

# Stirring Chamber Design Development to Increase the Potention of Chicken Egg Shells to Decrease Cadmium (Cd) Level in Blood Cockle (*Anadara Granosa*)

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## ABSTRACT

A study about chicken egg shells as an adsorbent to decrease Hg level in blood cockle (*Anadara granosa*) has been done by Suryono in 2017, its results showed that chicken egg shells could decrease Hg level in blood cockle. The lowest level of Hg (0.545 ppm or 93.64%) was using 45 minutes of stirring process with 75 grams of chicken egg shells, there was a significant difference of Hg level in blood cockle before and after the process. The Hg level decrease from 0.582 ppm to 0.037 ppm. Those processes include the use of chicken egg shells as adsorbent cannot reduce all the level of Hg. This study used One Group pretest-posttest Design. Samples were blood cockle (*Anadara granosa*). Stirring chamber was a food sanitation tool, it had ability to decrease heavy metal level such as Cd in blood cockle using the stirring and adsorbent temperature principles. Samples were taken using purposive sampling. There were 9 treatments and 3 replications. The stirring process was done in 15 minutes using 50 rpm, 150 rpm, and 250 rpm of speed. The adsorbent temperature were 35°C, 50°C and 65°C, it used 50 grams of chicken egg shells (adsorbent) in 1 liter of water. The results showed that blood cockle (*Anadara granosa*) which was taken from Kenjeran coastal area, Surabaya contain 0.93 ppm of Cd level in average. The level of Cd in the control group was 0.82 ppm. While the average level of Cd in the blood cockle in the treatment groups were 0.15 ppm. The amount of Cd level decreasing in treatment groups were 82.1% (0.67 ppm). The stirring speed and adsorbent temperature were contributed to give significant difference of Cd level in blood cockle. From the results we could conclude that the intervention stirring and adsorbent temperature can decreased Cd level. We suggest that societies can use stirring and heating using chicken egg shells as an adsorbent to control food contamination of Cd.

**Keywords:** *Stirring chamber, Stirring speed, Adsorbent temperature, Chicken egg shells*

## INTRODUCTION

Food quality that is not fulfil health requirements was a main problem of food safety. It needs awareness to understand that this was some parties responsibility. They were governments, food industries, food producer, and also consumer<sup>(1)</sup>. The regulation in Indonesia (UU No.18, 2012) mention that farmers, fishermen, fish farmers, and food business actors are obliged to apply food safety norms, standards, procedures and criteria.

Food safety intend to prevent the possibility of biological, chemical and other contaminants that can interfere, harm and endanger human health. Seafood was potential to contaminate by heavy metal<sup>(2)</sup>.

Suryono et al. reported that blood cockle that was taken from Kenjeran coastal area in Surabaya contain 0.620 ppm of Mercury (Hg). Mercury contamination also was found in Asian green mussel (*Mytilus viridus*)<sup>(3)</sup>. Trisnawati mention that the level of Cadmium (Cd) in Asian green mussel was 50.23-70.39 pmm inside its gill, 31.08-44.53 pmm in its liver, and 6.73-7.37 ppm on the sea water<sup>(4)</sup>. Fransiska et al. also proved that there were 0.76073 mg/kg of lead (Pb) in blood cockle that was taken from Kenjeran coastal area, Surabaya<sup>(5)</sup>.

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Simple and inexpensive efforts to decrease the level of heavy metal that can be done were using chicken egg

shells. Suryono found that the use of 75 grams chicken egg shells powder and 45 minutes of stirring process can decrease 93,64% of Hg level<sup>(3)</sup>. Aimi et al. mention that this due to chicken egg shells contains CaCO<sub>3</sub>. It can absorb metals<sup>(6)</sup>.

Besides Hg, blood cockle also contain Cd. The level of Cd in blood cockle which was taken from Kenjeran, Surabaya was 0.93 ppm<sup>(3)</sup>. This level is still safe based on SNI No.7387, 2009. But consume food that is contaminated by Cd have potential to damage the organs or death due to the accumulation of Cd inside the body. The aim of this research is to analyse the difference of Cd level in blood cockle (*Anadara granosa*) after it is given a treatment by using the stirring speed and adsorbent temperature principles.

