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Soaking Water Of Pineapple Peel (*Ananas comocus L. Merr*) Solution On Reducing Formaldehyde Levels In Salted Fish

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ABSTRACT Formaldehyde in salted fish processing is used to extend the shelf life of salted fish, potentially causing harmful effects on health. Prolonged and repeated exposure to formalin can cause serious impacts on human health, such as eye irritation, menstrual disorders, liver, kidney, pancreas and central nervous system dysfunction, and even loss of consciousness or coma. Before processing, such as soaking using pineapple peels can be done to reduce formaldehyde levels so that it is not harmful to health. The purpose of the study was to analyze the differences in the reduction of formaldehyde levels in salted fish before and after soaking using a pineapple peel solution. This research is a pre-experimental study with a group Pretest and Posttest Design. The object of research is salted fish soaked in pineapple peel solution concentrations of 20%, 40%, 60%, and 80% with 4 replications so that the total sample is 24 samples of salted fish. Soaking time is done for 60 minutes. The method of checking formaldehyde levels using the spectrophotometer method. The data that has been obtained is then analyzed using a paired t-test. The results of the examination of formaldehyde levels of salted fish before soaking amounted to 13.30 mg/kg. In contrast, after soaking the pineapple peel solution concentration of 20%, 40%, 60%, and 80% respectively amounted to 6.58 mg/kg, 4.16 mg/kg, 0.15 mg/kg, and 0.11 mg/kg, and tap water of 8.14 mg/kg. The Paired t-test obtained the $P < \alpha$ (0.05), meaning there is a significant difference in decline. The percentage of formaldehyde levels decreased after soaking in pineapple peel solution at concentrations of 20%, 40%, 60%, 80% respectively by 50,45%, 68,66%, 98,82%, and 99,14% with a soaking time of 60 minutes. There is a significant difference between formaldehyde levels in salted fish before and after soaking using a pineapple peel solution. The use of pineapple peel solution can be an alternative effort in reducing formaldehyde levels in salted fish before processing for consumption and using other fruit peels with different concentration variations and different soaking times in salted fish.

INDEX TERMS Formaldehyde (CH_2O), salted fish, pineapple peel soaking solution (*Ananas comocus L. Merr*).

I. INTRODUCTION

Fish is a food that is easily damaged by microorganisms so prevention is needed to prevent the process of decay in fish [1]. Decay in fish can be prevented through traditional preservation, namely drying and salting [2]. In the process of making salted fish, salt plays a role in preventing damage by enzymes in fish and spoilage by microorganisms [3]. The process of drying fish in a traditional way is very dependent on the intensity of sunlight because enough sunlight can reduce the water content in fish so that microbes cannot grow back and avoid the process of decay so some salted fish processors use chemicals as preservatives to avoid spoilage [4]. POM Regulation No. 7/2018 on prohibited raw materials in processing states that formaldehyde is declared a hazardous material that is prohibited from being added to processed food. Formalin is a preservative that is usually misused by fish processors for salting salted fish. The addition of formalin to the salting process can produce salted fish with a fast drying process, more durable and long-lasting [5], The addition of formalin in the salting process can produce salted fish with a fast drying process, more durable and durable [6].

Based on an initial study conducted by researchers on February 25, 2023, formalin was found in salted tuna sold in the market. Research conducted by Lathifah also mentioned that formalin was found in tuna sold in the market [7], so that

if formalin fish is consumed continuously and enters the body, it can have harmful effects on the body [8].

Formalin enters the body through ingestion. The food that enters will accumulate in the body, the higher the level of formaldehyde that accumulates in the body, the more dangerous the consequences can be [9]. Consuming food with formaldehyde levels that exceed the body's tolerance limit can cause various complaints, such as irritation and corrosiveness of the mucous membranes of the digestive tract accompanied by nausea, vomiting, intense stinging, stomach injuries, convulsions, unconsciousness, and coma [10].

According to WHO, the safe threshold for formaldehyde to enter the body in daily intake through ingestion is around 0.15 mg/kgBB. The *Occupational Safety and Health Standards* (OSHA) states that formaldehyde entering through ingestion of 30 ml (2 tablespoons) of formaldehyde solution can cause death. Health problems due to formalin content in salted fish can be reduced risk through efforts to reduce formalin levels by processing [11].

