

CITRIC ACID REDUCES THE CONTENT OF Pb AND Cd OF KUPANG BERAS (*Corbula Faba*)

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ABSTRAK

*Kupang adalah produk perikanan bergizi, namun di sisi lain juga telah terkontaminasi oleh Pb dan Cd yang telah membahayakan manusia. Oleh karena itu, perlu untuk mengurangi isi Pb dan Cd di Kupang sehingga aman untuk dikonsumsi. Tujuan dari penelitian ini adalah untuk mempelajari penggunaan asam sitrat untuk mengurangi isi Pb dan Cd dalam kupang beras (*Corbula faba*) sebanyak mungkin. Penelitian ini Eksperimental Benar dan digunakan Lengkap Acak Desain dengan 3 perlakuan, yaitu penambahan 5,3%, 16% dan asam sitrat 26,6%, dan dibandingkan dengan data control. The diperoleh dari penelitian menunjukkan temuan bahwa tanpa pengobatan (kontrol) yang isi rata-rata adalah 1,281 ppm Pb, Cd adalah 1,254 ppm,. Konten Pb di Kupang beras adalah 1,281 mg / kg, itu berarti bahwa beras Kupang boleh dikonsumsi oleh manusia yang 156-234 gram / hari. Cd konten dalam kupang beras adalah 1,254 mg / kg, itu berarti bahwa kupang beras boleh dikonsumsi oleh manusia adalah 19,9-47,8 gram / hari. Temuan penelitian menunjukkan bahwa dengan menambahkan asam sitrat terjadi penurunan Pb oleh 96,1-97%, penurunan Cd oleh 97,5-98,9%, Penambahan asam sitrat terbaik digunakan untuk mengurangi isi dari logam berat Pb dan Cd 26,6, % konsentrasi.*

ABSTRACT

*Kupang is nutritious fishery product, but on the other hand it also been contaminated by Pb and Cd which has been endangering human being. Therefore, it is necessary to decrease the content of Pb and Cd in Kupang so that it is safe to be consumed. The objective of this research is to study the use of citric acid to decrease the content of Pb and Cd in kupang beras (*Corbula faba*) as much as possible. The research is True Experimental and used Completely Randomized Design with 3 treatments, namely, the addition of 5.3 %, 16 % and 26.6 % citric acid, and compared with control. The data obtained from the research finding show that without treatment (control) the average content of Pb is 1.281 ppm, Cd is 1.254 ppm,. Pb content in Kupang beras is 1.281 mg/kg, it means that Kupang beras allowed to be consumed by human being that is 156-234 gram/day. Cd content in kupang beras 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 research findings show that by adding citric acid there is decrease of Pb by 96.1-97 %, a decrease of Cd by 97.5 – 98.9 %, The best addition of citric acid used to decrease the content of Pb and Cd heavy metals 26,6, % concentration.*

Keywords: *Corbula faba*, Pb, Cd citric acid

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INTRODUCTION

Kupang fishery rice is a product that has high nutritional value and is one source of high quality protein and cheap. As animal food, kupang rice is a source of essential amino acids, minerals (iodine, calcium, phosphorus and iron), and the amount of omega - 3 are far more than terrestrial animals (Hirschborn 1992). Type kupang white/kupang rice is a type of kupang the most widely consumed by people (Purwati, 2001). Kupang is a source of animal protein with a complete category of cheap protein. Protein content approximately 24% (Subani (1983), Purwanti (1989), Sondakh (1989)), but according to Sardjina (1999) kupang rice protein content 9.04% .. High levels of essential amino acid which is about 85% - 95% of the total protein. From the

qualitative and quantitative analysis of the results obtained kupang there are 17 kinds of amino acids including essential amino acids and non-essential (Poedjiarti (1993), Santosa (1997) and Sardjina et al. (1999)). Kupang minerals containing high Zn and Fe. According Arbai (1999), Zn levels in rice kupang (*Corbula faba*) 14.836 ppm and kupang wasps (*Masculista senhousia*) 16.244 ppm, Fe content of rice kupang 133.9 ppm and 57.84 ppm kupang wasps. Thought (1991) reported that Zn levels in rice kupang 91.04 ppm and 205.92 ppm Fe, Broto (1997) reported that Zn levels in rice kupang 24.56 ppm and 24.56 ppm Fe as well as by Sutanto (2002) kupang Zn content of rice from 6.3 to 9.99 ppm.

