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# BIOACCUMULATION OF Zn AND $^{137}$Cs IN *Glauconomya virens* (*Linnaeus, 176*) UPON EXPOSURE TO SIGLE AND MIXTURE OF Zn OR $^{137}$Cs AND SALINITY

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## ABSTRACT

This study aims to determine the effect of concentrations and salinity of seawater on the bioaccumulation of zinc and cesium in the *Glauconomya virens.* Salinity conditions and contaminant concentrations in the marine environment can change due to weather and other inputs. A biokinetic experiment was carried out using a single compartment approach that used radiotracer $^{65}$Zn and $^{137}$Cs. The experiments conducted were biota collection, acclimatization, bioaccumulation, and elimination. Acclimatization aims for the adaptation of biota in an experimental environment. Bioaccumulation was by placing the biota in an aquarium containing seawater media spiked by $^{65}$Zn, Zn, and $^{137}$Cs radiotracer contaminants. The elimination process was the release of contaminants from the body of the biota by placing them in clean and flowing seawater. The experimental results show that the uptake and elimination of Zn and Cs were influenced by these two parameters (water concentration and salinity). The highest value of Concentration Factor (CF) for Zn was 11.14 ml.g$^{-1}$ under influences its concentration of 0.7 ppm in water. In the depuration process, Zn maintained by G virens were 39.44; 31.17; 23.62; and 23.92% after these organisms accumulate this element from seawater containing 0.1; 0.3, 0.5, and 0.7 ppm, respectively. The highest of $^{137}$Cs under influences its concentration of 3 Bg.ml-1 reached 2.65 mL.g$^{-1}$. The effect of salinity is directly proportional to the factor value of Zn and $^{137}$Cs concentration.



Keywords: bioaccumulation; *glauconomya virens*; zinc; cesium

## INTRODUCTION

One of the effects of industrial activities in coastal waters can increase metal contamination. Metal contamination is hazardous for marine organisms and humans who consume it so that this problem must receive special attention and good handling (Rainbow & Luoma 2011). Heavy metals released into the water pose a serious threat to human and animal health (Koropitan & Ikeda 2016).

Zinc is an essential element of the earth's crust that can be released through the process of erosion and weathering into the marine environment (Pouil et al., 2017). Besides, zinc is released in large quantities into the environment through mining, iron sulfide or refining, leaching of mine tailings, floods, and agricultural wastes (Krężel & Maret 2016). The effect of toxicity occurs when the absorption of metals is exceeded, and then their excretion is extracted. Over time there is a buildup of metals that are toxic to the body. Although Zn is an essential metal for animals, plants, and humans, concentrations of Zn in mil-

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limolar (mM) are toxic. Zn is a metal pollutant that cannot be degraded, and it can survive in the environment and accumulate (Wadige et al., 2014). Zinc can form stable complex glutathione and can reduce the ability of antioxidants to increase ROS or inhibition of free radical scavengers related to defense glutathione reductase (redox enzymes such as thiol-containing) as an antioxidant (Wadige et al., 2014).

Radionuclide $^{137}$Cs is one of the radioactive contaminants from loose nuclear activity (Ashraf et al., 2014). Radionuclide $^{137}$Cs are a fission product and become an environmental concern due to their high mobility to the waters and accumulated by marine organisms (Prihatiningsih et al., 2016a). This radionuclide can cause epithelial cell hyperplasia in the gills of fish in the secondary branch lamellae, hypertrophy of pillar cells, and blockage of blood vessels. This radionuclide can cause epithelial cell hyperplasia in the gills of fish in the secondary branch lamellae, hypertrophy of pillar cells, and blockage of blood vessels. The urgency of this research is that Jakarta Bay receives various heavy metal contaminants (such as Zn) from several related industrial sectors and the possibility of releasing $^{137}$Cs from the nuclear reactor and its supporting facilities in Serpong (Melinda et al., 2015; Prihatiningsih et al., 2016; Suseno et al., 2018).