Salted fish processing can be in the form of frying. The processing of salted fish is not able to remove formalin levels completely, frying can only reduce formalin levels by 19.76% [12], Therefore, the a need for treatment before the process of processing salted fish such as soaking with water with dissolved materials so that the levels of formalin in salted fish can be reduced optimally.

Methylene (-NCHOH) compounds formed because the aldehyde group of formaldehyde binds to protein elements in salted fish and can be decomposed back into protein and formaldehyde through hydrolysis reactions so that soaking using water can reduce formalin levels [13]. Research that has been done before not only uses water, but some also use natural ingredients to be able to reduce formalin levels optimally.

Natural ingredients used in research Edy namely Green chili [14]. Soaking using Green chili extract resulted in tofu experiencing the highest formalin content reduction at a concentration of 12.5% with a reduction value of 69.82%. In her research, it was mentioned that saponin compounds in Green chili extract had a significant effect on reducing formaldehyde levels. Another study states that saponin compounds play a role in reducing the formalin content in salted fish through soaking using natural ingredients, namely garlic peel with the highest value of 89.12% [15].

The content of saponins that can reduce formaldehyde levels is also in pineapple fruit parts, including pineapple skin [16]. Pineapple peels that contain saponins have never been utilized and are only disposed of as waste [17]. The alkaline ability of saponins in pineapple peels can bind formalin and is known as a saponification reaction [18]. The age of pineapple fruit also has an effect in reducing formaldehyde levels in salted fish because the higher the age of the fruit, the more saponin content in it [19].

The decrease in formalin levels in salted fish due to soaking is also influenced by variations in soaking concentration and soaking time. Based on research by Aini the concentration of turi leaf solution of 10%, 20%, 30%, and 40% can reduce formalin levels by 11.65%, 15.66%, 53.15%, and 58.68% with a soaking time of 60 minutes [20].

The nature of methylene compounds that can dissolve into alkaline solutions is assumed to get an optimal reduction in formalin levels. Based on this description, pineapple peel may be also able to reduce formalin levels in salted fish. The use of pineapple peel to reduce formalin levels in salted fish has not been widely researched and known by the public. The advantages of using pineapple peel to reduce formalin levels in salted fish are more environmentally friendly and utilizes waste.

Based on the background description above, researchers are interested in conducting research related to soaking salted tuna (*Euthynnus sp.*) in a solution of cayenne pineapple skin (*Ananas comocus L. Merr*) with concentrations of 20%, 40%, 60%, 80%, and PDAM water as a control. Soaking is carried out for 60 minutes. The most optimal concentration of pineapple skin solution will be obtained from a comparison of the formalin content values of the four concentrations. This study aims to analyze the decrease in formalin levels in salted tuna (*Euthynnus sp.*) before and after soaking in a solution of pineapple skin (*Ananas comocus L. Merr*).

II. METHODOLOGY

This study uses a type of pre-experimental research with the research design "*One Group Pretest and Posttest Design*", where this design is only measured before soaking and after soaking so that the difference in the two measurement results is considered as the effect of soaking. The soaking carried out is soaking salted tuna using pineapple peel solution with concentrations of 20%, 40%, 60%, and 80% and clean water (PDAM water) as a control with soaking time for 60 minutes. then examined formalin levels by spectrophotometric method. The selection of concentration and time variations was determined based on previous research, where the results of the study reduced the highest formalin levels by 58.68% with a concentration of 40% and a soaking time of 60 minutes. The following are the steps in this research.

A. SALTED FISH SAMPLE PREPARATION

Here's the process of making salted fish with formaldehyde:

1. Fish used as salted fish samples come from fresh tuna that has a length of ± 25 cm with a fish weight of ± 300 grams per fish, then wash the fish with clean running water so that all the dirt that is still attached especially in the abdominal cavity and the remaining blood vessels can be cleaned.
2. Drain the fish and arrange it in a container with the belly facing down so that no water stagnates in the abdominal cavity.
3. Then the addition of formalin is done by mixing 10 ml of 37% formalin with 10 liters of water, then the fish can be immediately immersed into the solution for 2 hours.
4. After the drained fish is slightly dry, then weigh the weight of the fish to calculate the amount of salt needed

in the salting process. The amount of salt required is at least 15 - 20% of the total weight of the fish.

