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Metode Depurasi dengan Variasi Suhu dan Lama Perendaman pada Kerang Hijau (*Perna viridis*) Terkontaminasi Kadmium

Depuration Method with Various Temperature and Soaking Time in Green Mussels (Perna viridis) Contaminated Cadmium

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ABSTRAK

Aplikasi metode depurasi pada kerang hijau (*Perna viridis*) pada penelitian ini menggunakan perlakuan variasi suhu dan lama perendaman. Penelitian bertujuan untuk mengetahui kandungan logam berat kadmium pada kerang hijau di Pesisir Brebes sebelum dan sesudah dilakukan depurasi, persentase perubahan kandungan logam berat kadmium pada kerang hijau dan standar keamanan konsumsi kerang hijau di pesisir Brebes. Metode penelitian yang digunakan adalah metode kuantitatif dengan analisis menggunakan uji nonparametrik *Kruskal-Wallis* dan uji lanjut *MannWhitney*. Hasil penelitian menunjukkan kandungan logam berat Cd sebelum metode depurasi sebesar 0,10 mg/kg sedangkan sesudah metode depurasi menunjukkan nilai yang bervariasi dan seluruhnya masih dibawah batas baku mutu yang telah ditetapkan sebesar 0,2 mg/kg. Lama perendaman 24 jam menunjukkan hasil yang lebih baik dibandingkan perendaman 48 jam. Kategori nilai EDI dan THQ untuk seluruh perlakuan ialah tidak ada resiko kesehatan yang dapat ditimbulkan. Namun perlu memperhatikan batas maksimum konsumsi sebesar 4,55 ± 0,61 kg/minggu. Hal ini agar tidak berpotensi menimbulkan dampak kesehatan yang buruk akibat konsumsi kerang hijau dari pesisir Brebes yang telah terkontaminasi kadmium.

Kata Kunci: depurasi, kadmium, kerang hijau

ABSTRACT

The application of the depuration method to green mussels (Perna viridis) in this study used variations in temperature and soaking time. The research aims to determine the heavy metal content of cadmium in green mussels on the Brebes Coast before and after depuration, the percentage change in heavy metal cadmium concentration, and safety standards for the consumption of green mussels on the Brebes Coast. The research method used is a quantitative method with analysis using the nonparametric Kruskal-Wallis and Mann-Whitney tests. The research results showed that the heavy metal content of Cd before the depuration method was 0.10 mg/kg, while after the depuration method it showed varying values, all of which were still below the quality standard limit that had been set at 0.2 mg/kg. Soaking for 24 hours showed better results than soaking for 48 hours. The EDI and THQ value categories for all treatments are those that do not pose health risks. However, pay attention to the maximum tolerable intake (MTI) of 4.55 ± 0.61 kg/week. This is so that there is no potential for bad health impacts due to green mussel consumption from the Brebes coast, which has been contaminated with cadmium.

***Keywords**: depuration, cadmium, green mussels*

INTRODUCTION

Green mussels (*Perna viridis*) are a type of mussel that can be developed in a cultivation system because they grow quickly and cultivation activities can be carried out consistently throughout the year. Green mussels have a high level of survival against changing ecological conditions and are economically profitable for a cultivation system. (Sagita *et al*., 2017).

Green mussels are a commodity that is widely traded and exported abroad. The KKP report stated that the volume of Indonesian shellfish exports in 2019 reached 13.57 thousand tons with a total profit of US$ 17.3 million (KKP, 2020). However, there are drawbacks to this profitable food commodity, namely that green mussels have the possibility of accumulating heavy metals because they are sessile and filter feeders can't avoid pollutants, so they are very risky to human health when consuming them (Rejeki *et al*., 2022).

One of the heavy metals that has the potential to accumulate is cadmium, which comes from natural and anthropogenic activities (Jais *et al*., 2020; Suhani *et al*., 2021). The heavy metal cadmium (Cd) is a type of heavy metal that is toxic and dangerous (Pulungan & Wahyuni, 2021). The accumulation of the heavy metal cadmium in the bodies of biota will cause an increase in heavy metals in the body tissues of aquatic organisms (Kusuma & Supriyantini, 2022). This will certainly pose a high risk to the health of humans who consume green mussels, both short-term and long-term (Rahmaniyyah *et al*., 2023).