Bioindicators are needed to monitor the Jakarta Bay environment (Koropitan & Ikeda 2016). Bivalves are used as a biomonitor of contaminants in the marine environment because bivalves are a good biomonitor, have a long and settled life, also easy to handle due to their pliable tissue mass for metal analysis. Bivalves fulfill most characteristics of good biomonitor, so it is often used. The seawater bivalve *Glauconomya virens* (Linnaeus, 176) chosen in the present study also has these characteristics. *G.virens* contain fatty acids (omega-3 and omega-6) (Abdullah et al., 2016). These shells are native species of the Indo-Pacific region and scattered from the southern tropical Pacific, the Philippines, Cambodia, Myanmar, Laos, Vietnam, Thailand, Malaysia, Singapore, Indonesia and northern Australia (WHO 1983). Limited bioaccumulation studies of Zn and $^{137}$Cs that used radiotracer have been conducted (Suseno et al., 2016). Bioaccumulation of metals in the soft tissue of *Patella Aspera* been studied (Cravo & Bebianno 2005). Characterization of $Zn^{2+}$ and $Cd^{2+}$ mainly on the cell wall followed by intracellular accumulation have been studied (Lin et al., 2012). The mycelium was deformed, aggregated, and formed precipitate of zinc and cadmium on the cell surface (Lin et al., 2012). There is a correlation of Zn bioaccumulation by *M. galloprovincialis* against ocean acidification (Passarelli et al., 2018). However, these studies used the non-radiotracer technique. Furthermore, the bioaccumulation study of Zn in Jakarta Bay still limited.

Bioaccumulation studies of $^{137}$Cs have been carried out using various species of marine organisms. Temperature and salinity effects on bioaccumulation, gill structure, and radiation dose estimation in the milkfish *Chanos chanos* exposed to $^{137}$Cs (Prihatiningsih et al., 2016). Furthermore, the study used a double-tracer radioisotope to assess the simultaneous bioaccumulation of cesium in the olive flounder *Paralichthys olivaceus* (Hansman et al., 2018) and its bioaccumulation by egg and juvenile life stages of a small shark (Jeffree & Johansen, 2017).

This study used *G. virens* as a biomonitor of Zn and $^{137}$Cs in the coastal area. This study aims to understand the bioaccumulation of Zn and $^{137}$Cs influenced by the concentration and water salinity. The concentrations of these two pollutants and the water salinity change depending on their release and climate. On the other hand, very little bioaccumulation of data from the tropics. Most data are from the subtropical region. Tropical data are needed for MODARIA (Modeling and Data for Radiological Impact Assessments), International Atomic Energy Agency project. The results of this research are expected to contribute data on the bioaccumulation ability of Zn and Cs-137 by tropical benthic to the international project database (IAEA MODARIA) (Periáñez et al., 2016).

## METHODS

The stages of the experiment consisted of acclimatization (Herve-Fernandez et al., 2010; Reinardy et al., 2011), bioaccumulation, and depuration. Individuals of *G. virens* were acclimatized for three weeks at laboratory conditions. The condition of acclimatization was 400-L, aquariums continuous open-air circuit with 10% renewed filtered water carbon, salinity of 29.5, temperature 30 ± 1.0 °C and light/dark cycle 12 hours/12 hours). During acclimatization, *G. virens* were fed with a combination of *isocrysis galbama* and *skeletonema*. The same feeding regime was maintained during experimental exposures where *G. virens* were fed several quickly consumed foods. Furthermore, the experiments were carried out at the PTKMR -National Nuclear Energy Agency's aquatic Laboratory, Jakarta. The experiment method refers to Jeffree et al. (2010). The uptake experiment was carried out for 14 days, and the elimination experiment was carried out for seven days