Habitat kupang rice in the sea waters precisely in the area near the mouth of the river estuaries. Kupang live clustered in the bottom waters in the form of mud or mud mixed with sand (Purwati, 2001). Sea is a place bermuaranya all rivers, both small streams and large rivers, the sea will thus become a gathering place substances pollutants carried by the flow of these rivers. Many factories (industrial) that industrial waste into rivers without any sewage treatment process in advance and results of activities of household waste dumped into rivers. These wastes will be washed into the sea by the river which will pollute the sea (Yanney 1990). One of the most dangerous contaminants are heavy metals, because the heavy metals are generally toxic (poison) and most of the water in the form of ions. Some heavy metals are often located in the waters of various kinds, there are essential metals (required), among others, Zn, Fe and some non-essential heavy metals (which are not needed) in between Pb and Cd.

Kupang is one of the marine animals can accumulate heavy metals in the environment, because kupang have a sedentary nature of life, slow to get away from pollution and have a high tolerance to pollutants (Darmono, 2001). Kupang and other species of molluscs absorb heavy metals through three ways, namely from the dissolved form in water, absorbed in the mucus layer that surrounds his body and through the food chain. The higher levels of heavy metals in waters greater the levels of heavy metals in their bodies. In the body, heavy metals that are similar to the nutrients metabolized and partly deposited in certain places (Handajani et al., 2000). Kupang containing heavy metals, harmful to life. If these kupang human consumption, it could lead to accumulation of heavy metals in the body that could be bad for your health. Among the heavy metals that are harmful to health is Pb (lead/lead) and Cd (Cadmium).

Results of research on heavy metal content in marine organisms have been carried out, among others: Think (1991) who reported that the levels of Pb in Surabaya Kenjeran kupang 28.842 ppm, 8.171 ppm Cd, Fe and Zn 91.04 ppm 205.92 ppm, while levels Pb shells 3.1 ppm - 9.64 ppm, 0.136 ppm Cd shells - 1.2 ppm. Arbai (1999) reported Pb levels in Sidoarjo kupang wasp rice kupang 0.25 ppm 0.202 ppm, 0.136 ppm Cd kupang rice. Handajani (2000) reported Pb levels in rice kupang Surabaya 1.1084 ppm, 1.0143 ppm kupang wasps, Pb kupang rice in Sidoarjo 2.4795 ppm, 5.6794 ppm kupang wasps, Pb kupang rice in Pasuruan 1.5543 ppm, kupang wasp 2.9031 ppm. The study showed that pollution in the waters of the most high compared Surabaya Sidoarjo and Pasuruan. Handajani et al. (2001) reported that Pb levels in Sidoarjo in kupang raw rice at 3.1902 ppm and 2.8903 ppm kupang cook rice.

Sutanto (2002) reported that Pb levels in rice in Pasuruan kupang 2.98 to 3.38 ppm. Kurnianta Jimmy (2002) reported that levels of Cd in rice in Pasuruan kupang 2.64 ppm. Purwanto (2000) reported that the Hg content of raw rice in Sidoarjo kupang amounting to 1.796 ppm, 0 ppm kupang boiled, broth kupang 0.016 ppm, 0.025 ppm kupang paste, crackers kupang 0.01 ppm, while the food plus kupang paste and broth contained 0.318 ppm Hg. The results showed that levels of heavy metals in kupang has exceeded the threshold of heavy metal content which is recommended by FAO/WHO where the marine animals that may be used for human consumption to a maximum of 0.1 ppm Cd and Pb 1 ppm. Under the terms of the ADI (Acceptable-Daily-Intake) tolerance limit of Cd intake in the body of 25-60 ug/day for Pb and 200-300 ug/day (Hamilton 1980). According to the provisions of ISO content of Pb is allowed a maximum of 2 mg/kg.

