REDUCTION OF LEAD (Pb) LEVELS IN RED KUPANG (*MUSCULISTA SENHAUSIA*) USING WULUH STARFRUIT (*AVERRHOA BILIMBI*) EXTRACT

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Abstract

Red kupang (Musculista senhausia) is one of the protein-rich fisheries resources that is widely consumed by the population. However, red kupang contains a significant amount of heavy metal. This can be harmful to people if consumed in the long term and not processed properly. The boiling method that has been used to remove heavy metals is not effective, especially for reducing the levels of lead (Pb), which is difficult to dissolve in water. The accumulation of lead (Pb) in red kupang can be reduced by extracting it using citric acid, a chelating agent. This study aims to determine the effect of differences in citric acid concentration (0.5%v/v, 1%v/v, 1.5%v/v, 2%v/v, and 2.5%v/v) from starfruit juice solvent and stirring speed (150 rpm, 180 rpm, 210 rpm, 240 rpm, and 270 rpm) in the solid-liquid extraction method (leaching) on lead (Pb) levels in red kupang. Analysis of lead (Pb) levels was carried out using AAS. The analysis results showed that the levels of lead (Pb) tended to decrease as the stirring speed and citric acid concentration increased. The best results were obtained at a citric acid concentration of 2.5%v/v and a stirring speed of 210 rpm, which resulted in a residual lead (Pb) levels of 0.251 mg/kg. The results are in accordance with SNI 7387:2009, which states that the limit for lead metal contamination in food is 1.5 mg/kg.

Keywords: Extraction, lead (Pb), red kupang, wuluh starfruit

Abstrak

Kupang merah (Musculista senhausia) merupakan salah satu hasil perikanan yang kaya protein dan banyak dikonsumsi oleh masyarakat. Namun, kupang merah diketahui mengandung logam berat dalam jumlah yang signifikan. Kandungan ini dapat berbahaya bagi kesehatan jika dikonsumsi dalam jangka panjang tanpa melalui proses pengolahan yang tepat. Metode perebusan yang selama ini digunakan untuk menghilangkan logam berat belum efektif, terutama dalam menurunkan kadar timbal (Pb) yang sulit larut dalam air. Akumulasi timbal (Pb) dalam kupang merah dapat dikurangi melalui proses ekstraksi menggunakan asam sitrat yang berperan sebagai agen pengikat (chelating agent). Penelitian ini bertujuan untuk mengetahui pengaruh variasi konsentrasi asam sitrat (0,5%v/v, 1%v/v, 1,5%v/v, 2%v/v, dan 2,5%v/v) dari pelarut sari belimbing wuluh serta kecepatan pengadukan (150 rpm, 180 rpm, 210 rpm, 240 rpm, dan 270 rpm) dalam metode ekstraksi padat-cair (leaching) terhadap kadar timbal (Pb) dalam kupang merah. Analisis kadar timbal (Pb) dilakukan menggunakan instrumentasi AAS (Atomic Absorption Spectrophotometry). Hasil analisis menunjukkan bahwa kadar timbal (Pb) cenderung menurun seiring dengan meningkatnya konsentrasi asam sitrat dan kecepatan pengadukan. Hasil terbaik diperoleh pada konsentrasi asam sitrat 2,5%v/v dan kecepatan pengadukan 210 rpm, dengan kadar residu timbal (Pb) sebesar 0,251 mg/kg. Hasil ini sesuai dengan SNI 7387:2009 yang menetapkan batas maksimum cemaran logam timbal dalam pangan adalah 1,5 mg/kg.

***Kata kunci**: Ekstraksi, timbal (Pb), kupang merah, belimbing wuluh*

INTRODUCTION

Red kupang (*Musculista senhausia*) are a fishery resource that belongs to the Bivalvia class (Nurjanah et al., 2014). Red kupang, also known as Javanese mussels or wasp mussels, are small shellfish with thin and elongated oval shells. Red kupang are used by the people of East Java, especially the area around Surabaya, as a typical food that complements *lontong sayur*. In addition, red kupang are also processed into mussel soup, crackers, and shrimp paste (Santi et al., 2021).

Kupang is an alternative source of animal protein because it has a high protein content of 65.20% (db) (Yuniar, 2019). Kupang contains amino acids and fatty acids, which are very good for fulfilling the body's nutritional needs. However, due to its sedentary nature and slowness in avoiding pollution, kupang can contain heavy metal contaminants (Liu et al., 2022). Lead (Pb) is a widespread heavy metal element that is widely used in industry. Usually appearing as a dark grey powder, lead (Pb) is widely used in the production of batteries and ammunition, as well as in the manufacture of paint components, tetraethyl lead, radiation shields, pipe coatings, cable sheathing, ceramic glass, electronic goods, and brazing processes. Lead (Pb) can accumulate in the human body through the consumption of contaminated food, water, soil, and dust. Exposure to lead (Pb) has a very detrimental impact on many organs in the human body, especially the nervous system, blood formation system, kidneys, heart system, and reproductive system (Ardillah, 2016). The accumulation of lead (Pb) metal in the body from consumption of red kupang is potentially dangerous to health. Therefore, consuming excessive mussels can cause serious health risks because lead (Pb) metal can accumulate in the human body.