Cadmium has various toxicity mechanisms for damaging various organs. The organs targeted by cadmium are the kidneys and liver (Triwuri, 2017). The toxicity mechanisms include replacing sulfhydryl groups, essential ions, and enzyme groups (Bernhoft, 2013). The consequences of the cadmium toxicity mechanism include disorders of the blood vessel system, respiratory problems, bone growth disorders, and decreased liver and kidney function, which endanger health (Rosita & Andriyati, 2019) .

Referring to the things that can result from the accumulation of heavy metals, efforts are needed to reduce the heavy metal content. One effort is to carry out depuration (Aminin *et al*., 2020). Depuration is a step that can be taken to reduce the content of various contaminants in shellfish (Albores *et al*., 2020) .

Factors that influence the depuration rate include water temperature and soaking time (Riyadi *et al*., 2016). The filtration rate of green mussels will also decrease as the temperature increases (Kusumawati *et al.*, 2015). The temperature of the aquatic environment has an impact on the solubility of heavy metals in water (Rahayu & Mangkoedihardjo, 2022). The research results of Aminin *et al*. (2020) showed that the effect of soaking for 24 hours resulted in a better reduction in heavy metals than 8 hours.

In order to evaluate food suitability standards, it is necessary to assess several parameters, such as Estimated Daily Intake (EDI), Target Hazard Quotients (THQ), Maximum Weekly Intake (MWI) and Maximum Tolerable Intake (MTI). Therefore, this research is needed so that the post-harvest process of green mussels produces green mussels that are safe, suitable for consumption, and whose quality is maintained.

RESEARCH METHOD

Tools and Materials

The tools used in this research were a tray (22.5 x 10 x 8cm), grinder (Kris), oven (GSM Machinery), surgical tools, digital scales (50 x 0.001g), zip lock, container box (52 L), aerator, air stone, hose, cooler box, cable ties, and water heater. Meanwhile, the materials used in this research were green mussels (size 11.78 ±

1.52 cm and weight 90.75 ± 24.17 g), ice cubes, and sea water.

Time and Location of Research

The place used as a research location for sampling green mussels is in the waters of Brebes Regency, Central Java, Indonesia. Data was taken in January 2023 with data analysis carried out at the Ecobiology Laboratory of the Faculty of Fisheries and Marine Sciences, Jenderal Soedirman University and analysis of the concentration of the heavy metal Cadmium (Cd) carried out at the Aquatic Productivity and Environment Laboratory (ProLing) of the Bogor Agricultural Institute.

Research Methods

The method used in this research is the method of sampling green mussels (*Perna viridis*) measuring 11.78 ± 1.52 cm in the waters of Brebes Regency, in January 2023. The samples of green mussels obtained were then given depuration treatment in the laboratory. The treatment given was depuration application using temperature variations (control, 25°C, 30°C, and 35°C) and soaking time (24 hours and 48 hours).

Collection and Treatment Depuration

Samples were obtained from green mussel farmers in Brebes Waters, with the size of green mussels being 11.78 ± 1.52 cm. Green mussels come from ropes, wood, and bamboo that are installed in bodies of water. Container boxes, water heaters, and aerators were prepared, and after that, they were given ¾ full of sea water from Cilacap. The shells that have been taken are then put into each of the 3 container boxes, and a water heater has been installed in which there are 6 trays. Meanwhile, another container box was left without a water heater as a control.

Data Calculation

a. *Survival Rate* (SR)

The death of green mussels that have been treated with depuration is caused by different levels of stress. The number of live shellfish in the total samples taken is called the survival rate (Sanjayasari and Jeffs, 2019). The survival rate can be calculated using the following formula:

$$SR\ (\%) = \frac{N_t}{N_0} \times 100$$

Where SR states *survival rate* (%), N_t : Number of green mussels at the end of treatment (tail), N_0 : Number of green mussels at the beginning of treatment (tail).

b. Percentage Change in Heavy Metal Content

The parameters tested included the metal content the Cadmium (Cd) in green mussels (*Perna viridis*) before and after going through the depuration process. According to Chaerunnisa & Supardi (2021), to determine the magnitude of the reduction in heavy metal content in green mussels, it can be calculated using the formula:

$$I\ (\%) = \frac{I_0 - I_t}{I_0} \times 100$$

Where I shows the level of heavy metal content (%), I_0 : heavy metal content before (mg/kg), I_t : heavy metal content after (mg/kg).