An experiment of influences of Zn concentration was carried out in a 15 L aquarium. These aquariums were filled with sea water aerated by air from outside at pH 8,3 ± 0.1; the salinity of 29.5 ‰; temperature 27 ± 0.5 °C; light/dark cycle 12 h/12 h (representation of condition in Jakarta bay environment). Conductivity, dissolved oxygen, temperature, and pH of the water were measured once a week. *G. virens* were put in aquariums. One aquarium as control without $^{65}$Zn and four aquariums enriched with stable zinc (0,1; 0,3; 0,5; 0,7 ppm) and $^{65}$Zn. Aquarium was spiked amounts of $^{65}$Zn (5 Bq.mL$^{-1}$), and three individuals *G. virens* (per aquarium) were incubated for several days under the same conditions of temperature, pH, and light as previously described. After 24 hours, all shells were processed as described below to measure the amount of $^{65}$Zn. After that, all specimens were depurated in aquariums containing unpolluted seawater for several days and were analyzed for their Zinc content

The second experiment was designed to assess the effect of salinity (23‰, 25‰, 27,6‰) on zinc uptake. Three shells *G. virens* were put in three 15 L aquariums containing 10 L filtered seawater and incubated at a constant temperature. The seawater was spiked with stable Zn ($ZnSO_4$) 0,5 ppm in the aquariums. Then the aquariums were spiked with trace amounts of $^{65}$Zn (5 Bq.mL$^{-1}$) and were incubated under the same conditions. After 24 hours, all shells were processed as described below to measure the amount of $^{65}$Zn used gamma spectrometer. All specimens were depurated in aquariums containing unpolluted seawater for several days and were analyzed for their zinc content.

The third experiment was designed to investigate the concentration-dependent bioaccumulation Cesium in *G. virens*. Five aquariums (15L) were filled with 10 L of filtered seawater; One aquarium as control, and four aquariums with stable cesium. To obtain the following concentrations (in triplicate): 1, 2, 3, 4, and 5 Bq.mL$^{-1}$, the aquariums were then spiked amounts of $^{137}$Cs (2 Bq.mL$^{-1}$), and three *G. virens* (per aquaria) was incubated for several days under the same conditions of temperature, pH, and light as previously described. After 24 hours, all shells were processed as described below to measure $^{137}$Cs using a gamma spectrometer. All specimens were depurated in aquariums containing unpolluted seawater for several days and were analyzed for their $^{137}$Cs content. The fourth experiment was designed to assess the effect of salinity (23‰, 25‰, 27,6‰) on cesium uptake. The salinity of seawater in the aquarium was set according to specified and spiked with $^{137}$Cs. The same step was carried out as the above experiment. Radionuclide analysis was performed using a high-resolution gamma spectrometer consisting of a Canberra GC GC 2020 type HPGE detector connected by a multi-channel analyzer and personal computer for spectra analysis (Gennie).

Bioaccumulation is influenced by influx (system entry) and efflux (exiting the system) to be very dynamic (Prihatiningsih et al., 2016b). The accumulated concentration is affected by the balance between influx and efflux. Bioaccumulation occurs when the influx flow is greater than the efflux flow. Simply, organisms are treated without considering internal transportation as a single compartment. Several kinetic models are needed to simulate this model. Absorption of contaminants or bioaccumulation concentrations can be calculated by the following equation that is defined as Bioconcentration Factor (BCF) (Wang, 2016). Simply, The concentration (bioaccumulation) of a contaminant in an organism (box) is determined by the ratio between influx and efflux if the organism (box) can be viewed as a single compartment (or box) without considering any internal transportation. Bioaccumulation is a highly complex mechanism that is influenced by both incoming (influx) and outgoing flows (efflux) (Wang, 2016).

Since kinetic modeling is not limited by equilibrium considerations, it can simulate contaminant bioaccumulation kinetic changes over time. Several kinetic models have been developed, ranging from the simplest one-compartmental model to multicompartmental models. The uptake of contaminant from the dissolved phase is known as the Bioconcentration Factor (BCF). The following equation can calculate it:

$$BCF = \frac{C}{Cw}$$

C is the contaminant concentrations in the organisms (mg.Kg$^{-1}$) under equilibrium condition, Cw is the contaminant concentration in the water (mg.L$^{-1}$). BCF gives important information about the ability of an organism to take up contaminants from the seawater. BCF can also be calculated with known $K_u$ (influx rate) and $K_e$ (efflux rate) to estimate contaminant concentrations under steady-state conditions (Wang, 2016). BCF is a key concept in environmental risk management since it provides objective information on a contaminant's ability to be grasped by organisms from water (Wang, 2016). It will then be possible to determine the pollutant concentrations under