Starfruit (*Averrhoa bilimbi*) has traditionally been used by the community as food and medicine (Alhassan et al., 2016). In Indonesia, starfruit is used as a cooking spice because of its distinctive taste and aroma. Starfruit contains formic acid, citric acid, flavonoids, and glucosides, along with high levels of ascorbic acid (vitamin C), tannins, saponins, and various minerals such as calcium and potassium in the form of potassium citrate plus calcium oxalate (Setyawan et al., 2021). Citric acid has several important functions in preserving food, such as an antioxidant that prevents rancidity and maintains colour and aroma (Ondu et al., 2019). In addition, citric acid also acts as a chelating agent, a chemical compound that can form complex bonds with heavy metals (Hattu et al., 2014). Previous experimental conducted by Putri (2023) showed that soaking lorjuk meat with citric acid for 4.5 hours can reduce the levels of heavy metal Pb in lorjuk meat by 14.38%v/v.

Leaching is a solid-liquid extraction method using organic solvents. Based on previous studies, the solid-liquid extraction method can reduce lead (Pb) levels. The solid-liquid extraction method can accelerate dissolution compared to the soaking method, so it can be more effective in reducing lead (Pb) levels (Sembiring et al., 2024).

In experimental conducted by Hidayat, et al. (2015), the reduction of lead (Pb) in red kupang (*Musculista senhousia*) was carried out using the acid braising method. The results showed that boiling mussel meat with different types of acids (citric acid and EDTA) and varying concentrations had a significant effect (α=0.05) on lead (Pb) levels and pH values. The best result was obtained by braising the mussel meat in a 0.25M citric acid solution, reducing the Pb content to 0.91 ppm.

This study aims to influence the difference in citric acid concentration from the starfruit extract solvent and the stirring speed in the solid-liquid extraction method (leaching) on lead (Pb) levels in red kupang. The extraction results were then analyzed for lead (Pb) levels using the Atomic Absorption Spectrophotometry (AAS) method.

RESEARCH AND METHODS

Materials and Equipment

The materials used in this research are red kupang (*Musculitas senhausia*) taken from Pabean Market Surabaya, starfruit (*Averrhoa bilimbi*), and aquadest. The equipment used in this research is a series of leaching extraction equipment with magnetic stirrers. The instrumental analysis in this study was carried out by using atomic absorption spectrometry (AAS).

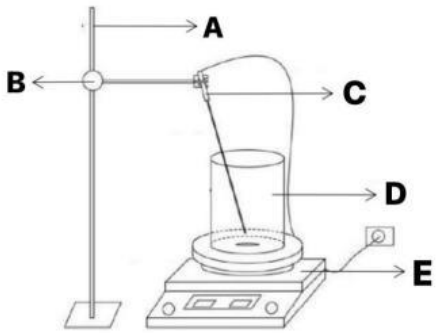

Figure 1. Extraction process equipment

A. Clamp
B. Laboratory stand
C. Thermocouple
D. Beaker glass
E. Magnetic stirrer

Methods

Red kupang preparation

The red kupang were washed with distilled water several times to remove sand, dust, and dirt and to reduce impurities. Conduct an initial analysis of lead (Pb) levels in red kupang.

Citric acid preparation

Squeeze the wuluh starfruit to obtain starfruit extract. Analyze the citric acid concentration in wuluh starfrui by using alkalimetric titration method. The 4.11%v/vv/v of citric acid concentration was obtained from wuluh starfruit extract. Dilute the citric acid according to the variations of citric acid concentrations: 0.5%v/vv/v, 1%v/v v/v, 1.5%v/v v/v, 2%v/v v/v, and 2.5%v/v v/v as a extraction solvent.

Extraction process

The extraction of red kupang starts by weighing 50 grams of red kupang. Then extracted with 300 ml of wuluh starfruit juice according to the variation of citric acid concentration, namely 0.5%v/v, 1%v/v, 1.5%v/v, 2%v/v, and 2.5%v/v. Extraction was carried out with a stirring variation of 150 rpm, 180 rpm, 210 rpm, 240 rpm, and 270 rpm at a temperature of 30 °C for 60 minutes. The extraction results were filtered to separate the filtrate and sediment. The sediment obtained was analyzed for lead (Pb) levels using AAS.

RESULTS AND DISCUSSION

The determination of the initial lead (Pb) levels contained in red kupang was carried out to determine the initial lead (Pb) levels before extraction. The results of the initial analysis of lead (Pb) levels in red kupang showed in Table 1.