c. *Estimated Daily Intake* (EDI)

The EDI value is based on the daily consumption level of seafood and the concentration of contaminants in the food. This value varies depending on human body weight (Purbonegoro, 2020). Calculation of the estimated daily intake (EDI) value according to (Rayyan *et al*., 2019) can be calculated using the formula:

$$EDI = \frac{EF \times ED \times IR \times C_m}{WAB \times TA}$$

Where EF indicates *exposure frequency* (365 days/year), ED indicates *exposure duration* (70 years based on the average life according to (Anandkumar *et al*., 2018; Keshavarzi *et al*., 2018; Liu *et al*., 2018)), IR shows *ingestion rate* (0.14 g/day based on shellfish consumption data in Brebes in 2022 (Central Statistics Agency, 2022)), C_m shows *Concentration of metal* (mg/kg), WAB shows Average body weight (60 kg), Meanwhile, TA shows *the average lifetime*

(70 years × 365 days/year, est, 25550 days).

d. *Target Hazard Quotient* (THQ)

Target Hazard Quotient (THQ) is the ratio of potential exposure to a substance where there are no adverse effects (Satriawan *et al*., 2021). The THQ value can be calculated using the following formula (Hidayati *et al*., 2022):

$$THQ = \frac{EDI}{RfD}$$

Where EDI shows *Estimated Daily Intake*, RfD shows *Oral Reference Dose* (According to USEPA, (1987) for the heavy metal Cd of 0.001 mg/kg/day).

e. *Maximum Weekly Intake* (MWI)

Maximum Weekly Intake (MWI) is the initial calculation stage before determining the MTI value of a food ingredient (Haeruddin *et al*., 2022). Maximum *weekly intake* or the maximum limit of contaminant concentration of food that may be consumed per week can be calculated using the following formula (Mirawati *et al*., 2016) :

$$MWI = W \times PTWI$$

Where MWI has units of mg/week, W indicates body weight (kg), PTWI is *Provisional Tolerable Weekly Intake* (Cd=0.007 mg/kg).

f. *Maximum Tolerable Intake* (MTI)

The maximum tolerable intake (MTI) value is a reference for avoiding the negative effects that heavy metals can have if they enter the body (Gafur & Abbas, 2022). The MTI value can be calculated using the following formula (Türkmen *et al*., 2009):

$$MTI = \frac{MWI}{Ct}$$

Where MTI has units of kg/week, MWI shows *Maximum Weekly Intake* (mg/week), Ct indicates the concentration of heavy metals in green mussels (mg/kg).

RESULTS AND DISCUSSION

The depuration method with variations in temperature and soaking time uses samples of adult green mussels (*Perna viridis*) with a length of 11.78 ± 1.52 cm and a weight of 90.75 ± 24.17 g. The total sample of green mussels used in this study was 192 individuals with 24 individuals for each treatment. However, in the depuration method with a treatment temperature of 35°C, soaking for 48 hours, there were 5 dead green mussels. Therefore, the *survival value obtained* in treatment H (temperature 35°C, soaking time 48 hours) was 79.2% while all the remaining treatments were 100%.

Content of the Heavy Metal Cadmium (Cd) in Green Mussels (*Perna viridis*)

The research results of the analysis of the heavy metal cadmium in green mussels (*Perna viridis*) before and after the depuration method can be seen in **Figure 1.**

The heavy metal content of cadmium after depuration showed varying results (*Kruskal-Wallis*, P≤0.01). The concentration of the heavy metal cadmium in green mussels with a soaking time of 24 hours after depuration had a lower value than that with a soaking time of 48 hours (*Mann-Withney*, P≤0.05). The cadmium concentration of all post-depuration treatments is categorized as not exceeding the maximum limit for heavy metal contamination in food for cadmium metal based on SNI:7387 (2009) of 0.2 mg/kg. The heavy metal content of cadmium before depuration application was 0.10 mg /kg.