5. After adding formalin and draining, salt is sprinkled on the bottom of the container used. Arrange the fish in an orderly manner on the salt layer with the belly of the fish facing the bottom of the container. Then, salt is sprinkled over the fish again so that the entire surface of the fish is covered with salt. Do the same so that the fish is not infested with flies. Then close the top of the container.
6. Fish that has changed texture to become firm and solid is a sign that the salting process is complete.
7. Then the fish is dried in the sun to dry the fish. During the drying process, the fish is flipped over to dry evenly.
8. The salted tuna used as a sample is the body of the fish, then the fish body is cut with a size of ± 3 cm, and the weight of each piece is ± 65 cm.

B. MAKING PINEAPPLE SOLUTION

1. The pineapple peels used were the ripe Cayenne (honey pineapple) type obtained from fruit sellers and juice sellers in the Gubeng area, Surabaya. The pineapple skin obtained was weighed at 7 kg and then mashed with a blender without using water. Then the pineapple skin was squeezed and filtered, where the result of the squeeze was a filtrate with a concentration of 100%.
2. The clean water used as a solvent comes from PDAM water. Clean water was prepared according to the volume needed to make a solution of 4 liters.
3. Pineapple peel filtrate and tap water were homogenized in each container according to the volume required for each solution concentration.
   a. Pineapple peel solution with a concentration of 20% is made from 400 ml of pineapple peel filtrate and 1600 ml of water.
   b. Pineapple peel solution with a concentration of 40% is made from 800 ml of pineapple peel filtrate and 1200 ml of water.
   c. Pineapple peel solution with a concentration of 60% is made from 1200 ml of pineapple peel filtrate and 800 ml of water.
   d. Pineapple peel solution with 80% concentration is made from 1600 ml of pineapple peel filtrate and 400 ml of water.

C. CLEAN WATER PREPARATION

The clean water used is from PDAM water (control). Clean water is prepared according to the volume required for soaking, which is 500 ml.

D. TREATMENT PROCESS

1. Prepare samples of formalin salted fish that have been made for 4 repetitions for each 1 (one) concentration of soaking water.
2. There are 6 treatments carried out, namely:
   a. Immersion of salted fish with 500 ml of pineapple peel solution of 20% concentration
   b. Soaking salted fish with 500 ml of 40% concentration pineapple peel solution
   c. Soaking salted fish with 500 ml of 60% concentration pineapple peel solution
   d. Soaking salted fish with 500 ml of 80% concentration pineapple peel solution
   e. Soaking salted fish with 500 ml PDAM water
   f. Salted fish without using soaking
3. Samples of formalin salted fish that have been prepared, put into each solution that has been made, and the immersion is done for 60 minutes. This process causes the formalin content in salted fish to be dissolved in the soaking water.

E. PACKAGING PROCESS

1. All salted fish samples that have been soaked are then packaged t f secueg the sample, where the samples are packaged using sterile plastic clips and labeled on each package. The label consists of sample code information and time information.
2. Then the salted fish samples were sent to the laboratory to check the formalin content.

F. DATA ANALYSIS

1. Data processing techniques
   Data processing is done by data entry, editing, coding, and tabulating data
2. Data analysis
   Data analysis in this study applies the Paired t-test to determine the decrease in formalin levels in salted tuna after soaking using pineapple skin solution

III. RESULT

The examination of formalin content was carried out on salted tuna with formalin that had not been soaked. Salted tuna given 37% formalin is dissolved in 10 liters and then immersed into the solution for 2 hours. The following are the results of the examination of formalin levels in salted tuna without soaking:

TABLE 1
Formalin Content of Salted Tuna Before Soaking

Replication	Formalin content of salted tuna mg/kg (ppm)
1	12,65
2	13,60
3	14,06
4	12,90
Total	53,21
Average	13,30

