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Vinegar Acid As Binder To Heavy Metals LeadAnd Cadmium In Kupang

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ABSTRACT

Kupang is nutritious food product, but on the other hand it also been contaminated by lead and Cadmium which has been endangering human being. Therefore, it is necessary to decrease the content of Lead and Cadmium in *Kupang* by so that it is safe to be consumed. The objective of this research is to study the use of vinegar acid todecrease the content of lead and Cadmium as much as possible of *kupang (Corbula faba)*. From this research, it is hoped to find the best treatment to decrease the content of Lead and Cadmium of *kupang*.

The research is True Experimental and used Completely Randomized Design with 3 treatments, namely, the addition of 5 %, 15 % and 25 % Vinegar acid and compared with controlled treatment. The data obtained from the research finding show that without treatment (control) the average content of lead is 1.281 ppm, Cadmium is 1.254 ppm.

If it is related to the regulation FAO/WHO with says that the content of heavy metal allowed in food product that can be consumed by human being for lead is not more than 1 ppm and for Cadmium is not more than 0.1 ppm. Intake limit for lead based on the regulation of ADI (Acceptable Daily Intake) is 200 - 300 μg/day, for Cadmium is 25 – 60 μg/day. Lead content in *Kupang* is 1.281 mg/kg , it means that *Kupang* allowed to be consumed by human being that is 156 - 234 gram/day. Cadmium content in *kupang* is 1.254 mg/kg, it means that *kupang beras* allowed to be consumed by human being is 19.9 – 47.8 gram/day. The results showed that with the addition of vinegar, there was a decrease in lead by 90.1 – 95.7%, and cadmium by 97.3 – 98.5%. The addition of acetic acid which is best used to reduce the heavy metal content of lead and cadmium is a concentration of 25% with .

I. INTRODUCTION

Kupang is a nutritious food. Thecommunity, especially the East Java area, is very fond of culinary made from kupang, with mussel production centers in the Sidoarjo, Surabaya, Gresik, and Pasuruan areas. One of the problems with mussels is high levels of heavy metals, especially lead (tin), which is 4.01 ppm. Lead metal content exceeds the maximum limit of heavy metal contamination in food based on the Regulation of the Head of the Food and Drug Supervisory Agency (BPOM) which is 1.5 ppm. Pollution of heavy metal lead (tin) can come from nature and as a result ofhuman activities, especially in industrial andtransportation activities, which causes the amount of lead content (tin) to increase[1].

Lead (black lead) enters the human body, it will cause anemia, kidney disorders, and neurological disorders and brain damage (neuropathy). Cadmium can motivate bone demineralization, increase bone fragility and fracture risk, cause anemia and hypertension, testicles cause hyperplasia which is the beginning of cancer[2]. For this reason, efforts need to be made to reduce the levels of lead and cadmium so that they are safe for human consumption. For this reason, efforts should be made to reduce harmful heavy metals in mussels. One of these efforts is to use vinegar so that it can free food from metal contamination[3]. Vinegar is an organic acid that is soluble in water. Vinegar acid is capable of forming complex compounds with metals. Conducted a study of lead (Black Tin) levels in mussel meat which was boiled in pure vinegar for 30 minutes. Conducted a study that soaking 25% lime solution for 30 minutes can reduce cadmium levels in blood clams[3].

The purpose of this study was to study the addition of vinegar in an effort to reduce the levels of Lead and Cadmium Kupang (Corbula faba). From this research, it is hoped that the best treatment can be found in an effort to reduce the levels of Lead and Cadmium in rice by using vinegar in an easy, simple and effective way so that it can be socialized to the public so that the impact of exposure to heavy metals Lead and Cadmium can be avoided[2].

II. METHOD

Design research True Experiment Research. True experimental research aims to determine the possibility of causality by applying one or more treatment conditions to one or more experimental groups and comparing the results with one or more control groups whose treatment conditions are not recognized[3]. Pure experiments testing independent and dependent variables were carried out on samples of the experimental group and control group, where the subjects studied in the two groups were taken randomly[1].