The presence of the heavy metal cadmium in pre-depurated green mussels indicates that the samples used had been previously polluted in the waters of origin. Considering the many activities and industries around Brebes waters such as agriculture, settlements, ship landings, oil refineries, factories and other home industries (Zahroh *et al*., 2019; Yusuf, 2022). The Brebes water body has also been polluted by heavy metals such as Hg and As amounting to <0.5 ppm and Mg > 2.5 ppm (Suryono *et al*., 2018). Meanwhile, the content of the heavy metal cadmium in agricultural irrigation water in Brebes Regency reached 0.02 mg/L and was stated to have exceeded the set threshold value (Wijayanti *et al*., 2018). This can lead to the accumulation of heavy metals in sea waters. Remembering that irrigation water can flow into other water bodies such as rivers, lakes, seas and even oceans (Setiyono & Rahayu, 2018).

industries running around Cilacap Waters (Yudo, 2018; Wahyudi, 2022).

Research depuration tanks using a flooding system without regular water

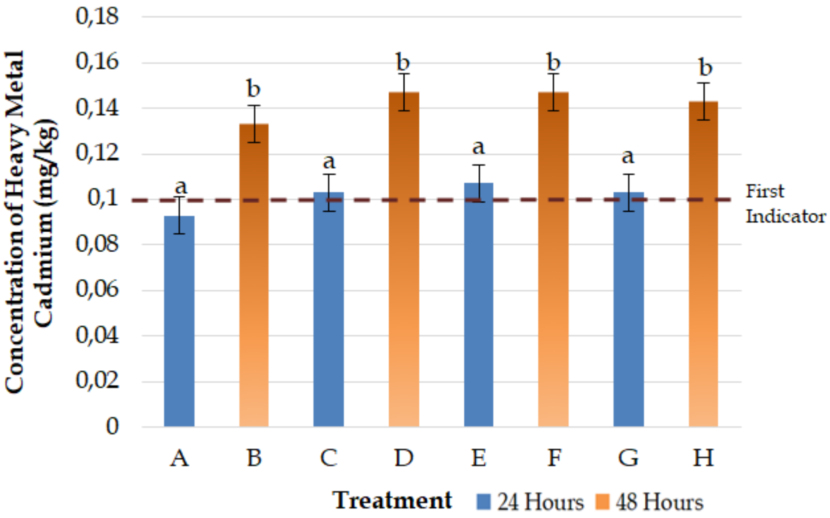

Figure 1. Content of B metal and Cadmium (Cd) in Green Mussels

Note: Different letters in the column indicate significant differences between treatments, (*Mann-Withney* , P≤0.05). Treatment A=control soaking time for 24 hours, B=control soaking time 48 hours, C=temperature 25°C soaking time 24 hours, D=temperature 25°C soaking time 48 hours, E=temperature 30°C soaking time 24 hours, F=temperature 30°C soaking time 48 hours, G=temperature 35°C soaking time 24 hours, H=temperature 35°C soaking time 48 hours.

The increase in the content of the heavy metal cadmium after depuration in almost all treatments is thought to be caused by the water source used as a soaking medium being polluted and not suitable for supporting the life of aquatic organisms. However, during the research, the concentration of the heavy metal cadmium and water treatment were not measured first. The water used as a soaking medium is sea water originating from the waters of Cilacap, Central Java. Cilacap waters in 2008 had concentrations of the heavy metal cadmium in the range of 0.004-0.050 mg/L. Then in 2014 it had a heavy metal content of cadmium of 0.024 mg/L (Hidayati *et al*., 2014). Meanwhile, from August 2015 to January 2016, the concentration of the heavy metal cadmium was 0.008 mg/L (Kasari *et al*., 2017). The year 2020 shows a concentration range for the heavy metal cadmium in water of 0.007 – 0.22 mg/L (Piranti *et al*., 2020; Hidayati *et al*., 2014). The concentration of the heavy metal cadmium can increase over time, especially with the large number of changes are only recommended for relatively shorter soaking periods such as 6 hours. Long soaking times in contaminated water conditions will cause a continuous risk of contamination (Syahid, 2017). Because variations in the length of immersion in stagnant water affect the heavy metal content in green mussels (*Perna viridis*) (Mahardhika *et al*., 2016).

The high content of the heavy metal cadmium during the soaking period of 48 hours is thought to be caused by placing *the tray* at the bottom of the container without any barrier to the bottom of the tub. This is in line with Marlinda *et al*. (2020) that heavy metals will go downwards following Earth's gravity and settle at the bottom of the waters. The high content of heavy metals at the bottom of the waters will affect the accumulation of heavy metals in organisms living around them through the feed filtration process (Suryani *et al*., 2018).

