The Processing of Golden Snail (*Pomacea canaliculata*) to Reduce Level of Heavy Metal Lead (Pb) and Cadmium (Cd)

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Abstract. The decline of environmental quality has an impact on the high accumulation of heavy metals in the organs of aquatic biota such as the golden snail (*Pomacea canaliculata*). Food processing before consumption is expected to reduce the levels of heavy metals in golden snail's meat. This study aims to take a look at the effect of golden snail meat processing methods on reducing levels of heavy metals Pb and Cd. The research method is an experiment with processing, namely steaming, boiling, frying. The results of ANOVA show that there is an effect of processing methods on reducing levels of heavy metals. It is shown with the significance value (sig.) 0,000 < α = 0,05. The highest decline of heavy metasl content was in boiling process with a reducing percentage in Pb content of 44.39%, and Cd content of 43.30%.

Keywords: Golden Snail Processing, Reduce, Pb, Cd

1 Introduction

People's way of life which ignores the environment increases the pollution. For example, water pollution caused by various dangerous chemical intake into the water. These chemical substances come from industrial wastes, household wastes, vehicle exhaust, plastic wastes, pesticides, and chemical fertilizer. Heavy metals such as Cd and Pb are usually produced as chemical factories wastes, electroplating activities, and household wastesn [1]. Overused of chemical fertilizer and vehicles emission are also contribute to heavy metal pollution in the environment [2]. Pesticides used in farming location get into water through irrigation and move into other land in other location through runoff [3]. Those situation increase the heavy metal content in the water followed by the accumulation inside the aquatic biota, such as

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golden snail. Heavy metals found in the mollusc correlate significantly with those found in the water [4].

Golden snail is actually worthless fishery product, but based on the proximate test it has a high level of protein content [5]. The research showed that golden snail has 21.34% of protein, 2.28% of fat, 6.63% of fiber, 14% of ashes, 29.33% of calcium, and 0.13% of phosphor [6]. Almost all of essential amino acid contained in the golden snail are fulfilled the recommended ideal protein pattern. Its proportion of unsaturated fatty acids is higher than the saturated one, which is 39.5% [7]. Nevertheless, mollusk are the most efficient and proper bioindicator for heavy metal pollution since it can accumulate the pollutant without killing itself [8]. The slow movement of golden snail, its lifestyle in the bottom of the water, and its ability to be a filter feeder result in the increasing of heavy metal contained in this organisms. If they are consumed by human, it can be dangerous since there will be a biomagnification of the heavy metal inside the human body and disturb the metabolism system.

Pb metal can get into the human body through respiration, food, and beverages [9]. The small amount of heavy metals can be accumulated inside human body. Finally, it will cause a negative effect and healthy problem [10]. The accumulated heavy metals inside the tissue, if more than the tolerable intake, can be poisonous since it is carcinogenic.

Food and Agricultural Organization/World Health Organization (FAO/WHO) declare that provisional tolerable intake (PTWI) for Pb inside human body is 25 μg/kg of body weight (equals to 1500 mg/g/wk for a-60 kg-man [11], while for Cd is 7 μg/kg of body weight [12]. Moreover, food processing can reduce the pollutant contained. A proper food processing can decrease the heavy metal contained inside the food before consumed [13]. Furthermore, processing the food from animal sources can also kill the pathogens inside them. Decreasing of Cd is affected by the washing frequency and boiling time [14], while steaming, boiling and stir-frying can reduce the Pb and Cd content inside the leaves and fruit of long beans [13]. A similar result is also found in animal-source food such as golden snail, since animal tissues are more easily damaged for the absence of the cell wall. The boiling process damages the plasm membrane as well as the organelle's membranes so the heavy metal can easily escape from the tissues.

Based on those facts, this research aims to look find out the most effective way from various processing of golden snail (*Pomacea canaliculata*) to reduce its heavy metal content (Pb and Cd).

2 Method

The research is started by conducting a survey along the river flow started from Way Raman 36 Kalibening, Pekalongan,East Lampung to DAM Raman, Purwoasri, North Metro, Metro City, Lampung Province, Indonesia, which is indicated polluted by heavy metals. The research design used is Completed Randomized Design (CRD) with a Purposive Sampling methods. Golden snail meats are processed in various ways: steamed, boiled, and stir fried. There is also unprocessed golden snail meat as control. The measurement of heavy metal content used is Vogel's Spectrophotometer UV-Vis method followed by Two-Way Variance Analysis to determine the significance of various processing of golden snail meats on Pb and Cd content decreasing. The research was done in 1st May – 20th June 2018.

3 Results and Discussion

3.1. The Profile of heavy metals in the water, sediment, and biota.

DAM Raman is the riverbank of Way Raman with 24ha wide and an artificial reservoir that equipped by irrigation infrastructures [15]. Moreover, it also plays a role as conservation ecotourism area. Agricultural land around that site contributes to heavy metals pollution into the water. Following histogram (Fig. 1) shows the heavy metals content in the water, sediment, and golden snails taken from the research area.