Kupang samples obtained from Sidoarjo Kupang were washed, then boiled at 100oC for 2 hours, to separate the shell and meat. Kupang meat was then taken to the laboratory to be weighed 100 grams each as many treatments, namely 9 + 1 control with 4 replications so that 4 kg of meat as needed. Then each was placed in a plastic basin/place and soaked in 5% vinegar (5 ml of vinegar in 100 ml of distilled water), 15%(15 ml of vinegar in 100 ml of distilled water) and 25% (25 ml of vinegar in 100 ml of water) distilled water) all ingredients were soaked in a solution of acetic acid with various concentrations for 1 hour. After 1 hour, the mussels were washed with distilled water and then the levels of lead and cadmium were measured in the mussel meat. This design can be described as follows.

III. RESULT

Average and decreased levels of Lead, Cadmium Kupang due to the addition of vinegar with different concentrations

Table 1 Average Levels of Lead, Cadmium Kupang Rice due to the addition of vinegar.

Vinegar Acid	Lead drop (%)	Cadmium (%)
AAR (5%)	90,1	97,3
AAS (15%)	92,2	98,1
AAT(25%)	95,7	98,5

Looking at the table above, it can be explained that with the addition of vinegar, the lowest average levels of Lead and Cadmium occurred in the addition of 25% vinegar. The results of the analysis of the decrease in the levels of Lead, Cadmium due to vinegar treatment compared to the control are presented in the following table:

Table 2. Decreased levels of Lead,Cadmium due to the administration of vinegar compared to the control.

Vinegar acid	Lead content (mg/kg)($x \pm$ SD)	Cadmium content (mg/kg)($x \pm$ SD)
K	1,28 ± 0,03	1,25 ± 0,02
AAR (5%)	0,13 ± 0,01	0,03 ± 0,01
AAS (15%)	0,10 ± 0,01	0,02 ± 0,01
AAT(25%)	0,06 ± 0,01	0,02 ± 0,01

Looking at the table above, it can be explained that the effect of giving vinegar acid to decrease levels of Lead and Cadmium is highest in the administration of 25% vinegar.

1. Differences in Levels of Lead, Cadmium in Kupang Rice Meat Due to the Addition ofVinegar Acid.

Differences in the levels of Lead, Cadmium, due to the simultaneous addition of vinegar can be identified by the MANOVA test. Theresults of the Manova test can be seen that there are differences in the levels of Lead, Cadmium due to the addition of vinegar with F = 128.176 and p 0.000 (p <0.05). Differences in the levels of Lead, Cadmium due to the addition of vinegar separately can be identified by the Anova test, so that it is known what heavy metal levels in the rice mussel meat are affected by the addition of vinegar.

2. Differences in Lead Levels in Kupangmeat due to the addition of vinegar.

Levene's test shows that the lead contentdata meets the assumption of homogeneity with p value = 0.059 (p > 0.05) meaning the variance is homogeneous, so the ANOVA test can be used. The results of the ANOVA test can be seen that the level of vinegar has an effect on the content of black tin in the meat of the rice kupang. This can be seen from the value of F = 6505.801 and p = 0.000 (p <0.05). Multiple comparison test (Multiple Comparation) to determine differences in lead levels due to the addition of vinegar with different concentrations used the different HSD test can be seen In table 3. . Different test of the effect of vinegar acid levels on lead levels. The table above can be explained that: There is a significant difference in lead levels between the control group and the group thatreceived the addition of 5%, 15% and 25% acetic acid. There was no significant difference in lead levels between the groups that received the addition of 5% acetic acid and 15% acetic acid. There is a significant difference in lead levels between the group that received the addition of 25% acetic acidand the group that received the 5% and 15% acetic acid.