TABLE 1 shows that the results of the examination of formalin levels in salted tuna with the highest value of 14.06 mg/kg and the lowest level with a value of 12.65 mg/kg with an average of 13.30 mg/kg. Examination of formalin levels is carried out on salted formalinized tuna after soaking using PDAM water with a soaking time of 60 minutes. Clean water used as soaking is PDAM water which is then prepared according to the amount of volume needed for 4 replications of 2000 ml. The following are the results of the examination

of formalin levels in salted formalized tuna after soaking in PDAM water:

TABLE 2
Formalin Content of Salted Tuna After Soaking

Replication	Formalin content of salted tuna mg/kg (ppm)
1	9,11
2	7,88
3	7,01
4	8,58
Total	32,58
Average	8,14

TABLE 2 shows that the results of the examination of formalin levels in salted tuna with the highest value of 9.11 mg/kg and the lowest level with a value of 7.01 mg/kg with an average of 8.14 mg/kg. Examination of formalin levels was carried out on salted tuna with formalin after soaking using pineapple peel solution concentrations of 20%, 40%, 60%, and 80% with a soaking time of 60 minutes. The pineapple peel solution is made by smoothing the pineapple peel using a blender and then squeezing and taking the filtrate to obtain a concentration of 100% pineapple peel solution (without dilution). The soaking water of pineapple peel solution concentrations of 20%, 40%, 60%, and 80% used for soaking was made by homogenizing the pineapple peel filtrate with the solvent, namely PDAM water. The following are the results of the examination of formalin levels in salted fish after soaking:

TABLE 3
Formalin Content of Salted Tuna After Soaking in Pineapple Peel Solution

Replication	Formalin Level mg/kg (ppm)			
	Pineapple Peel Solution			
	20%	40%	60%	80%
1	7,05	4,31	0,16	0,12
2	6,18	3,90	0,18	0,11
3	7,01	4,60	0,13	0,10
4	6,08	3,85	0,15	0,12
Total	26,32	16,66	0,62	0,45
Average	6,58	4,16	0,15	0,11

TABLE 4
Formalin Content of Salted Tuna Before And After Soaking At 20% Concentration

Replication	Formalin Level in Salted Fish Tongkol mg/kg (ppm)		The difference in Reduction of Fromalin Level mg/kg (ppm)	Decrease of Fromalin mg/kg (ppm)
	Before	After		
1	12,65	7,05	5,60	44,26
2	13,60	6,18	7,42	54,55
3	14,06	7,01	7,05	50,14
4	12,90	6,08	6,82	52,86
Average	13,30	6,58	6,72	50,45

TABLE 3 shows the results of the examination of formalin levels in salted tuna with the highest mean value of 6.58 mg/kg and the lowest level with a mean value of 0.11 mg/kg. The following are the results of the decrease in formalin levels in salted formalized tuna before and after soaking in pineapple peel solution. TABLE 4 shows that the results of the examination of formalin levels in salted tuna before and after soaking in pineapple peel solution of 20% concentration have an average decrease of 6.72 mg/kg with a percentage decrease of 50.45%.

TABLE 5
Formalin Content of Salted Tuna Before And After Soaking 40% Concentration

Replication	Formalin Level in Salted Fish Tongkol mg/kg (ppm)		The difference in Reduction of Fromalin Level mg/kg (ppm)	Decrease of Fromalin mg/kg (ppm)
	Before	After		
1	12,65	4,31	8,34	65,92
2	13,60	3,90	9,70	71,32
3	14,06	4,60	9,46	67,28
4	12,90	3,85	9,05	70,15
Average	13,30	4,16	9,13	68,66

TABLE 5 shows that the results of the examination of formalin levels in salted tuna before and after soaking in 40% concentration pineapple peel solution have an average decrease of 9.13 mg/kg with a percentage decrease of 68.66%.

TABLE 6
Formalin Content of Salted Tuna Before and After Soaking at 60% Concentration

Replication	Formalin Level in Salted Fish Tongkol mg/kg (ppm)		The difference in Reduction of Fromalin Level mg/kg (ppm)	Decrease of Fromalin mg/kg (ppm)
	Before	After		
1	12,65	0,16	12,49	98,73
2	13,60	0,18	13,42	98,67
3	14,06	0,13	13,93	99,07
4	12,90	0,15	12,75	98,83
Average	13,30	0,15	13,14	98,82

TABLE 6 shows that the results of the examination of formalin levels in salted tuna before and after soaking in pineapple peel solution with a concentration of 60% have an average decrease of 13.14 mg/kg with a percentage decrease of 98.82%.