Water temperature is the main limiting factor for aquatic organisms which have a narrow tolerance range (Fauzia *et al*., 2016). The temperatures used in this research are room temperature, 25°C, 30°C and 35°C. Meanwhile, the temperature that shows the best results is room temperature. An increase in temperature every 10°C will increase the speed of chemical and biological reactions in aquatic organisms by 2 to 3 times. This increase in temperature will affect the metabolic rate which can result in high respiration due to increased oxygen consumption by aquatic organisms to compensate for ongoing chemical reactions (Muarif, 2016). Large green mussels tend to have lower metabolic capacity because they have passed their peak growth period (Os *et al*., 2014).

Temperatures in the range of 27.5 – 34°C are the temperature range that can still be tolerated by green mussel (*Perna viridis*) organisms (Haryanti *et al*., 2019). Meanwhile, from the results of research that has been carried out, the best depuration treatment is using room temperature with a response to reducing heavy metal content. This is thought to be because the temperature in the control tank is the optimum temperature and is more supportive of the life of green mussels. It is known that the room temperature without cooling is in the range of 26-27°C (Firdian *et al*., 2018). This is in line with the reference that the temperature that supports the life of green mussels is 26°C (Arrieche *et al*., 2020).

Water temperatures ranging from 33°C to 35°C can be said to be unfavorable for the life of green mussels and trigger the death of the organism (Nair & Appukuttan, 2003) . High temperatures can disrupt the enzymatic reactions of green mussels, causing protein denaturation which can ultimately trigger damage to protein structure and function (Noviyanti & Ardiningsih, 2013). This can be seen when the depuration process was in progress, there were 5 individuals of green mussels that died in the 35°C treatment with a soaking time of 48 hours, resulting in a *survival value* of only 79.2 %. The death of organisms is a form of response to organisms that cannot adapt to their environment (Suwarjono *et al*., 2019). According to Pratiwi & Sari (2019), a depuration process that results in the death of test organisms can result in re-contamination and a decrease in water quality.

Depuration is strongly discouraged in tanks with no flow rate. According to Lee *et al*. (2008) the minimum flow rate for the depuration tank is 20 liters/minute. Apart from that, the basic construction of the tank and sample tray must be made at a minimum angle of 1:100 or more towards the contaminant discharge point. So that excretory material and contaminants can be pumped towards the lowest position and then removed from the container for disposal. It is ensured that contaminants that have entered the disposal tank are not suspended, triggering re-accumulation.

Physiological factors in green mussels are also thought to influence the research results that have been obtained. It is known that the size of the green mussels used in this study was 11.78 ± 1.52 cm with a weight of 90.75 ± 24.17 gr. This is in line with references according to Purnomo *et al*. (2014), that depuration with variations in shell sample size has a significant influence on the depuration rate. The depuration rate results for large shells are relatively lower, only ranging between 0.052 – 0.071%/hour.

Percentage Change in Heavy Metal Cadmium Content

The calculation of the percentage change in the content of the heavy metal cadmium in green mussels (*Perna viridis*) after using the depuration method with variations in temperature and soaking time can be seen in **Figure 2.**

Based on the information presented in **Figure 2**, there are two responses to changes in heavy metal content after depuration, namely increasing and decreasing levels of the heavy metal cadmium. The result of reducing the content of the heavy metal cadmium using the depuration method only occurred in treatment A (24 hour soaking time control), namely 7%. Meanwhile in all other treatments there was an increase with a value range of 3 – 47%. This can be possible due to several factors including the use of temperature variations, soaking time and a less effective depuration system. Based on references according to Riyadi *et al*. (2016), stated that the optimal soaking time for the depuration process is 24 hours.