Levels of Pb and Cd at high kupang affect health. Pb deficiency causes anemia and hemoglobin, renal dysfunction and brain damage (neuropathy). Cd can motivate bone demineralization, increased bone fragility and fracture risk, causing anemia and hypertension, the testes causes hyperplasia, which is the beginning of the occurrence of cancer (Hadisoegondo 1990).

Kupang is the fishery products are nutritious, but on the other hand has also been tainted kupang Pb and Cd are dangerous for men, for it is necessary to attempt to reduce levels of Pb and Cd that is safe for human consumption. One such effort is to use a metal fastener (chelating agent) is citric acid. Citric acid is a tricarboxylic acid is very effective as a binder metal (metal chelating agent) (Grosch 1987, Min 1992). Citric acid is an acid tribasa that can form complexes with metal (Reynolds 1982 and Vogel 1985). Citric acid has three lone pairs on the carboxylic group can be assigned to the metal ions to form complex ions are readily soluble in water (Rival 1995). Citric acid to simultaneously coordinate the three places on the metal atoms with coordination number 3 which is a very stable complex (Soen 1989). Merupakan tricarboxylic acid citric acid, each molecule contains three carboxyl and one hydroxyl group attached to carbon atoms in the middle.

The purpose of this research is to study the addition of citric acid in an effort to lower the levels of Pb and Cd kupang rice (*Corbula faba*). Of research is expected to find the best treatment in an effort to decrease levels of Pb and Cd kupang rice by using citric acid in a way easy, simple and effective that can be disseminated to the general public especially the rice cake seller kupang so that the impact of exposure to heavy metals Pb and Cd can be avoided.

MATERIALS AND METHODS

This research is an experimental fact (True Experimental). This study wanted to determine the effect of the addition of metal binding (chelating agent), measured levels of Pb, Cd from rice kupang. The research was conducted as follows: 1. Random (R) rice kupang classified into two groups, namely the control group (K) and group treatment/test. 2. The treatment group given the addition of a binder metal (chelating agent) in this case citric acid with various concentrations (5.3%, 16%, 26.6%), whereas the control group given the addition aquades. 3. After a period of 1 hour was measured levels of Pb, Cd or both of the control group than the treatment group. Kupang rice samples obtained from Balongdowo Village, Sidoarjo as a collection center kupang rice taken from the waters of estuaries Sidoarjo. Kupang rice washed, then boiled with a temperature of 100oC for 2 hours, to separate the shells and meat. Meat kupang rice was then taken to a laboratory to be weighed each 100 grams of treatment is 4 + 1 control with repeat 4 times so it takes 2kg of meat kupang. Then each placed in a basin/place of plastic and do immersion 5.3% citric acid (5.3 grams of citric acid in 100 ml aquades), 16% (16 grams of citric acid in 100 ml aquades, 26.6% (26, 6 grams in 100 ml aquades), After 1 hour, washed rice kupang aquades then measured levels of Pb, Cd in meat kupang.

RESULTS

The results of the analysis the average levels of Pb, Cd due to citric acid treatment are presented in Table 1.

Table 1. The average levels of Pb, Cd kupang meat rice due to the addition of citric acid.

Citric acid	Pb content (mg/kg) ($\bar{x} \pm SD$)	Cd content (mg/kg) ($\bar{x} \pm SD$)
C	1.28 $\pm$ 0.03	1.25 $\pm$ 0.02
LCA (5.3%)	0.051 $\pm$ 0.020	0.031 $\pm$ 0.004
MCA (16%)	0.048 $\pm$ 0.026	0.021 $\pm$ 0.008
HCA (26.6%)	0.039 $\pm$ 0.036	0.014 $\pm$ 0.002

Description:

C = Control

LCA = Low Citric Acid

MCA = Medium Citric Acid

HCA = High Citric Acid

The administration of citric acid, the average Pb and Cd the lowest levels occurred in 26.6% of citric acid and the decline in average levels of Pb, Cd Kupang Rice Due to Addition of citric acid with different concentrations (Table 1). Table 2 describes the effect of citric acid to decrease levels of Pb and Cd in meat

kupang highest rice occurred in 26.6% of citric acid. From the MANOVA Test Results can be seen the influence of the addition of citric acid on levels of Pb and Cd kupang rice with a value of $F = 128.176$ and $p = 0.000$ ($p < 0.05$). Likewise, the ANOVA test (Tukey HSD) can be seen that the levels of citric acid influence on meat kupang Pb levels in rice. It can be seen from the value $F = 2015.516$ and $p = 0.000$ ($p < 0.05$). As for Cd, from the ANOVA test (Tukey HSD) can be seen that the levels of citric acid influence on Cd levels of rice kupang meat. It can be seen from the value $F = 11726.794$ and $p = 0.000$ ($p < 0.05$).