## MATERIALS AND METHOD

This was experimental research using one group pretest-posttest design. Independent variables were the speed of stirring and adsorption temperature. We used 50 rpm, 150 rpm, and 250 rpm of speed. The adsorption temperature was 35°C, 50°C, and 65°C. The dependent variable was Cd level. Samples were blood cockle from Kenjeran coastal area, Surabaya.

The stages to make the chicken egg shells adsorbent were: 1) Washed the chicken egg shells then take the membrane and all the dirt, 2) Soaked with hot water in 15 minutes then let it dry, 3) The egg shells then be mashed using blender, 4) Sifted the chicken egg shells powder with 120 mesh sieve, 5) Put the powder in the oven for 15 minutes 100 °C, 6) Activated the powder using 0.1 M of HCl in 48 hours, 7) After 48 hours drain well and wash until the pH 7 or neutral, 8) Put the powder in oven again to make it dry for 30 minutes 100 °C.

If the chicken egg shells powder as adsorbent was ready, put 50 grams of the powder to a liter of water and 250 grams blood cockle inside the stirring chamber. Adjust the adsorbent temperature and stirring speed, then analyze the Cd level in blood cockle using Atomic Absorption Spectrophotometry.

## FINDINGS AND DISCUSSION

The results of Cd level test in blood cockle (*Anadara granosa*) with 50 grams of chicken egg shells as adsorbent before and after the treatment using stirring speed and adsorption temperature can be seen below. We use three replication.

**Table 1: The average Level of Cd in Blood Cockle (*Anadara granosa*) with 50 grams of chicken egg shells as adsorbent before the treatment**

Samples Code	Stirring	Adsorption	Results
	Speed (rpm)	Temperature (°C)	Cd (ppm)
KAT1		35	0.93
KAT2	50	50	0.87
KAT3		65	0.75
KBT1		35	0.79
KBT2	150	50	0.80
KBT3		65	0.80
KCT1		35	0.82
KCT2	250	50	0.82
KCT3		65	0.79
Total			7.37
Average			0.82

Based on SNI (Indonesian Standard) No. 7387, 2009, the level of Cd in blood cockle after it soaked with adsorbent chicken egg shells powder was below the maximum allowable threshold value (1 ppm). But we need to consider the effect of blood cockle consumption continuously in short time.

The accumulation of heavy metal in seafood can be happen due to food chain cycle. Palar explained that in the body of aquatic biota, the amount of heavy metal will accumulated and continue to increase (biomagnification) in the food chain, where biota at the higher level in the food chain will experience more accumulation<sup>(7)</sup>.

**Table 2: The average level of Cd in Blood Cockle (*Anadara granosa*) with 50 grams of chicken egg shells as adsorbent after the treatment**