TABLE 7

Formalin Content of Salted Tuna Before and After Soaking 80% Concentration

Replication	Formalin Level in Salted Fish Tongkol mg/kg (ppm)		The difference in Reduction of Fromalin Level mg/kg (ppm)	Decrease of Fromalin mg/kg (ppm)
	Before	After		
1	12,65	0,12	12,53	99,05
2	13,60	0,11	13,49	99,19
3	14,06	0,10	13,96	99,28
4	12,90	0,12	12,78	99,06
Average	13,30	0,11	13,19	99,14

TABLE 7 shows that the results of the examination of formalin levels in salted tuna before and after soaking in 80% concentration pineapple peel solution have an average decrease of 13.19 mg/kg with a percentage decrease of 99.14%. The following are the results of the decrease in formalin levels in salted formalized tuna before and after soaking in PDAM water:

TABLE 8
Formalin Content of Salted Tuna Before and After Soaking in PDAM Water

Replication	Formalin Level in Salted Fish Tongkol mg/kg (ppm)		Difference in Reduction of Fromalin Level mg/kg (ppm)	Decrease of Fromalin mg/kg (ppm)
	Before	After		
1	12,65	9,11	3,54	27,98
2	13,60	7,88	5,72	42,05
3	14,06	7,01	7,05	50,14
4	12,90	8,58	4,32	33.48
Average	13,30	8,14	5,15	38,41

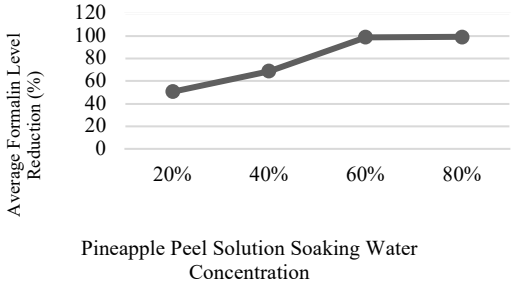

FIGURE 1. Reduction in formalin content of salted fish tuna before and after soaking in pineapple peel solution

TABLE 8 shows that the results of the examination of formalin levels in salted tuna before and after immersion in PDAM water have an average decrease of 5.15 mg/kg with a percentage decrease of 38.41%. Based on the normality test shows that the data is normally distributed, so the test can continue using the *Paired t* test. Based on the results of the *Paired t* test (appendix 4) between the salted fish group before soaking with the salted fish group after soaking with pineapple peel solution, the result of $P = 0.000 < \alpha$ (0.05) shows that there is a significant difference in the decrease between formalin levels in salted fish tuna group before soaking with the group after soaking using pineapple peel solution.

Based on the *Anova* statistical test (appendix 4), the result of $P = 0.000 < \alpha$ (0.05) shows that there is a difference in the value of formalin levels between the soaking water of 20%, 40%, 60%, 80% pineapple peel solution, and PDAM water on salted tuna, then based on the *Post Hoc Test* further test (appendix 4) shows the results that soaking using 20%, 40%, 60%, and 80% pineapple peel solution can reduce formalin levels in salted tuna significantly. This shows that the higher the concentration of pineapple peel solution, the greater the decrease in formalin levels in salted tuna.

IV. DISCUSSION

A. FORMALIN LEVELS IN SALTED TUNA BEFORE SOAKING AND AFTER SOAKING IN PINEAPPLE PEEL SOLUTION

Based on the results of laboratory examinations of formalin levels in salted tuna that has not been done soaking or the group without soaking has an average value of formalin levels of 13.30 mg/kg. While formalin levels in salted tuna after soaking or treatment groups have an average value of formalin levels in pineapple peel solution of 20% concentration of 6.58 mg/kg, 40% concentration of 4.16 mg/kg, 60% concentration of 0.15 mg/kg, and 80% concentration of 0.11 mg/kg. Formalin levels in salted tuna after soaking can be lowered again through processing salted fish to be ready for consumption such as frying to make it safer to consume. Formalin is a hazardous substance that is prohibited from being added to processed food. Consuming food with formalin levels that exceed the body's tolerance limit can have harmful effects on the body including irritation of the digestive tract, nausea, vomiting, stomach injuries, seizures, and coma [11]. A concentration of 0.5 to 1 ppm in the air can be identified by its smell, while a concentration of 2 to 3 ppm can cause mild irritation. Concentrations of 4 to 5 ppm are generally not tolerated by humans [21].