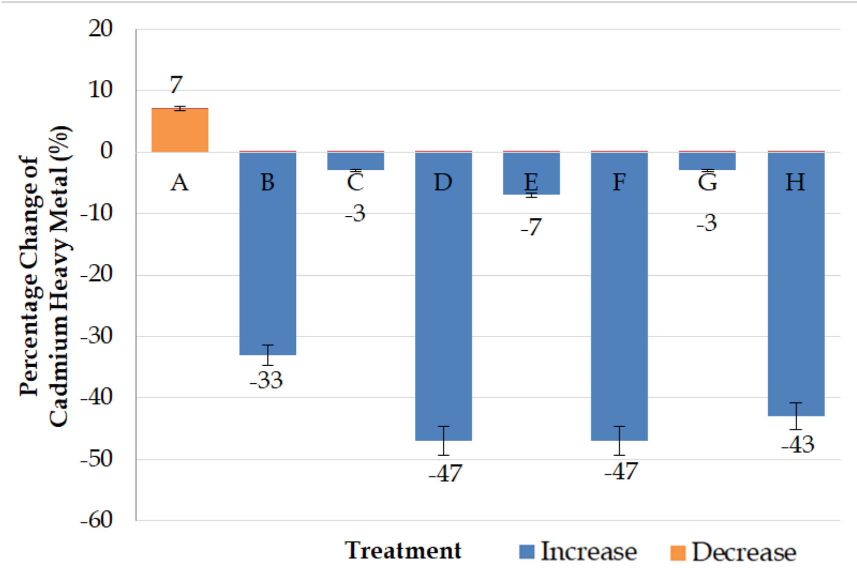

Figure 2. Percentage Change in Heavy Metal Cadmium Content in Green Mussels

Note: Positive values indicate a decrease in heavy metal content and negative values indicate an increase in heavy metal content. Treatment; A=control soaking time 24 hours, B=control soaking time 48 hours, C=temperature 25°C soaking time 24 hours, D=temperature 25°C soaking time 48 hours, E=temperature 30°C soaking time 24 hours, F = temperature 30°C soaking time 48 hours, G=temperature 35°C soaking time 24 hours, H=temperature 35°C soaking time 48 hours.

Based on Riswanti *et al*. (2023) that the longer the soaking time will increase the accumulation of heavy metals in green mussels. Depuration by immersing the media in stagnant water without regular water changes is not effective in reducing heavy metal contamination (Lee *et al*., 2008). The increase in heavy metal concentrations in biota is also influenced by the size of the biota, the number of organisms, and the physiology of the organisms (Pratiwi & Sari, 2019; Sari *et al*., 2017). In addition, the use of large amounts of green mussels that have previously been contaminated with heavy metals in their native waters may increase the contribution of heavy metal input in the soaking media which results in re-contamination (Syahid, 2017).

Consumption Safety Standards Based on EDI, THQ and MTI Values

Consumption safety standards can be estimated based on EDI (*Estimated Daily Intake*), THQ (*Target Hazard Quotient*) and MTI (*Maximum Tolerable Intake*) calculations. Based on the heavy metal cadmium content in green mussels (*Perna viridis*) that has been studied, it can be seen that the estimated EDI and THQ values are presented in **Table 1** and the MTI values are presented in **Table 2**.

Based on the information presented in **Table 1**, the EDI and THQ values for the heavy metal cadmium in green mussels (*Perna viridis*) with an assumed body weight of 60 kg have varying values (*Kruskal-Wallis*, $P \leq 0.01$). The EDI value with the 24 hour soaking treatment showed a tendency to lower values compared to the 48 hour soaking treatment (*Mann-Withney*, $P \leq 0.05$).

The estimated EDI value for all depuration treatments varies with a range of values from $22 \times 10^{-5} \pm 3 \times 10^{-5}$ to $34 \times 10^{-5} \pm 1 \times 10^{-5}$ mg/kg/day and shows a lower figure compared to the RfD value for metal cadmium weight. It is known that the RfD value for the heavy metal cadmium according to USEPA (*US Environmental Protection Agency*) is 0.001 mg/kg (USEPA, 1987). This indicates that people who consume green mussels contaminated with the heavy metal cadmium from Brebes waters do not have the potential to experience bad health risks as long as they observe the maximum consumption limit (Yap *et al*., 2016).

Meanwhile, the THQ value for all treatments shows a value of less than 1 or (∑THQ) < 1, so it can be indicated that consuming green mussels from Brebes waters does not pose any health risks. However, it should be noted that green mussels from Brebes waters have previously been contaminated with cadmium, so it is hoped that consumption should be maintained within reasonable limits or quantities (Rayyan *et al*., 2019). Because cadmium can move and increase in the food chain at trophic levels continuously (Suhani *et al*., 2021) .

After knowing the EDI and THQ values. Calculation of the MTI value is also needed to determine the maximum limit of consumption of green mussels that can be tolerated by humans. The following is a table of *Maximum Tolerable Intake* calculation results which can be observed in **Table 2**.