3. Differences in Cadmium Levels in Kupang meat due to the addition of vinegar.Levene's test shows that the Cadmiumcontent data meets the assumption of homogeneity with a value of p = 0.123 (p > 0.05) meaning the variance is homogeneous,so the ANOVA test can be used. From the ANOVA test, it can be seen that the level of vinegar has an effect on the Cadmium content of the rice mussel meat. This can be seen from the value of F = 10711 and and p= 0.000 (p < 0.05). Multiple comparison test (Multiple Comparation) to determine differences in Cadmium levels due to the addition of vinegar with different concentrations used the HSD difference test can be seen in Table 4

Table 4. Different test of the effect of vinegar acid levels on Cadmium levels

Tukey HSD			
Vinegar acid	N	Subset	
		1	2
Higt level	4	.01850	
Moderate level	4	.02425	
Low level	4	.03350	
control	4		1.25350
Sig.		.325	1.000

The table above can be explained that: There is a significant difference in cadmium levels between the control and the group that received the addition of 5%, 15% and 25% acetic acid. There was no significant difference in lead levels between the groups that received the addition of 5%, 15% and 25% vinegar.

Heavy metal content in mussels.

The results obtained the average levels as follows: Lead 1,281 ppm, Cadmium 1,254 ppm. FAO/WHO states that the permissible content of heavy metals in the bodies of marine animals that can be consumed by humans for lead is not more than 1 ppm and for cadmium not more than 0.1 ppm. Decree of the Director General of Drug and Food Control No. 03725/B/SK/VI/99 concerning the maximum limit of metal contaminationin food states that the permissible level for Cadmium is 1 mg/l while for Lead is 2 mg/l.Meanwhile, according to SNI, the maximumpermissible level for black lead is 2 mg/kg, and for Zn 100 mg/kg. Based on the foregoing, it means that mussel from Sidoarjo has been contaminated with heavy metals, lead and cadmium. The high content of heavy metals Lead and Cadmium in mussels is due to the nature of the low mobility of mussels and settles in a certain habitat, namely in sediments or the seabed, so that mussels can be used as bioindicators of pollution in a waters. Through the food chain, heavy metals in the water can enterthe body of the rice mussel because it is a "filter feeder" animal. The greater the levels of heavy metals in the environment and the longer the kupang is in the place, the greaterthe levels of heavy metals in the body of the kupang. Kupang absorbs heavy metals in three ways, namely from the form dissolved in water, absorbed in the mucus layer that covers the body and through the food chain.

Heavy metal is a pollutant that is dangerous because it is toxic in large quantities and can affect various aspects of the waters, both ecological and biological aspects. There are many types of metals that pollute marine waters, including cadmium (Cadmium) and lead metal (Pin). These two metals are combined with mercury (Hg) as the big three heavy metals which have the highest level of danger to human health, besides thatthese three metals are most often found as metal contaminants in nature[4]. Namely poisoning in the circulatory system, namely poisoning the red blood formation system, nervous system such as headaches, kidney system, digestive system such as stomach ulcers and kidney and digestive system disorders production[5].

Lead intake limit based on the provisions of ADI (Acceptable Daily Intake) 200 – 300 g/day, for Cadmium 25 – 60 g/day. The lead content of rice kupang kupang is 1,281 mg/kg, thus the kupang that can be consumed by humans is 156-234 grams/day.The Cadmium content of mussel is 1.254 mg/kg, thus the mussel that can be consumed by humans is 19.9 – 47.8 mg/kg. Based on the ADI provisions, it shows that the levels of Cadmium in foods that are allowed for human consumption are lower than the levels of Lead, this indicates that Cadmium heavy metal is more dangerous than Lead Heavy metal. Based on this, the intake limit for rice mussels that may be consumed by the public is based on the levels of Cadmium present in mussels, which are 19.9 – 47.8 mg/day, so that the people of Sidoarjo and

surrounding areas consume mussel meat in a day the maximumallowed is Rp. 19.9 – 47.8 mg/day. This is toavoid the negative effects of heavy metals in the human body, especially those who consume rice mussel meat.

Differences in Lead, Cadmium Levels Due to the Addition of Vinegar Acid

The chemical properties of an element (lead, cadmium) are mainly determined by the number and arrangement of electrons in the outermost electron shells surrounding the atomic nucleus and to a lesser extent by the number of electrons in the deeper shells. These electrons in turn depend on the number and types of particles, protons and neutrons in the nucleus. Atoms with one, two or three electrons in the outer shell tend to lose these electrons and become positively charged ions due to the excess protons in the nucleus called cations becausethe ions move towards the cathode (negativeelectrons).