steady-state conditions employing known $K_u$, $K_e$, and Cw. BCF can also be calculated using the two kinetic parameters:

$$BCF = \frac{Ku}{Ke}$$

The following equation can simulate the simple kinetic model one compartment:

$$\frac{dC}{dt} = k_u . C_w - k_e . C$$

$K_u$ is the influx rate constant from water, Cw is the contaminant concentration in the water (mg.L$^{-1}$), $K_e$ is the efflux rate constant, and C is the accumulated concentration (mg.g$^{-1}$). After integration, the accumulated concentration of a contaminant at time t can be described by the following equation:

$$C_t = k_u \times \frac{C_w}{k_e} \times \left[1 - e^{-k_e t}\right]$$
$$C_t = C_{Fss}\left[1 - e^{-k_e t}\right]$$
$$\ln C_t - \ln C_{Fss} = -k_e t$$

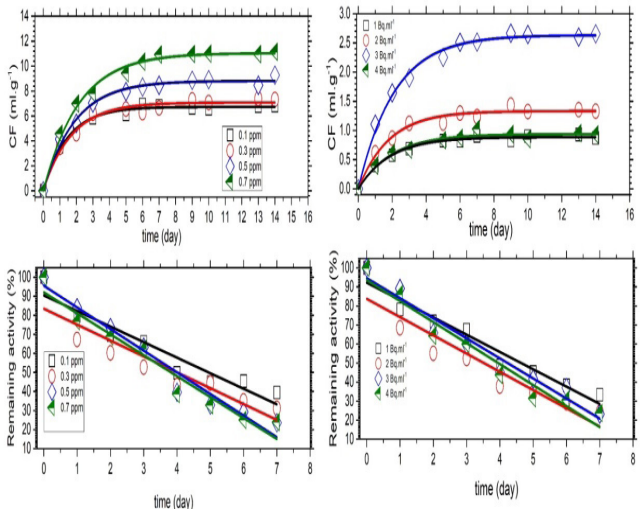
Under the steady-state condition, = 0, calculated as (Wang 2016):

$$C_{ss} = k_u x \frac{C_w}{k_e}$$

## RESULTS AND DISCUSSION

Currently, the behavior of zinc in seawater is not well understood, but the principal dissolved species is probably $Zn^{2+}$ with "colloidal" and "particulate." The amount of zinc in seawater depends on concentrations and types of particles and dissolved materials. Zinc is biologically active in metalloenzymes, although the actual metabolic requirement for zinc by organisms is probably relatively low to the availability of the element in seawater (Fowler et al., 1971). Unlike $Zn^{2+}$, $^{137}Cs$ is not biologically active and a fission product. It is inversely related to the availability of potassium. However, it was chemically similar to potassium (the principal dissolved species in seawater is $Cs^{+}$) (Fowler et al., 1971).

Many people consume Bivalvia G. virens as seafood. On the other hand, this organism can be used as a potential biomonitor to evaluate zinc contamination in seawater. Accumulation of zinc concentration in all body tissues of *G. virens* reflects zinc exposure and shows zinc accumulation depending on exposure under steady conditions (Wadige et al., 2014). A high percentage of zinc accumulation in hepatopancreas tissue, such as protein and metal-rich granules, is detoxified and stored in metallothionein. 59-70% of zinc accumulated in biologically active metal pools is stored in the lysosome microsomal fraction. The ability of *G. virens* to accumulate and depurate Zn was represented as a concentration factor (CF). CF value is a ratio of the $^{65}Zn$ concentration in *G. virens* to $^{65}Zn$ concentration in water. Based on Figure 1A, an increase in Zn concentration in seawater can increase the ability of this mollusk accumulation to Zn.




