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Removal lead (Pb) and mercury (Hg) from juaro fish (*Pangasius polyuranodon*) using citric acid from pineapple extract (*Ananas comosus*) as chelating agent

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ABSTRACT

An assessment of dietary risk of heavy metals exposure to human is important since it is the main of exposure. The aim of study to measure the contamination of lead and mercury in juaro fish meat and the effort to reduce contaminations using citric acid from pineapple extract as a chelating agent. Samples was soaked and boiled in citric acid extract at concentration 50%, 75 %, 100 % for, 15 min, 30 min, 45 min at 25 ^{o}C, 50 ^{o}C and 100 ^{o}C. The concentration of lead and mercury in Juaro fish lower than the maximum acceptable lever for Pb and Hg respectively (1 mg/kg for Pb, 0.5 mg/Kg for Hg). The result indicated that after soaking and boiling in citric acid solution form pineapple extract at concentration 100 % for 45 min at 100 ^{0}C reducing heavy metals Pb from 0.02 mg.Kg^{-1} to 0.003 mg.Kg^{-1} and Hg from 0.011 mg.Kg^{-1} to lower than 0.0001 mg.Kg^{-1}. The increasing of soaking time and boiling temperature, the levels of Pb and Hg in Juaro fish Tissue will decreasing.

Keywords: Citric Acid solution, Pineapple extract, heavy metal

1. INTRODUCTION

Heavy metals are the most important and basic pollutants because of their bioaccumulation and high toxicity even at very low dosage and cause serious dangers to ecological system as well as human health (Tadjuradi, 2016). With the rapid growth of population and industrialization in the world, the frequency of accidently heavy metal pollution in soil, food and aquatic ecosystems boosted fast in recent years. Due to its non-biodegradation and non decomposing characters. Heavy metals ion can be accumulated through food chain and absorbed by human being.

Pollutions in the aquatic ecosystems has received much concern, due to the abundance, toxicity, persistence, ubiquity and non-degradability in the ecosystems and subsequent bio-accumulation of heavy metals (Liu *et al*, 2016). Heavy metals in polluted habitats may accumulate especially in fish tissue which in turn may enter into human food chain and eventually lead health risk (Ahmed *et al*, 2015). Eddy *et al* (2012) had reported the aquatic ecosystems in musi river contaminated by heavy metals such as lead and mercury. Juaro Fish (*Pangasius polyuranodon*) is one of aquatic species which is thought to have high lead and mercury accumulations due to predatory fish.

Mercury is one the most hazardous heavy metal contaminants. The environment pollution by mercury originates from two source-natural and anthropogenic. Coal burning, waste combustion, mining, sewage sludge, deposition, Hg wood impreqnation and industrial practices are the main anthropogenic sources. (Alloway, 1995). Long term exposure to mercury compounds from food and water can lead to toxic effects on brain, cardiovascular, pulmonary, urinary, gastrointestinal and neurology system (Kim *et al*, 2016; Turaga *et al*, 2014). Lead causes severe health risks such as fatigue, irritability, myalgia, coma, kidney, liver and brain damage, seizures encephalopathy nervous system dysfunction, disturbance of immune system and development of cancer (Sander *et al*, 2009; Goldstein *et al*, 1992).

The technologies used for reduce contaminations in food using chelating agent. Citric acid has potential as chelating agent to remove toxic metals (Jiang *et al*, 2017; Aderhold *et al*, 2017; Shakour *et al*, 2014). Pineapple (*Ananas comosus*) is one of the fruits that have high concentrations of citric acid. Citric acid includes a chelating agent which is a stabilizer at food processing. Citric acid binds the heavy metals in the form of complex bond and can reduce side effects of heavy metals in food (Hikmawati and lilis, 2016).

Interaction of citric acid with heavy metals can be enhanced by soaking (Ulfa *et al*, 2014) and boiling process at high temperature (Sari *et al*, 2014). The aim of the experimentations was to evaluate the metal mobilization induced by citric acid from pineapple extract when samples were soaking and boiled until 45 minute.

2. EXPERIMENTAL SECTION

2.1. Experimental site

The experiment was performed in food and beverage analysis laboratory, faculty of health science, musi charitas catholic university,

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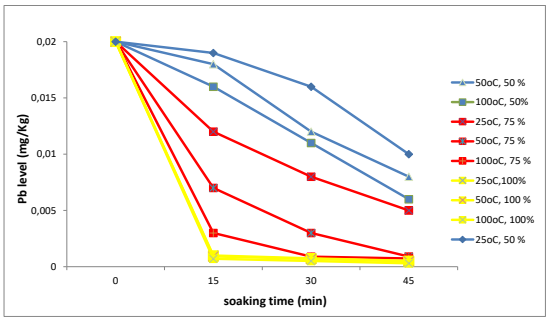

Figure 1. Reduction of lead (Pb) in Juaro fish

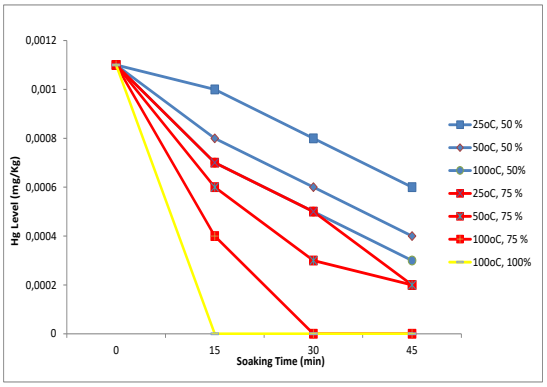

Figure 2. Reduction of Hg in Juaro fish

Palembang, Indonesia. The instrument was used a water-bath, hotplate magnetic stirrer and glassware instrument.

