), the average total plate count (TPC) of each treatment was obtained as follows: treatment D (salted anchovies soaked in 600mL of tamarind water) with a value of 3.87×10^2 cfu/g; treatment B (salted anchovies soaked in 600mL of rice washing water) with a value of 3.80×10^2 cfu/g; treatment C (salted anchovies soaked in 600mL of salt water) with a value of 3.10×10^2 cfu/g; and treatment A (salted anchovies soaked in 600mL of plain water as a control) with a value of 1.77×10^2 cfu/g.

The results of the analysis (ANOVA) showed that the total plate count (TPC) in salted anchovies (*Stolephorus* sp.) had an F-count value of 83.4, which was greater than the F-table values at 5% (4.07) and 1% (7.59) significance levels, indicating that the treatments were significantly different.

Moisture

The average moisture of salted anchovies (*Stolephorus* sp.) is shown in Fig. (5).

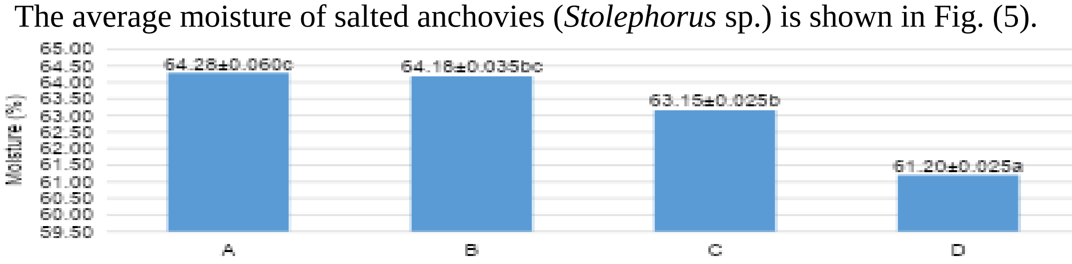

Fig. 5. Graph of the average moisture of salted anchovies (*Stolephorus* sp.) fish

Fig. (5) shows that the highest average moisture content was found in treatment A (salted anchovies soaked in 600mL of plain water as a control) with a value of 64.28%, followed by treatment B (salted anchovies soaked in 600mL of rice washing water) with a value of 64.18%, treatment C (salted anchovies soaked in 600mL of salt water) with a value of 63.15%, and treatment D (salted anchovies soaked in 600mL of tamarind water) with a value of 61.20%.

The results of the analysis (ANOVA) of the moisture content in salted anchovies (*Stolephorus* sp.) showed an F-count value of 4032.01, which was greater than the F-table values at 5% (4.07) and 1% (7.59) significance levels, indicating that the treatments were significantly different.

DISCUSSION

Step 1 research

Based on Fig. (2a, b, c, d & e), it can be seen that the higher the formalin content in salted fish, the more intense the color change reaction will be. If the sample changes color to purplish yellow or deep purple, then the sample is positive for formalin compounds, but if the sample does not change color at all and remains the same as the original, then the sample does not contain formalin compounds.

All salted fish samples from the traditional markets in Kapuas Regency, Central Kalimantan, were indicated to be positive for containing formalin. The highest formalin content in salted fish was found in salted anchovies, which were shown by a deep purple color on the sample, and after matching with the measuring paper, it was at 1.5mg/ L.

Salted anchovies have high formalin content, probably because during processing, hygiene aspects are not properly maintained. This is in accordance with the opinion of **Tabassum *et al.* (2019)**, who stated that the processing of salted anchovies is traditional and pays little attention to sanitation and hygiene aspects during preparation, processing, and storage. As a result, dried salted anchovies are easily damaged microbiologically, chemically, and organoleptically. To overcome this, many business actors take shortcuts by using harmful chemicals such as formalin **(Kusmarwati *et al.*, 2020; Lubis *et al.*, 2021)**.

Step 2 research

Formalin

Based on the formalin test on salted anchovies that had undergone soaking treatments, the highest formalin value was obtained in treatment A (salted anchovies soaked in 600mL of plain water as a control) at 0.73mg/ L, followed by treatment B (salted anchovies soaked in 600mL of rice washing water) at 0.35mg/ L, treatment C (salted anchovies soaked in 600mL of salt water) at 0.53mg/ L, and the lowest formalin content was found in treatment D (salted anchovies soaked in 600mL of tamarind water) at 0.15mg/ L.