Table 1. The initial lead (Pb) levels of red kupang before extraction

Parameter	Results
Lead (Pb)	18.732 mg/kg

The high lead (Pb) levels is caused by the metal that accumulates in red kupang when they are in the waters where they live (Liu et al., 2022). High lead (Pb) levels can pose serious health risks because lead (Pb) can accumulate in the human body if you consume red kupang excessively and without proper processing. Foodstuffs containing heavy metal contamination can be released through citric acid (Jaishankar et al., 2014). Based on the results of the initial analysis, the citric acid content of the wuluh starfruit used in this study was 4.11%v/v. This shows that the citric acid content in wuluh starfruit is quite high. The high citric acid content of wuluh starfruit extract as a solvent in this study can reduce the levels of lead (Pb) that accumulate in the bodies of red kupang (Ernawati et al. 2022). The results of the reduction in lead (Pb) levels in the study can be seen in Figure 2.

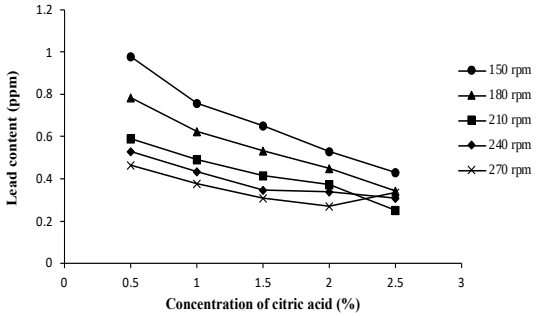

Figure 2. Relationship between citric acid concentration and lead (Pb) levels

In **Figure 2**, it can be seen that the effect of citric acid concentration on lead (Pb) levels is inversely proportional, where the higher the concentration of citric acid used, the lower the remaining lead (Pb) levels in red kupang. The best extraction results were obtained at a citric acid concentration of 2.5%v/v with a stirring speed of 210 rpm, resulting in a residual lead (Pb) levels of 0.251 mg/kg in red kupang. This can happen because citric acid is a chemical compound that binds metal in a complex form, so the higher the concentration of citric acid in the solvent used, the more lead (Pb) ions will be bound and the lead (Pb) levels in red kupang will decrease (Widiyanto et al., 2023). The results of the lead (Pb) levels in this study have reached the SNI 7387:2009 standard, where the maximum lead (Pb) levels permitted in food is 1.5 mg/kg. Starfruit extract has been proven to be effective in reducing lead (Pb) levels in red kupang because of its very high citric acid content. The results obtained in this study are in line with research conducted by Fitriyani (2022), namely reducing lead (Pb) levels in green mussels by soaking them with starfruit extract as a solvent. In his study, the highest amount of lead (Pb) levels was obtained at a concentration of 45%v/v from the previous level, namely 10.517 mg/kg, then decreased to 4.400 mg/kg.

The results of the study showed that the concentration of citric acid in the wuluh starfruit extract used in the extraction process can affect the lead (Pb) levels in red kupang. This is in line with the stirring speed used during the extraction process, as shown in **Figure 1**. This result is proven by the fact that the fact that the higher the stirring speed used, the lower the lead (Pb) levels. The best extraction results were obtained at a stirring speed of 210 rpm with a concentration of 2.5%v/v, which resulted in a residual lead (Pb) levels of 0.251 mg/kg. This can occur because the higher the stirring speed used for extraction, the greater the amount of lead **(**Pb**)** extracted, so that the remaining lead (Pb) levels in the

red kupang meat is reduced. However, **Figure 2**. also showed that at a citric acid concentration of 2.5%v/v with a stirring speed of 240 rpm and 270 rpm, there was an increase in lead (Pb) levels. This can occur due to stirring that is too fast, causing vortex formation during the extraction process (Budiyati et al., 2013). In addition, the higher the stirring speed used, the more the more it can damage the material being extracted, so that it can reduce the collision process between solid molecules and the solution. This condition causes the distribution of dissolved components to be less even, so that the extraction process is less effective. Furthermore, the increase in lead (Pb) levels can be caused by the influence of solvent concentration. In general, the higher the solvent concentration, the more efficient the extraction process will be. However, if the solvent concentration used is too high, it can also damage the sample because the interaction between the solvent and the sample can be more aggressive. It caused the lead (Pb) levels using 2.5%v/v of citric acid at 270 rpm was higher than 210 rpm.

CONCLUSION

The high citric acid content of wuluh starfruit extract has been proven effective in reducing the concentration of lead (Pb) in red kupang samples. Citric acid, as a chemical compound, forms a complex bond with metals, thereby reducing the metal content. The best results for reducing lead (Pb) were at a citric acid concentration of 2.5%v/v and a stirring speed of 210 rpm with a remaining lead (Pb) levels of 0.251 mg/kg.

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