Table 2. Decreased levels of Pb, Cd addition of citric acid compared with controls.

Citric acid	Pb Reduction (%)	Cd Reduction (%)
LCA (5.3%)	96.1	97.5
MCA (16%)	96.3	98.3
HCA (26.6%)	97.0	98.9

DISCUSSION

The results obtained average levels as follows: Pb 1.281 ppm, 1.254 ppm Cd. FAO/WHO stated that the heavy metal content allowed in marine animals that can be consumed by humans for Pb not more than 1 ppm and for Cd not more than 0.1 ppm. Decree of the Director General of Drug and Food No. 03725/B/SK/VI/99 about the maximum limit of metal contamination in the food that is permissible levels for Cd 1 mg/l while for Pb 2 mg/l. Meanwhile, according to SNI maximum allowable levels for Pb 2 mg/kg. Based on the above means of Sidoarjo kupang rice has been contaminated heavy metals Pb and Cd. The same thing ever done by Arbai (1999), Handajani (2000), Handajani (2001) and Sutanto (2002). The high content of heavy metals Pb and Cd in rice because of the nature kupang kupang a low mobility and settled in a particular habitat that is in the sediment or the seabed, so the rice can be used as kupang bioindikator pollution in an aquatic. Through the food chain of heavy metals in water can enter the body kupang rice because rice is an animal kupang "filter feeder". The greater the levels of heavy metals in the environment and the longer kupang rice are in place, the greater levels of heavy metals in the body kupang rice. Kupang rice absorbs heavy metals in three ways, namely from the dissolved form in water, absorbed in the mucus layer that covers his body and through the food chain.

Kupang has the ability to accumulate heavy metals to an extent which does not cause toxic effects on the organism itself because it has a metal-binding protein

(metallothionein) is a protein involved in the regulation of essential metals and as a detoxifying agent of non-essential metals (Roesijadi 1992). Metallothionein store heavy metals in liver and kidney tissue. Metallothionein has two functions: as a protein that bound metal ions in the regulation of essential and non essential metal detoxifying agent whose levels are excessive in the body (Engel and Roesijadi 1987). The existence of the role of metallothionein is causing many organisms are able to accumulate heavy metals if they are living in heavy metal polluted waters. But when the heavy metal content is too high can interfere with homeostatic functions of metallothionein and can eventually poison the organism (Roesijadi 1992). With the presence of metals in the body of this organism will affect the protein inhibits enzyme activity, among others, the configuration is not the function of proteins, binds a negative residual gas phospholipids and protein residues (Darmono 1995).

Limit intake of Pb under the provisions of the ADI (Acceptable Daily Intake) 200-300 microg/day, for Cd 25-60 microg/day. Pb levels of rice kupang 1.281 mg/kg, thus kupang rice for human consumption is allowed 156-234 grams/day. Cd levels of rice kupang 1.254 mg/kg, thus kupang rice may be consumed manusia is 19.9 to 47.8 mg/kg. Under the terms ADI indicates that levels of Cd in foods that are allowed for human consumption is lower than the levels of Pb, this suggests that the heavy metals Cd is more dangerous than the heavy metal Pb. Based on that then limit intake kupang rice may be consumed by the public is based on existing levels of Cd in rice kupang ie from 19.9 to 47.8 mg/day, so that the people of Sidoarjo and the surrounding rice kupang when eating meat in a day maximum allowed for 19.9 to 47.8 mg/day. This is to avoid the negative effects of heavy metals in the human body, especially the consumption of meat kupang rice.