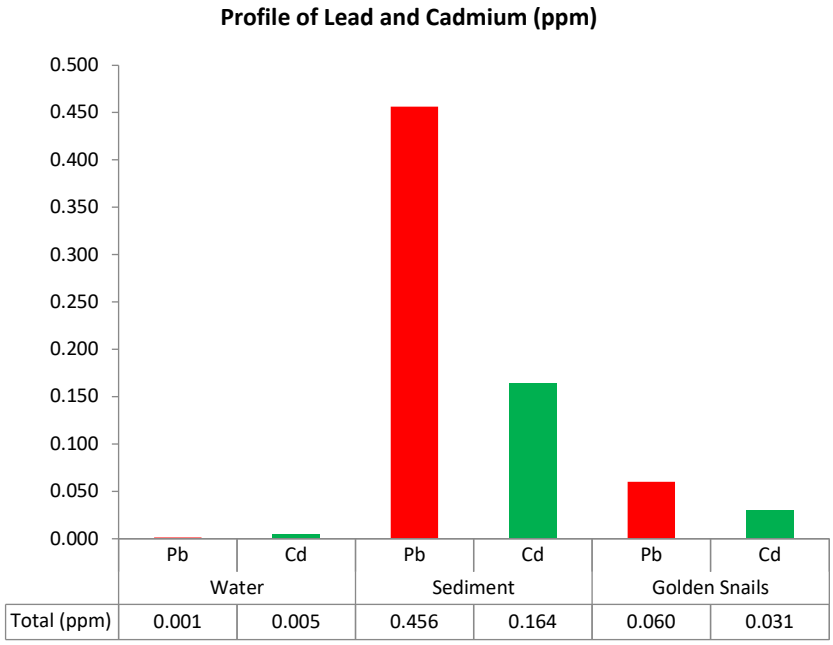

Fig 1. The Comparison of Heavy Metals Content (PB and Cd) in the Water, Sediment, and Golden Snails taken in the Research Area

Figure 1 shows that the heavy metals (Pb and Cd) contents in the water respectively are0.001 ppm and 0.005 ppm, while in the sediment are 0.456 ppm and 0.164 ppm, and inside the biota (golden snail) are 0.060 ppm and 0.031 ppm. Those numbers are still below the threshold based on NOAA (National Oceanic and Atmospheric Administration), US department of Commerce, which is 30.240 ppm [16]. Meanwhile, the Cd threshold set by KepMen LH no 51 year 2004 is 0.47 ppm [17]. Likewise, based on CCME (Canadian Council of Ministers for the Environment), the Pb threshold in the sediment is 30.2 ppm and Cd is 0.7 ppm [18].

However, those numbers still need to be watched since heavy metals are easily bind organic matters, especially in filter feeder process when the food get inside the biota bodies

and biomagnification is happened. So that, the more filtered food, the more accumulated heavy metals are inside the water biota.

3.2. The Profile of heavy metals (Pb and Cd) in the golden snails meats due to processing factors.

The profile of Pb content. The following histogram (Fig. 2) shows the decreasing of Pb content in various processing ways.

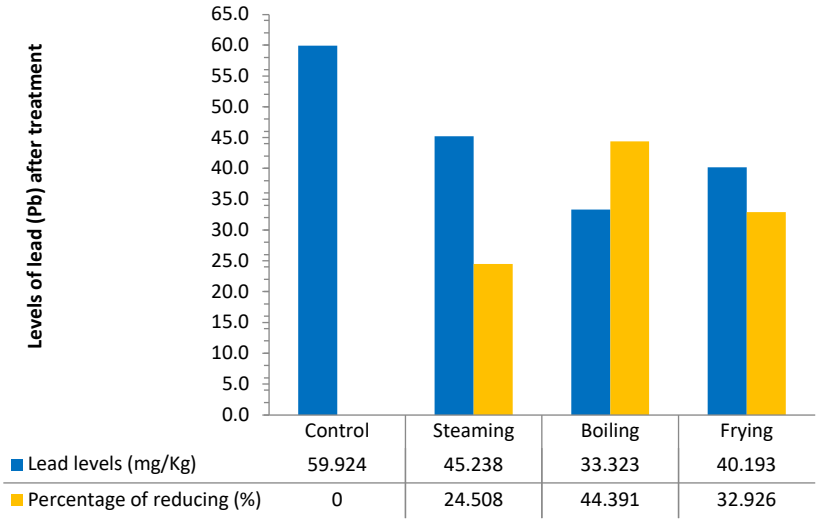

Fig 2. The Pb Content Decreasing (Percentage) in Various Processing Methods

Figure 2 depicts that the percentage of Pb content decreasing are different in various processing methods. By boiling, the percentage decreases for 44.39%; stir frying for 32.92%; and steaming for 24.50%. It can be seen that boiling is the most effective processing methods to decrease the Pb content, if conversed into ppm it equals to 0.0333ppm of Pb content trace. It is followed by stir frying (0.0401 ppm) and steaming (0.0452 ppm).

The Profile of Cd content. This following histogram (Fig. 3) shows the decreasing of Cd content in various processing methods.