(A) (B)

**Figure 1.** Influence Concentration of Zinc (A) and $^{137}Cs$ (B) to Bioaccumulation and Elimination Processes

Increasing zinc exposure resulted in decreased total antioxidant capacity and measurable increases in the sublethal effects, lipid peroxidation, and observed lysosomal membrane destabilization (Wadige et al., 2014). At Zn concentration of 0.1 ppm, the CF value on the first day was 3.54 mL g$^{-1}$ and the last day was 6.82 mL.g$^{-1}$. At Zn concentration of 0.3 ppm, the CF value on the

first day was 3.47 mL.g$^{-1}$, and the last day was 7.31 mL.g$^{-1}$. At a concentration of 0.5 ppm, the CF value on the first day was 4.15 mL.g$^{-1,}$ while the last day reached 9.27 mL. g$^{-1}$. The CF value at the highest concentration of 0.7 ppm reached 4.57 mL.g$^{-1}$ on the first day, while the last day reached 11.14 mL.g$^{-1}$. This data shows that the higher the Zn concentration in the water, the higher the Zn exposure can accumulate in *G. virens*. Zn exposure accumulated on *G. virens* represented by CF values increases until it reached a steady-state on the 10th day. A steady-state was a condition when the condition or nature no longer changes in a specific time (has reached equilibrium). In this case, influx and efflux in the body of the biota occur at the same rate, resulted in a balanced condition (Wang, 2016). In steady-state conditions, the resulting CF tends to be constant. On the 13th and 14th days, CF values decreased due to disruption of the metabolic process in biota due to the high exposure of Zn accumulated. High concentrations of Zn can interfere with the metabolic processes in biota by reducing the ability of bioaccumulation (McGeer et al., 2003).

Zinc can indirectly increase ROS by depletion of antioxidant capacity via the formation of more stable coordination complexes with glutathione (GSH) and/or alteration or inhibition of free radical scavengers such as thiol-containing redox enzymes related to antioxidant defenses glutathione reductase (GR) (Krężel & Maret 2016). Decreased concentration Zn in the *G. virens* during the elimination process is represented by percent retention (percentage of contaminants held in the *G. virens*). The retention percent value is the ratio of Zn concentration in *G. virens* on certain days of depuration to concentration Zn on the last day of the bioaccumulation process, shown in Fig 1, the process of elimination occurs in all biota. Different concentration is produced different from percent retention. On the last day of the elimination process, Zn maintained by *G. virens* were 39.44; 31.17; 23.62; and 23.92% after these organisms accumulate this element from seawater containing 0.1; 0.3; 0.5; and 0.7 ppm, respectively. Zn concentration in *G. virens* (after accumulated Zn from seawater 0.5 ppm and 0.7 ppm) in the elimination process decreased dramatically.

Figure 1B shows the effect of $^{137}$Cs concentration on bioaccumulation and elimination by *G. virens*. The different concentrations of $^{137}$Cs in the seawater affected the concentration factor (CF) of $^{137}$Cs. The Cs concentration in the environment tends to change (Wang, 2016). As the high $^{137}$Cs concentration in seawater will increasingly accumulate in *G. virens*. In this study, *G. virens* were simulated in aquatic conditions containing $^{137}$Cs with concentrations of 1, 2, 3, and 4 Bq.mL$^{-1}$. Based on Figure 1B, the CF value at the $^{137}$Cs concentration of 1 Bq.mL$^{-1}$ was 0.4 0 mL. g$^{-1}$ on the first day and last day at 0.87 mL. g$^{-1}$. At $^{137}$Cs concentration of 2 Bq.mL$^{-1}$, the CF value on the first day was 0.62 mL. g$^{-1,}$ and the last day was 1.33 mL. g$^{-1}$. At the $^{137}$Cs concentration of 3 Bq.ml$^{-1}$, the CF value on the first day was 2.21 mL. g$^{-1}$ and the last day reached 2.65 mL. g$^{-1}$. The CF value at $^{137}$Cs concentration of 4 Bq.ml$^{-1}$ reached 0.40 mL.g$^{-1}$ while the last day reached 0.93 mL.g$^{-1}$. At concentrations of 1 to 3 Bq.ml$^{-1}$, exposure to $^{137}$Cs in *G. virens* increased with increasing Cs concentration until it reached a steady-state on day 9. However, at a concentration of 4 Bq.ml$^{-1}$, CF values represented concentrations exposed to *G. virens* decreased. It is assumed that the high concentration of $^{137}$Cs damaged the metabolic system in biota so that the bioaccumulation process that occurs was not optimal (McGeer et al., 2003). In the depuration process, the elimination of $^{137}$Cs from G. *virens* tends to be greater in organisms exposed to 137Cs 2 Bq.ml$^{-1}$. Correlation between CFss to the contaminant concentration was shown in Figure 2 dan Figure 3.