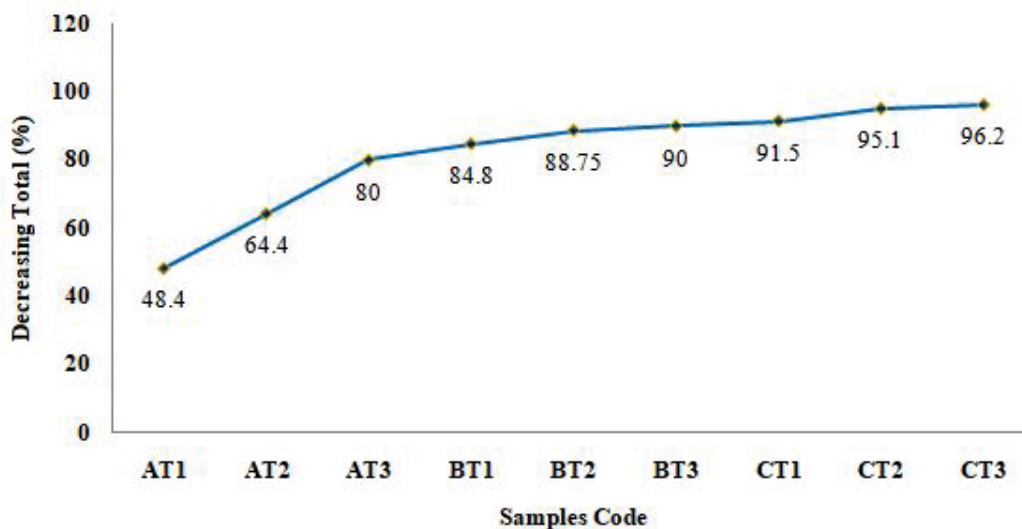
Samples Code	Stirring	Adsorption	Results
	Speed (rpm)	Temperature (°C)	Cd (ppm)
AT1		35	0.48
AT2	50	50	0.31
AT3		65	0.15
BT1		35	0.12
BT2	150	50	0.09
BT3		65	0.08
CT1		35	0.07
CT2	250	50	0.04
CT3		65	0.03
Total			1.37
Average			0.15

The average difference of Cd level in blood cockle before and after the treatment using stirring speed and adsorption temperature was 0.82 ppm in before treatment group and 0.15 ppm in after treatment group. While the amount of Cd level decreasing can be seen in table 3.

**Table 3: The amount of Cd level decreasing in Blood Cockle (*Anadara granosa*) with 50 grams of chicken egg shells as adsorbent before and after the treatment**

Samples Code	Stirring Speed	Adsorption Temperature	Cd Results (ppm)		Decreasing Total	Decreasing Total
	(ppm)	(°C)	Before	After	(ppm)	(%)
AT1		35	0.93	0.48	0.45	48.4
AT2	50	50	0.87	0.31	0.56	64.4
AT3		65	0.75	0.15	0.60	80.0
BT1		35	0.79	0.12	0.67	84.8
BT2	150	50	0.80	0.09	0.71	88.75
BT3		65	0.80	0.08	0.72	90.0
CT1		35	0.82	0.07	0.75	91.5
CT2	250	50	0.82	0.04	0.78	95.1
CT3		65	0.79	0.03	0.76	96.2
Total			7.37	1.37	6.00	739.2
Average			0.81	0.15	0.67	82.1

The difference of average Cd level before and after treatment was 0.67 ppm (82.1%). It indicated that there was Cd level decreasing that is caused by stirring speed and adsorption temperature. This is the graphic which shows the percentage of Cd level in blood cockle (*Anadara granosa*) after the treatment using 3 variations of stirring speed and adsorption temperature with 50 grams of chicken egg shells as adsorbent.



**Figure 1: The Graphic of Cd Level Percentage in blood cockle (*Anadara granosa*) after the treatment using 3 variations of stirring speed and adsorption temperature with 50 grams of chicken egg shells as adsorbent.**

From the Figure 1, we can understand that the highest decreasing total was CT3 sample using 250 rpm of stirring speed and 65°C. The total decreasing in sample CT3 was 96.2%.

Ancova test was used to assess the difference of each stirring speed and adsorption temperature variation. This test also was used to know the amount of difference of Cd level before and after the treatment. The decreasing

of Cd level has a positive correlation with the increasing of stirring speed and adsorption temperature. This means that the higher the speed of the stirring and adsorption temperature, will lead to the increasing of Cd level in blood cockle (*Anadara granosa*).