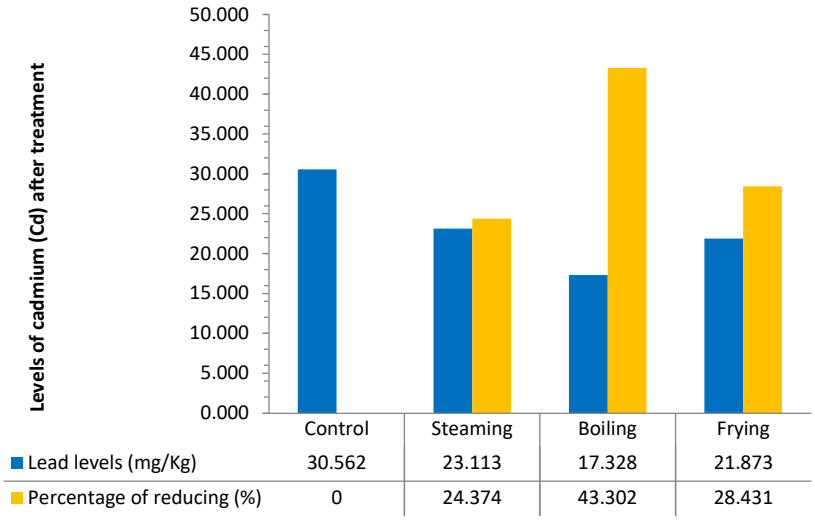

Fig 3. The Decreasing of Cd Content (Percentage) in Various Processing Methods.

Figure 3 shows that there is a decreasing of Cd content (percentage) in various processing methods. Boiling, stir frying, and steaming methods present these decreasing percentage respectively: 43.30%, 28.43%, and 24.37%. So, the most effective processing method is boiling, which only 0.0173 ppm of traced Cd. This number following by 0.0218 ppm (stir frying) and 0.0213 ppm (steaming).

3.2. The effect of various processing methods on the decreasing of Pb and Cd content.

The result of ANOVA test shows a significant decreasing of Pb and Cd content in golden snail meats (Pomacea canaliculata) due to various methods of food processing ($0{,}000 < \alpha = 0{,}05$). The processing methods are important techniques that should be done to reduce the heavy metal pollution content inside the food. These methods also can kill pathogenic microorganisms that endanger to the human body. Through certain processing methods, some toxic substances inside the food can be reduced or omitted completely. Commonly, high temperature is used to preserve food and exempt it from microbes [19].

The decreasing of Pb and Cd content is caused by the temperature used in food processing process that reach 100°C. The heat used in the process releases the bound heavy metals from the golden snail meats. In steaming process (B), the hot water vapors used in the process degrade the volatile heavy metals inside the golden snail meats and release them. Heating process can increase evaporation and chemical hydrolysis or degradation, so that decreases the residue level [20]. Meanwhile, boiling is the best and the most effective to reduce the Pb and Cd content in golden snail meats compare to two other process, steaming and stir frying. It is shown that Pb residue is only 0.0333ppm (44.39% of decreasing) and Cd residue is 0.0173 ppm (43.30%). Those low numbers are caused by boiling process, since the golden snail meats directly contact to boiling water (± 100°C) so that the high temperature spread evenly to the whole meat parts. The boiling water infiltrate the cell membrane by diffusion and dissolve the accumulated heavy metals within the tissues. Those numbers are also under the threshold

determined by the government (SNI) that is 1.5 mg/kg for Pb and 1.0 mg/kg for Cd. Nevertheless, it is still dangerous if they are consumed by human continuously since Pb is hard to be unraveled and can accumulated within the body [21].
The heavy metals like Pb and Cd are highly toxicity to human body. Lead can inhibit the hemoglobin (Hb) formation process thus can trigger anemic condition, central or peripheral nervous system disruption, renal and reproduction system disruption, imbecile in children, epilepsy, skeletal defects, and somatic cells disruption [22]. Lead that get into bloodstream can cause hypertension, increase the reactive oxygen species (ROS) production. ROS is a derivative of oxygen reacting to electron. Main source of ROS is cellular respiration and metabolism process [23].

The golden snails taken from DAM Raman waters after boiling process can be consumed 50.17 gr per week at most for a-60-kilo man, based on Pb Maximum Tolerable Intake (MTI) value. Moreover, based on Cd MTI value, the same man can consume up to 44.35 gram of golden snail meats per week.

The processing of golden snail meats is commonly conducted by people, such as boiling before trading in traditional market. Usually, the boiling process is done in order to ease the split the meat from its shell [24]. As mentioned before, it turns out that the heating process can also disrupt the plasm and organelle membranes, thus the heavy metals can be released easier from the tissue [25]. Besides cooking processes, washing and soaking using various types of lime and orange can also significantly reduce the lead and chromium content up to tolerant intake.

4 Conclusion

The cooking process of golden snail (*Pomacea canaliculata*) affects the declining of heavy metal content (Pb and Cd). This is shown statistically by value of sig. $0.000 < \alpha = 0.05$. The most effective method is boiling, which reduce the Pb content as much as 44.39%, and 43.40% for Cd. Those percentages equal to Pb residue of 0.0333 ppm and Cd residue of 0.0173 ppm.

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