2.2. Sample preparations

Juaro fish was purchased from traditional market in Palembang, South Sumatera, Indonesia. Samples of juaro fish was washed and separated their shells and meat. Meat of juaro fish was soaked in a extract of citric acid at 50 %, 75 %, 100 % for 15 min, 30 min, 45 min at 25 °C, 50 °C, 100 °C.

2.3. Heavy metals analysis

The heavy metals such as Pb and Hg at juaro fish meat were analyzed by atomic absorption spectrophotometer (AAS) shimadzu AA 7000 in industrial research and standardization laboratory Palembang and absorption spectrophotometer (AAS) shimadzu AA 2800 in environmental health and disease control laboratory Palembang. Sample (5 g) were dissolved in 25 ml $H_2SO_{4(p)}$, 20 ml $HNO_{3(p)}$, 20 ml HNO_3-$HClO_4$(1:1) then analyzed using AAS. For mercury analysis, Mercury Vaporizer Unit (HVU) was added to AAS.

2.4. Statistical analysis

The normality value of multiple groups were analyzed by one-way analysis of variance (ANOVA) with $p < 0.05$ was classified as statistically significant.

3. RESULT AND DISCUSSION

3.1. Pb Content in Juaro fish (*Pangasius polyuranodon*)

Heavy metals contamination has risen and become one of the most dangerous pollutants of environment pollution. Continuously lead metal is released into the environment both naturally and human activities. The bioaccumulation of Pb in food should be reduced by using chelating agent. Citric acid as a chelating agent with vary concentration from pineapple extract, soaking time and boiled temperature was used to reduce the level Pb in juaro fish.

The level of Pb studied were successfully reduced by citric acid and are presented in fig 1. The obtanined results from AAS showed that Pb content in juaro fish before soaking and boiled treatment was 0.02 mg.Kg^{-1}. The value shows that the Pb levels in juaro fish under the permissible limit. Based on Indonesia National standard the permissible limits of Pb content was 1 mg.Kg^{-1}.

Fish are considered as an important food source of macronutrients (carbohydrates, protein, fatty acids, vitamin and polyunsaturated fatty acids) and micro nutrients (copper, zinc, iron, selenium) for human health (Arulkumar *et al*, 2017). Bioaccumulation of lead and high toxicity even at very low dosage can cause serious dangers to human health (Tajarudin *et al*, 2016). Lead (Pb) in juaro fish successfully remove above 80 % after soaked and boiled with 100 % pineapple extract for 45 min at 100 °C.

Citric acid was effective for the removal lead ions which is likely due to its C=C bond (Jiang *et al*, 2017). Removal effect of toxic metals among organic acids more effective at acidic condition. (Pitsari *et al*, 2016) Citric acid has large pka (pka = 3,15) provide anions to complex with metals (doors, 2005). The statistical analysis showed that each treatment was significantly different and suggest that the higher boiled temperature and longer period of treatment time at any concentration of citric acid can increase the removal of Pb out from Juaro fish.

3.2. Hg content in juaro fish (*Pangasius polyuranodon*)

Citric acid with varying concentration of pineapple extract, soaking time and boiling temperature was used to level of Hg in juaro fish. The levels of Hg studied were successfully reduced by Citric acid presented in fig 2. The Hg level in juaro fish from AAS instrument before soaking dan boiling treatment was 0.011 mg.Kg^{-1}. The value shows that the Hg levels in juaro fish under the permissible limit. Although below the permissible limit, contamination of Hg must be concern due to bioaccumulation, neurotoxicity and carcinogenicity (Jomova, 2010).

Heavy metals especially mercury has contaminated aquatic system (Malvandi, 2017), seafood species (Morgano *et al*, 2013), croaker fish (Musa *et al*, 2016), horseshoe crab (Bakker *et al*, 2017) and fish (Arulkumar *et al*, 2017). The mercury accumulated in body upon the consumption of contaminated fish. The adverse effect of Hg are associated with development abnormalities children (Parashor, 2013). Mercury in juaro fish successfully removed above 80 % after soaked and boiled with 100 % pineapple extract for 45 min at 100 °C.

The statistically analysis showed that each treatment was significantly different and suggest that higher boiled temperature and longer period of treatment at any concentration of citric acid can increase removal of Hg out from juaro fish. It was indicates that an higher temperature related to increase the offered energy to separate the chemical bond of mercury metals in the materials and longer period of treatment time will give enough time for chelating agent to chelate with the heavy metals and extracted out from the juaro fish (Azele *et al*, 2014; Gzar *et al*,2014)

4. CONCLUSION

Citric acid was able to chelate the lead and mercury metals in juaro fish. The increasing of boiled temperature and longer period of treatment at any concentration of citric acid from pineapple

extract can increase of removal heavy metals (Pb and Hg) in juaro fish. The highest decreasing of Pb and H level up to 80 % when samples were boiled in pineapple extract for 45 min at 100 °C. Based on statistical data, the sig value of Pb and Hg 0.000 and 0.04, respectively. Which showed the variation of pineapple exctract have an effect on the decrease of Pb and Hg.

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