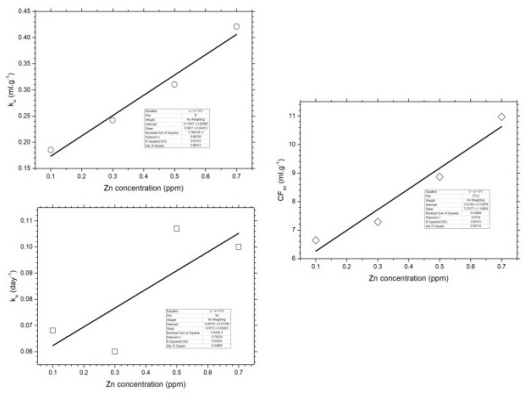



**Figure 2.** Influence the Concentration of Zn to the Constant Value of Uptake and Elimination and BCF

The bioaccumulation rate uptake constant ($K_u$) can explain the daily ability of biota to accumulated $^{137}$Cs and Zn in a certain period. On the other hand, it represents the process of releasing contaminants from the body of the biota. In Figure 3 and 4, the most significant uptake rate is found at the highest concentration of 0.7 ppm for Zn metal and 4 Bq for $^{137}$Cs, while the lowest is concentration 0.1 ppm for Zn metal and 1 Bq.ml$^{-1}$ for Cs.

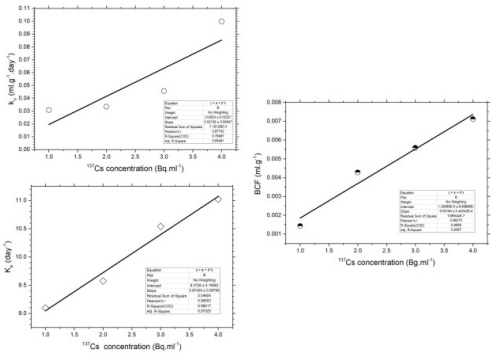
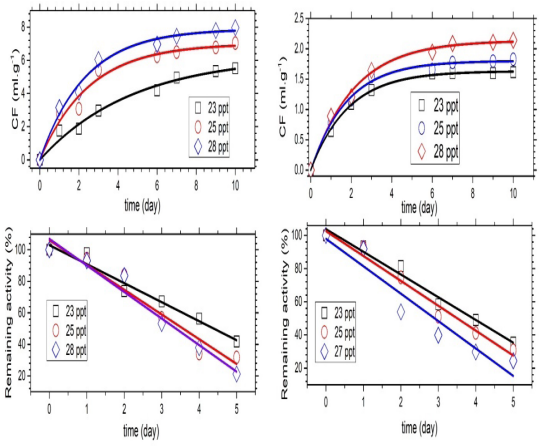