The detrimental health effects of formalin have been recognized since 2004 as a toxic substance and carcinogen by international research institutions, including the International Agency for Research on Cancer (IARC), the US Environmental Protection Agency (USEPA), and ECHA [22]. Specifically, the USEPA specifies that the maximum daily Formaldehyde dose is 0.2 mg/kgBB/day, while that set by the World Health Organization (WHO) is in the range of 0.15 mg/kgBB/day.

Formalin can preserve food because it has an aldehyde group that easily reacts with proteins to form methylene (-NCHOH) compounds [23]. The mechanism of formaldehyde as a preservative is due to the joining of formaldehyde with free amino acids from cell protoplasm or coagulate proteins.

When protein foods are watered or soaked in formalin solution, the aldehyde group of formaldehyde will bind to protein elements. The bound proteins cannot be used by spoilage bacteria, so the formalized food becomes more durable. In addition, proteins with methylene elements cannot be digested [24]. The following is the reaction between protein and formalin to form methylene compounds (Eq. (1)):

$$RCH(NH_2)COOH + CH_2O \rightarrow -NCHOH \quad (1)$$

Soaking salted tuna with 80% concentration pineapple peel solution has lower formalin levels than 20%, 40%, and 60% concentration pineapple peel solution. The factor that causes formalin levels in the 80% concentration pineapple peel solution is lower, one of which is due to the saponin compounds contained in the pineapple peel solution. Saponin is a type of glycoside found in plants. Saponin in reducing formaldehyde levels is known as a saponification reaction or soap formation reaction [18]. Formalin bound by saponin compounds will dissolve and form the following compounds (Eq. (2)):

$$C\,H\,O_{589427} + CH_2O \rightarrow C\,H\,O_{599528} \quad (2)$$

Surfactant or soap substances in saponins consist of long hydrocarbon-like chains and ions. The hydrocarbon part is hydrophobic and can dissolve in non-polar substances (oils and fats) while the ionic end is hydrophilic and can dissolve in polar (water) [25]. Saponin compounds adsorb and bind to formalin particles to obtain emulsion stability from polar groups. The ability of saponins to improve emulsion stability depends on the contribution of polar (hydrophilic) and nonpolar (hydrophobic) groups. After formalin is bound by the saponin compound, the saponin will dissolve and form micelles. The rounded part points out, namely the head and then interacts with water (polar in nature), so that formalin can dissolve with water [26] (Eq. (3)):

$$C\,H\,O_{599528} + H_2O \rightarrow C_{59}\,H\,O_{9528} - H\,O_2 \quad (3)$$

Formalin levels in salted tuna when after soaking using pineapple peel solution get the average value with the highest percentage reaching 99% which it can be caused by the age of pineapple skin. Different ages of pineapple fruit cause pineapple skin to also have different levels of water-soluble compounds. The higher the age of the pineapple peel, the higher the compound content in the pineapple peel [19].

The decrease in formalin levels in salted tuna is also caused by the thickness factor in slicing fish. Based on research conducted by Purwanti It is stated that the thickness of the slices can facilitate the process of reducing the levels of formalin contained in salted fish. This happens because the thinner the slices of salted fish in the soaking water, the methylene compounds can be hydrolyzed more quickly back into amino acids and formaldehyde [27].

B. FORMALIN CONTENT IN SALTED TUNA BEFORE SOAKING AND AFTER SOAKING IN PDAM WATER

Based on the results of laboratory examination of formalin levels in salted tuna before soaking has an average value of formalin levels of 13.30 mg/kg. While formalin levels in salted tuna after PDAM water immersion have an average value of formalin levels of 8.14 mg/kg, it can be concluded that there is a decrease between formalin levels in salted tuna before immersion and after PDAM water immersion. This is in line with other research which states that there is a decrease in formalin levels in salted fish soaked in water [28].