All treatments were able to reduce formalin content in salted anchovies and did not exceed the **SNI 8273:2016 (BSN, 2016)** limit of a maximum of 1.5mg/ L. **Fauziyya and Saputro (2020)** and **Effendy *et al.* (2023)** stated that efforts to reduce formalin levels in salted fish can be carried out using HPLC analysis, but they can also be done in a simpler way.

The treatment of soaking salted anchovies in 600mL of tamarind water at a concentration of 50% for 3 hours was able to reduce formalin from 1.5mg/ L to 0.15mg/ L, possibly because tamarind has the ability to break the bond between formalin and protein in salted anchovies. The research of **Malina (2023)** found that soaking in tamarind solution at a 30% concentration for 60 minutes could reduce formalin compounds in salted anchovies to 0%.

The decrease in formalin levels occurs because the bonds between formalin and protein in salted anchovies are released at a certain tamarind concentration. The acidic properties of tamarind are able to separate these bonds within 60 minutes of soaking. The acid content in tamarind helps break the bonds between formalin and proteins, and the saponin compounds contained in food also play a role in this process **(Guo *et al.*, 2024; Putri *et al.*, 2024)**.

Total plate count (TPC)

The average value of the total plate count for each treatment showed the highest value in treatment D (salted anchovies soaked in 600mL of tamarind water) at 3.87×10^2 cfu/g, followed by treatment B (salted anchovies soaked in 600mL of rice washing water) at 3.80×10^2 cfu/g, treatment C (salted anchovies soaked in 600mL of salt water) at 3.10×10^2 cfu/g, and treatment A (salted anchovies soaked in 600mL of plain water as a control) at 1.77×10^2 cfu/g.

The TPC test results for all treatments (A, B, C, and D) were below the **SNI 8273:2016 (BSN, 2016)** standard limit of 1×10^5 cfu/g. All soaking treatments were still within the safe range, allegedly because they were handled under controlled conditions and maintained sanitation and hygiene.

Factors that contribute to high levels of contamination may also include non-sterile, open, or contaminated sales and storage areas of samples during the production process **(Rosita, 2024)**. The TPC of salted fish is influenced by the length and place of storage and processing factors, such as washing or cleaning fish with unhygienic water contaminated with microbes **(Lubis *et***

***al.*, 2021; Huda & Ikerismawati, 2022)**. In addition, microbes require water for their growth and activity, so soaking for 3 hours can allow microbes to develop quickly **(Purna *et al.*, 2021)**.

Moisture

Based on the moisture test of salted anchovies that had undergone soaking treatments, treatments B, C, and D experienced a decrease in water content compared to treatment A (control), with the lowest moisture content found in treatment D (tamarind water). Overall, although moisture decreased, it still exceeded the **SNI 8273:2016 (BSN, 2016)** limit of 40%.

It is suspected that the moisture of salted anchovies remained high due to the soaking duration of 3 hours, which caused the anchovies to become moist during testing. According to **Edris *et al.* (2020)**, higher humidity in salted anchovies increases the potential for higher moisture content. Fig. (5) shows that all soaking treatments for 3 hours were not able to reduce the moisture of salted anchovies to meet SNI standards.

The high moisture content in salted anchovies is due to the length of soaking time; the longer the soaking (3 hours), the more water is absorbed, which increases moisture levels. A moisture content of around 16% carries a risk of clumping and microbiological damage, while levels below 6–8% can cause the product to become hygroscopic **(Gallego *et al.*, 2024)**. High moisture content can cause the product to absorb water from the environment, affecting its stability and quality.

The soaking solution also influences changes in water content. Since the sample material and soaking time were the same, differences in solution composition likely caused variations in water content. In addition, salted anchovies stored in humid conditions may retain higher moisture. According to **Kusmarwati *et al.* (2020)** and **Sipahutar *et al.* (2021)**, several factors can cause salted fish products to lose weight due to reduced moisture, including drying time, drying temperature, surface area, type and size of fish, and the amount of salt used.

CONCLUSION

The food safety test results of salted anchovies from the traditional markets of Kapuas Regency, Central Kalimantan, showed that they had the highest formalin content. The control effort using 600mL of tamarind water at a concentration of 50% was able to reduce formalin levels and total plate count in salted anchovies soaked for 3 hours, but it has not yet been able to reduce the moisture content of salted anchovies according to SNI standards.

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