This study showed the ability of vinegar to reduce heavy metal levels in the meat of ricekupang. The results showed that there were significant differences in the levels of lead, cadmium and control due to vinegar treatment (5%, 15% and 25%).

The difference in acid concentration will affect the decrease in Lead in Kupang meat. The results of the data indicate that the higher the acid concentration, the more acid will bind to metal ions so that the lower the lead content in red mussel meat. Citric acid (C6H8O7) is a tricarboxylic acid where each molecule contains a carboxyl group and one hydroxyl group bonded to a carbon atom, citric acid is very effective as a metal ion binder and is easily soluble in water[6]. While EDTA (C6H16N2O8) has two nitrogen atoms and four in the carboxylate group. This compound is a hexadentate ligand (there are six lone pairs of electrons) which will usually form a strong chelate complex[7].

Differences in lead levels due to the additionof vinegar

The results showed that there was a significant difference in the levels of black lead in the meat of the kupang between the addition of 25% vinegar and 5% and 15% vinegar. There was no significant difference between the addition of 5% vinegar and 15% vinegar. This shows that the concentration of 25% vinegar is able to bind lead ions and form the most lead acetate. Lead acetate is a compound that is difficult to dissociate. The decrease in lead due to vinegar treatment ranged from 90.1 to 95.7%[8]

The decrease in lead metal content is caused by acidic solutions that can damage the metal protein complex bonds. Almost all of the metal ions contained in the organism's body are bound to proteins[8]. The decrease in lead metal can be caused by the release of the protein metal complex bonds so that the metal ions come out of the mussel meat. Metal ions found in the body of organisms are almost all bound to proteins. Complex interactions between metal ions and proteins are metalloenzymes and metal proteins. Metalloenzymes are protein that bind to metals in the body or proteins that bind strongly to metal ions to form stable bonds. Metal proteins are proteins that bind to metals in the body and their metal ions are easily exchanged with other proteins[6].

To obtain Lead 2+ 6 stable coordination bonds, a ligand capable of forming a 5-6 corner ring with a metal is needed. The metal ion is coordinated with the electron pair of the EDTA nitrogen atoms as well as the four carboxyl groups present in the EDTA molecule. Generally, EDTA is used to treat poisoning by Hg and Lead and EDTA is used as a preservative to prevent spoilage caused by heavy metals in fish and shellfish products so that they can last for several days [7].

Differences in Cadmium levels due to the addition of vinegar

The results of this study showed that there was no significant difference in cadmium levels in rice kupang meat due to the addition of 5% vinegar acid, 15% vinegar acid and 25% vinegar acid. Thus the difference in concentration does not affect the levels of cadmium in the meat of the kupang. In the presence of vinegar, cadmium will be released and bind to OH- ions present in vinegar to form cadmium acetate compounds[9]. The decrease in cadmium due to vinegar treatment ranged from 97.3% - 98.5%. The decrease in cadmium was higher than the decrease in lead, this happened because in addition to vinegar, the presence of Zn also affected the decrease in cadmium levels. Cadmium is one type of heavy metal that is dangerous because this element is at high risk for blood vessels. When Cadmium enters the body, most of it will collect in the kidneys, liver and some are excreted through the digestive tract. Cadmium can affect the smooth muscle of blood vessels directly or indirectly through the kidneys, as a result of which there is an increase in blood pressure[10].

Some of the effects caused by cadmium exposure are kidney damage. liver, testes, immune system, nervous system and blood. The danger of this element is actually when humans consume (whether inhaled or eaten) in large enough quantities. Because in fact, cadmium is not easy to get out in the body. This metal will continue to accumulate inthe body. And when it reaches high levels, itwill attack the body's organs, especially the kidneys and lungs.

IV. CONCLUSION

Based on the results of the analysis and interpretation, it can be concluded that in an effort to reduce/eliminate the levels of Lead,Cadmium in mussels, it can be done in an easy, simple and effective way, namely by using vinegar acid by soaking mussels with vinegar acid as much as 5% (5 g 100 g mussel for 1 hour, because using 5% alone can reduce lead levels by 90% and reduce cadmium levels by 97%.

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