The decrease in formalin levels in salted tuna when soaking using PDAM water is due to the polar nature of formalin and water is also polar so it dissolves easily in water. Methylene compounds formed due to the aldehyde group of formaldehyde binding to protein elements in salted fish can be decomposed back into protein and formalin so that soaking using water can reduce formalin levels [13].

C. FORMALIN CONTENT IN SALTED TUNA AFTER SOAKING IN PINEAPPLE PEEL SOLUTION AND AFTER SOAKING IN PDAM WATER

Based on the results of laboratory examinations of formalin levels in salted tuna after soaking or treatment groups have an average value of formalin levels in pineapple peel solution of 20% concentration of 6.58 mg/kg, 40% concentration of 4.16 mg/kg, 60% concentration of 0.15 mg/kg, and 80% concentration of 0.11 mg/kg. The formalin content in salted tuna after PDAM water immersion has an average value of formalin content of 8.14 mg/kg. Salted tuna that has been soaked with PDAM water has the highest formalin content than the pineapple peel solution soaking water with various concentrations due to the reaction of decreasing formalin levels with water is reversible, which can form methylene but can break back, in research Purwanti It is mentioned that salted fish has decreased formalin levels but at minute 20 the formalin content in salted fish increases again because methylene bonds begin to form again in salted fish [27].

D. DIFFERENCES IN THE REDUCTION OF FORMALDEHYDE LEVELS BEFORE AND AFTER SOAKING IN PINEAPPLE PEEL SOLUTION

The difference in the decrease in formalin levels in salted fish tuna before and after soaking in pineapple peel solution with concentrations of 20%, 40%, 60%, and 80% and soaking time for 60 minutes is the highest decrease in the treatment of soaking in pineapple peel solution with a concentration of 80% of 13.19 mg / kg with a percentage decrease of 99.14%, while the lowest decrease is in the treatment of soaking in pineapple peel solution with a concentration of 20% of 6.72 mg / kg with a percentage decrease of 50.54%. Based on the results of the *Paired t test*, it is found that $P < \alpha$ (0.05) so that it shows that there is a significant difference in the decrease in formalin levels in salted fish tuna before and after soaking treatment with pineapple peel solution concentrations of 20%, 40%, 60%, and 80% and soaking time for 60 minutes.

The decrease in formalin levels in salted tuna is caused by pineapple peel which contains saponin compounds that can bind formalin in salted tuna which then dissolves with water. Variations in soaking concentration are the cause of differences in the decrease in formalin levels in salted fish.

The higher the concentration of pineapple peel solution used for soaking, the greater the decrease in formalin levels in salted fish on the cob. In line with research by Farid states that increasing the concentration of soaking can increase the percentage of decrease in formalin levels in salted fish [29]. This happens because the higher the concentration, the higher the saponin content in it.

V. CONCLUSION

Based on the results of the study, it can be concluded that formalin levels in salted tuna before soaking amounted to 13.30 mg/kg, formalin levels in salted tuna after soaking PDAM water amounted to 8.14 mg/kg, and formalin levels in salted tuna after soaking using pineapple peel solution concentrations of 20%, 40%, 60%, and 80% respectively amounted to 6.58 mg/kg, 4.16 mg/kg, 0.15 mg/kg, and 0.11 mg/kg. The soaking treatment of salted fish resulted in a significant difference in the decrease in formalin levels between the salted tuna group before and after soaking using pineapple peel solution soaking water with the percentage of formaldehyde levels decreased after soaking in pineapple peel solution at concentrations of 20%, 40%, 60%, 80% respectively by 50,45%, 68,66%, 98,82%, and 99,14%. Therefore it is very important to take steps to process salted fish in reducing the risk of formalin consumption. The community and home food industry can use clean water baths to reduce salted fish formalin levels and can also use clean water with a mixture of pineapple peel filtrate as an alternative in reducing salted fish formalin levels before processing to reduce formalin levels more effectively and safer for consumption. Other researchers are expected to be able to implement further research related to reducing formalin levels by soaking using other fruit skins with different concentration variations and soaking durations on salted fish.

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