**Table 4: Tests of Between-Subjects Effects**

Dependent Variable: Cd Level After Treatments								
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power <sup>b</sup>
Speed	0.163	2	0.081	568.125	0.000	0.985	1136.250	1.000
Adsorption Temperature	0.084	2	0.042	293.468	0.000	0.972	586.937	1.000
Speed * Adsorption Temperature	0.072	4	0.018	125.149	0.000	0.967	500.595	1.000

a. R Squared = .995 (Adjusted R Squared = .993)

b. Computed using alpha = 0.05

**Table 5: Pairwise Comparisons**

Dependent Variable: Cd Level After Treatments						
(I) Stirring Speed	(J) Stirring Speed	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
50 RPM	150 RPM	0.222*	0.010	0.000	0.201	0.243
	250 RPM	0.272*	0.008	0.000	0.254	0.289
150 RPM	50 RPM	-0.222*	0.010	0.000	-0.243	-0.201
	250 RPM	0.049*	0.006	0.000	0.037	0.062
250 RPM	50 RPM	-0.272*	0.008	0.000	-0.289	-0.254
	150 RPM	-0.049*	0.006	0.000	-0.062	-0.037

Based on estimated marginal means

\*. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

This test shows that chicken egg shells can be used as heavy metal adsorbent. Chicken egg shells can decrease Hg level in blood cockle. This indicates that activated chicken egg shells can absorb heavy metal. Napitapulu explain that physical activation can enlarge chicken egg shells pores. It happened due to chemical bonds breaking or surface oxidizing molecules so that the surface area increases and affects the adsorption potency<sup>(8)</sup>.

HCl as activator in chicken egg shells activation process can clean up the pores surface, remove impurities (non-carbon) compounds and rearrange the location of atoms exchanged. We can said that chemical

activation was a process to add certain reagents to clean and enlarge the surface of the chicken egg shell so that it can be used as an adsorbent.

Chemical activation method was the best way for adsorbent, in that research zeolite was used as adsorbent. It can adsorb water up to 13.77% after it is activated by chemical method<sup>(9)</sup>. Fitriyana & Safitri reported that chicken egg shells adsorbent potency test to ion, it results shows that non-activated chicken egg shells can adsorb 18.73% while physical activated chicken egg shells can adsorb 31%. This result indicated that activated chicken egg shells can adsorb ion better than non activated chicken egg shells<sup>(10)</sup>.

Aidha explained that activating adsorbent using HCl for 80 minutes can decrease up to 78.99% of calcium. Acid adding lead to cation exchange with H<sup>+</sup> thus enlarges the cavity in the adsorbent zeolite and increases the adsorbent power due to the increased porosity of the adsorbent<sup>(11)</sup>.

Beside of that, stirring speed and adsorption temperature contribute to decrease Cd level in blood cockle. Statistic analysis shows that there was an influence of stirring speed and adsorption temperature to the Cd level decreasing. The increasing stirring speed and adsorption temperature lead a greater decrease of Cd level in blood cockle. Stirring causes turbulent liquids which is containing adsorbents. The faster the stirring will cause the greater movements so that it will make the film layer that surrounds the adsorbent particles thinner which makes the adsorption process run fast.

Webber explained that adsorption was limited by film diffusion and pore diffusion process, it depend on movements in the system. If the movements was slow, the film which is coating the particles will be thick so adsorption will be slow. If the stirring process was enough, the film diffusion process will run faster<sup>(12)</sup>.

Syauqiyah et al. explained that increased temperature causes the energy and reactivity of the ions to increase so that more ions are able to pass through the energy level to interact chemically with the active layer on the surface, so that more ions can be adsorbed on the surface. The heating treatment in this process can increase the adsorbent power to decrease Pb and Cd level in blood cockle<sup>(13)</sup>.

Heating or adsorbent activating would increase adsorbent power due to the adsorbent's pores will be larger. But if the temperature was too high it could damage the adsorbent<sup>(12)</sup>. Flores et al. stated that adsorption power in chicken egg shells will increase on 15-35°C due to endothermic process. The absorption of Cd (II) occurs mainly in the calcareous layer (which contains CaCO<sub>3</sub>) and slightly in the membrane layer. This shows that the absorption of Cd (II) is irreversible and the main absorption mechanism is ion precipitation and exchange.

## CONCLUSION

Stirring speed and adsorption temperature can increase the potentation of chicken egg shells to decrease Cd level in blood cockle by develop stirring chamber tool.

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**Ethical Clearance:** Yes

**Conflict of Interest:** No

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