**Figure 3.** Influence the Concentration of $^{137}$Cs to the Constant Value of Uptake and Elimination and BCF

Salinity is defined as the weight in grams of dissolved inorganic matter in one kilogram of water (Stumm & Morgan, 1996; Pouil et al., 2018). It is therefore expressed as S‰ – in parts per thousand. Seawater has a remarkably constant salinity between 33‰ and 37‰. Salinity is also commonly measured by the electrical conductivity of the water, or more correctly, its specific conductance (Stumm & Morgan, 1996). In this study, *G. virens* were simulated in water with a salinity of 23 ‰, 25 ‰, and 28 ‰. The present trend of global warming has led to an increase in seawater salinity. The effects of increasing salinity on the accumulation of $^{137}$Cs by *G. virens were* studied under laboratory conditions to obtain information on *G. virens* adaptability under environmental changes. Our study indicated that the Cs uptake was considerably affected by ambient salinity, consistent with many previous observations on the effects of salinity on bioaccumulation. The concentration factor of cesium increased with salinity at the range of 26 to 29‰ and decreased from 32 to 35‰. The reason is that the salinity in the range of 26 to 29 ppt is the ideal condition for the bivalve so that the bioaccumulation process is complete. The optimal salinity for bioaccumulation in *Chanos chanos* was 29‰ (Prihatiningsih et al., 2016). A two-compartment model showed that Cd uptake rates in the digestive gland also increased as salinity decreased. However, no difference was observed in Cd uptake rates of *C.gigas* in the three higher salinities in the mantle. Cd depuration rates followed a reverse trend (Sun et al., 2018). In this study, the Zn concentration in seawater used was 0.5 ppm. The selection of these concentrations was based on the optimum uptake of the concentration-effect group. The pH of seawater used was 8.3. Based on Figure 4A and Figure 5, the effect of salinity is directly proportional to the factor value of Zn concentration.




(A) (B)

**Figure 4.** Effect of Salinity on Zinc (A) and $^{137}$Cs (B) to Bioaccumulation and Elimination Processes

At a salinity of 23 ppt, the CF value on the first day was 1.76 mL.g$^{-1}$ and 5.52 mL.g$^{-1}$ on the last day, showed a tendency to rise to the sixth day before entering a steady state on the seventh day. At 25 ppt salinity, the CF value increased by 2,79 mL.g$^{-1}$ on the first day and 7,04 mL/g on the last day, increased significantly from the second to the sixth day, and added value 3.07 mL.g$^{-1}$ to 6,24 mL.g$^{-1}$.

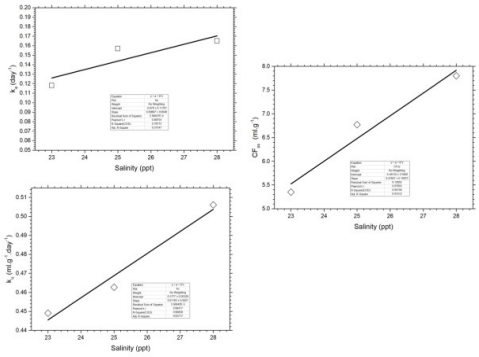



**Figure 5.** Effect of Salinity on the Constant Value of Uptake and Elimination of Zn

The CF value continued to increase until the sixth day and entered a steady-state on the seventh day. In salinity of 27 ppt, the highest CF value is 3.16 mL.g$^{-1}$ on the first day and 7.97 mL.g$^{-1}$ on the last day.