From the survey results revealed that with the addition of citric acid will cause a decline in Pb levels ranged from 96.1 to 97%. Cd and decreased levels of 97.5 to 98.9%. The analysis results show that there are significant differences levels of Pb, Cd to control due to the addition of citric acid This suggests that the addition of citric acid influence on levels of Pb, Cd. on meat kupang beras. Hal is demonstrated by the results of MANOVA and ANOVA test. Metal bonding agent in this case citric acid can bind to metals in the form of a complex bond. Metal ions can be detached from the bonds of the complex because of hydrolysis and degradation of free metal ions easily react and binder metal will bind metal ions (Winarno, 2004).

Molecules or ions with free electron pairs can coordinate or form complexes with metal ions.

Compounds having two or more functional group such as the one-COOH, which are on citric acid can mengkhelat metal in an appropriate environment (Winarno, 2004). To obtain a stable bond required metal ligands capable of forming a ring of 5-6 with a metal corner. Metal ions coordinated by pairs of electrons of nitrogen atoms and also with the fourth ligand carboxyl group contained in the ligand molecule. Carboxylic acid groups are not ionized is not a good electron donor, whereas the carboxyl ion is a good donor. (Winarno, 2004). Hydroxyl ions compete with metal ions and reduce the ability of chelating agents. Citric acid is a tricarboxylic acid in which each molecule contains a carboxyl group and one hydroxyl group attached to carbon atoms, citric acid is very effective as a binder metal (metal chelating agent) (Grosch 1987, Min 1992).

According to Anwar (1998) is a food additive citric acid binding metal so it can deliver food from metal contamination. Citric acid with heavy metal complex compounds likely to occur. Complex compounds are compounds formed by the merger of two or more compounds that each can stand alone. Because the citric acid can form a stable complex compounds, which citric acid had 4 pairs of free electrons in the molecules of the carboxylic group can be assigned to the metal ions that cause the formation of complex ions that are easily soluble in water (Rival 1995). Citric acid to simultaneously coordinate the fourth place on a metal atom with coordination number four, which is a stable complex (Saeni 1989).

Based on its chemical properties it has a valence of +2 and Pb +4 include group IV A and has the electron configuration (n) s² (n) p². Such configurations lead to the existence of two possible covalent bonding is when the s and p energy levels involved in the formation of compounds and ionic bonding when only two p electrons of highest energy is released to form the ion M⁺⁺ (Quagliano 1964).

Citric acid is a tricarboxylic acid in which each molecule contains a carboxyl group and one hydroxyl group attached to carbon atoms, so that. citric acid can form a stable complex compounds, which citric acid had 4 pairs of free electrons in the molecules of the carboxylic group can be given to the metal ions that cause the formation of complex ions that are easily soluble in water (Rival 1995). Citric acid to simultaneously coordinate the fourth place on a metal atom (Pb) with four coordination numbers which is a stable complex (Saeni 1989).

In the body kupang Pb bound in proteins or peptides to form compounds metallothionein, in the presence of citric acid is released and then the Pb ions bind to the

OH-and COOH-existing in the citric acid forming compounds of Pb citrate (Gaman and Sherringtonn 1994). Based on its chemical properties of metals Cd with a charge of +2. Is slightly electropositive and with oxidizing acids instead would require M^{++} ions.

In the body kupang Cd bound in proteins or peptides to form compounds of metallothionein, in the presence of citric acid having 4 pairs of free electrons in the molecules of the carboxylic group can be assigned to the metal ions that cause the formation of complex ions that are easily soluble in water, citric acid is coordinate simultaneous fourth place on a metal atom (Cd) with four coordination numbers which is a stable complex, the Cd is released and binds to the OH-ion and COO-are on citric acid to form citrate compound Cd (Gaman and sherringtonn 1994).

CONCLUSION

From the data and discussion in this study can be concluded that citric acid could reduce levels of Pb and Cd in rice kupang. With various concentrations of acid treatment sitratyang used to reduce levels of Pb and Cd of the obtained results that the acid concentration of 26.6% sitratdengan best digunakan to lower down the levels of Pb and Cd in rice kupang meat. With the results of this study can be found efforts to reduce the levels of Pb, Cd in a way easy, simple and effective.

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