Table 1. *Estimated Daily Intake* (EDI) and *Target Hazard Quotient* (THQ) values

Treatment	***Estimated Daily Intake* (EDI) (mg/kg/day)**	***Target Hazard Quotient* (THQ)**
Early Indicators	23×10^{-5}	23×10^{-2}
A	$22 \times 10^{-5} \pm 3 \times 10^{-5a}$	$22 \times 10^{-2} \pm 3 \times 10^{-2a}$
B	$31 \times 10^{-5} \pm 1 \times 10^{-5b}$	$31 \times 10^{-2} \pm 1 \times 10^{-2b}$
C	$24 \times 10^{-5} \pm 1 \times 10^{-5a}$	$24 \times 10^{-2} \pm 1 \times 10^{-2a}$
D	$34 \times 10^{-5} \pm 1 \times 10^{-5b}$	$34 \times 10^{-2} \pm 1 \times 10^{-2b}$
E	$25 \times 10^{-5} \pm 1 \times 10^{-5a}$	$25 \times 10^{-2} \pm 1 \times 10^{-2a}$
F	$34 \times 10^{-5} \pm 1 \times 10^{-5b}$	$34 \times 10^{-2} \pm 1 \times 10^{-2b}$
G	$24 \times 10^{-5} \pm 1 \times 10^{-5a}$	$24 \times 10^{-2} \pm 1 \times 10^{-2a}$
H	$33 \times 10^{-5} \pm 1 \times 10^{-5b}$	$33 \times 10^{-2} \pm 1 \times 10^{-2b}$

Table 2. *Maximum Tolerable Intake* (MTI) Value

Treatment	Heavy Metal Content Cd x̄± Stdev (mg/kg)	PTWI (mg/kg)	MWI (mg/week)	MTI x̄± Stdev (kg/week)
Early Indicators	0.100	0.007	0.42	4.20
A	0.093 ± 0.012^{a}	0.007	0.42	4.55 ± 0.6^{b}
B	0.133 ± 0.006^{b}	0.007	0.42	3.15 ± 0.13^{a}
C	0.103 ± 0.006^{a}	0.007	0.42	4.07 ± 0.22^{b}
D	0.147 ± 0.006^{b}	0.007	0.42	2.87 ± 0.12^{a}
E	0.107 ± 0.006^{a}	0.007	0.42	3.95 ± 0.22^{b}
F	0.147 ± 0.006^{b}	0.007	0.42	2.87 ± 0.12^{a}
G	0.103 ± 0.006^{a}	0.007	0.42	4.07 ± 0.22^{b}
H	0.143 ± 0.006^{b}	0.007	0.42	2.93 ± 0.12^{a}

Based on the information in **Table 2**, the MTI value or maximum consumption of green mussel (*Perna viridis*) meat before the depuration method is 4.2 kg/week, while after the depuration method it varies in the range of 2.87 ± 0.12 up to 4.55 ± 0.61 kg/week (*Kruskal-Wallis*, P≤0.01). The MTI value with the 24 hour soaking treatment showed a tendency to be relatively larger compared to the 48 hour soaking treatment (*Mann-Withney*, P≤0.05).

Humans with an assumed body weight of 60 kg should only consume 2.87 to 4.55 kg of green mussels/week so that their health is not affected by the influence of the heavy metal cadmium. If people consume green mussels from Brebes waters that exceed the estimated maximum consumption limit, it can have negative health effects that are toxic (Hadinoto & Setyadewi, 2020). The negative impact on health if poisoned by the heavy metal cadmium can include breast cancer, respiratory problems, kidney failure and the most serious is death (Istarani & Pandebesie, 2014).

CONCLUSION

Conclusion

Based on the research that has been carried out, it can be concluded that:

1. The content of the heavy metal cadmium (Cd) in green mussels before and after depuration was still below the established quality standard limit of 0.2 mg /kg.
2. Changes in the percentage of heavy metal cadmium content after depuration for all treatments showed an increase except for the 24 hour control treatment which experienced a decrease of 7%.
3. Food safety standards for green mussels from Brebes waters are based on the EDI and THQ values for all treatments categorized as safe for consumption, but you need to pay attention to the maximum consumption limit (MTI) of 4.55 kg /week.

Suggestion

The advice given for further research is to pay attention to the water flow system, relatively short immersion and ensure that the immersion water source is free of contaminants.

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