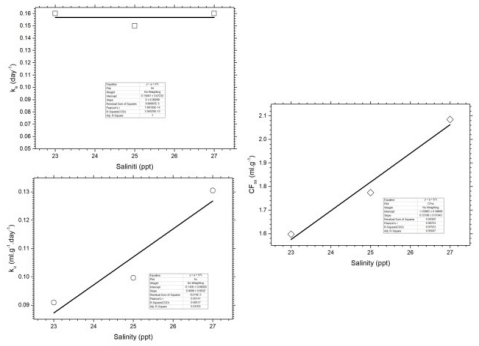



**Figure 6.** Effect of Salinity to the Constant Value of Uptake and Elimination of $^{137}$Cs

It demonstrated that the variability of cesium uptake at different salinities was primarily due to a change in ambient $K^+$ concentration (Ke et al., 2000; Baramanda et al., 2020). Generally, small increases in salinity and temperature increase the cesium uptake and biological activity (Prihatiningsih et al., 2016). In this study, the concentration of Cs in seawater used was 3 Bq.ml$^{-1}$. The selection of these concentrations was based on the optimum uptake of the concentration-effect group. The pH of seawater used was 8.3. Based on Fig 5, the effect of salinity directly proportional to the factor value of $^{137}$Zn concentration. Bioaccumulation of Cs metal in the *G. virens* increased when salinity increased through an increase in the $^{137}$Cs concentration factor. At salinity 23 ppt, the CF value on the first day was 0.64 mL.g$^{-1}$ and 1.61 mL.g$^{-1}$ on the last day. It showed a tendency to rise to the sixth day before entering steady-state on the 7th day. At 25 ppt salinity, the CF value increased 0.77 mL.g$^{-1}$ on the first day and 1.82 mL.g$^{-1}$ on the last day. The CF value continued to increase until the sixth day and entered a steady-state on the seventh day. In the last salinity of 27 ppt, the highest value of CF is 0.89 mL.g$^{-1}$ on the first day and 2.14 mL.g$^{-1}$ on the last day.

Based on Figures 5 and 6, the bioaccumulation process of Zn and Cs was carried out for ten days. There was a correlation between CFss of Zn to salinity and CFss of Cs to salinity. The bioaccumulation rate constant (Ku) can be obtained by using the slope of each salinity range and explain the daily ability of biota to accumulated $^{137}$Cs in a certain period. In Fig 6, the highest contamination rate is found at salinity 27 ppt for

Zn metal, while the lowest is the salinity of 23 ppt. Figure 6 shows the correlation between the $K_u$ value (contamination rate) and the increased salinity. For Cs, the highest contamination rate is found at the salinity of 27 ppt and the lowest in the 23 ppt. There was a correlation between the $K_u$ value and the increased salinity. Based on Fig 5 and Fig 6, the elimination process occurs in all biota. On the last day of elimination process, percent retention Cs at concentration 1; 2; 3; and 4 $Bq.ml^{-1}$ are 33.35; 24.12; 23.24; and 23.71 %. High $^{137}Cs$ concentration in *G. virens* decreased dramatically compared to low $^{137}Cs$ concentration. It shows that the acclimatization process of *G. virens* in an uncontaminated seawater medium can reduce accumulated contaminants in *G. virens*. Figure 6 show variation of concentration affects a decrease of contaminant $^{137}Cs$. From the first day until the fourth day, there was a significant decrease in the concentration of Cs contaminants. Whereas from the fifth to seventh day the decrease in $^{137}Cs$ concentration was not too significant.

The release of contaminant rate (Zn and $^{137}Cs$) in *G. virens* is represented by the value of the elimination rate constant ($K_e$), obtained from the slope of the curve of the relationship between time (day) and percent retention. The relationship of the variation of contaminant (Zn and $^{137}Cs$) concentration to $K_e$ is shown in Fig. 5 and Fig 6. The contaminant released rate with concentration is quite linear, shown by linear regression Zn and $^{137}Cs$. It explains the concentration to affects the released rate of Zn and $^{137}Cs$ in the *G. virens.*

## CONCLUSION

The highest CF value for Zn was 11.14 $ml.g^{-1}$ under influences of its concentration of 0.7 ppm in water. In the depuration process, Zn maintained by *G. virens* was 39.44; 31.17; 23.62; and 23.92% after these organisms accumulated this element from seawater containing 0.1; 0.3; 0.5; and 0.7 ppm, respectively. The highest of $^{137}Cs$ under influences of its concentration of 3 Bg.ml-1 reached 2.65 mL. $g^{-1}$. The effect of salinity is directly proportional to the factor value of Zn and $^{137}Cs$ concentrations. Increasing the concentration of zinc in seawater from 0.1 to 7 ppm will increase the value of the Bio Concentration Factor because besides accumulating in the tissue, Zn is also needed as an enzyme cofactor. With the increase in the $^{137}Cs$ concentration from 1 to 4 Bq, its accumulation ability increases because in that concentration range, the impact of radiation exposure can still be tolerated by the bivalve.

## ACKNOWLEDGEMENTS

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