Proceeding International Conference of Health Sciences
e-ISSN : 2827-9891 Vol. 2 Number 1
https://ocs.unism.ac.id/index.php/ICoHS Januari 2024

POTENTIAL ACTIVATED CARBON BODY SCRUB CORN WEEVIL (Zea mays) USING HYDROCHLORIC ACID ACTIVATOR AS DETOXIFICATION

Novitalita Selendra[1*], Tuti Alawiyah[2], Setia Budi[3], Nur Hidayah[4]

[1] *Program Studi Sarjana Farmasi, Fakultas Kesehatan, University Sari Mulia*

** novitalita196@gmail.com*

Abstract

Corn weevil has activity as activated carbon and asadsorbent for anions, cations, organic and inorganic compounds. Activated carbon can be novated into a product that can be used by the public, it can be in the form of semi-prepared cosmetics, such as a body scrub activated carbon corn weevil (Zea mays), capable of detoxifying properties. To see the potential of corncob activated carbon body scrub (Zea Mays) in formulas I, II and III as a detoxification by testing iodine absorption. The research method was carried out in an experimental study with a completely randomized study design with three treatment groups consisting of three variations in the concentration of activated carbon, namely 8%, 10% and 12%. The results of the study, formulas I, II and III met the physical evaluation requirements for body scrub preparations, but formula I was better because it met the physical evaluation test standards. On the detoxification potential of body scrubs, formula I is 1,382.025 mg/g, formula II is 1,902.442 mg/g and III is 2,175.277 mg/g, but formula III has an activated carbon concentration of 12% which is better so it has the potential to be a detoxifier. It can be concluded that the three formulas for body scrub preparations of corn weevil activated carbon (Zea mays) have potential as detoxification, namely formula III with an absorption capacity of 2,175.277 mg/g.

Keywords: Body scrub, corn weevil, activated carbon, detoxification

Introduction

Corn plants are one of the abundant natural resources in Indonesia. Every year corn production increases in Indonesia, according to the Central Statistics Agency (BPS) in 2021, South Kalimantan was 264,168 tons. With an increase in corn production, more corn plant waste will also be produced. The proportion of corn plant waste per percent of dry matter is 20% cobs, if you convert the amount of corn weevil waste from the total production above, you will get 52,833.6 tonnes of corn weevil waste (Rostini et al., 2022).

Activated carbon has good absorption capacity for anions, cations and molecules in the form of organic and inorganic compounds, both in solution and gas. Activated carbon can be differentiated from charcoal based on the properties of its surface. The surface of charcoal is still covered by hydrocarbon deposits which inhibit its activity, while the surface of activated charcoal is relatively free from deposits, has a wide surface and open pores, so it has high absorption capacity (Novita Rachmawati et al., 2018).

According to (Suwantiningsih et al., 2020), corn weevil can be used as activated charcoal because they contain cellulose (41%), hemicellulose (36%) and (16%) lignin. According to (Kanengoni et al., 2015) Corn weevil contain (45%-55%) cellulose, (25%-35%) hemicellulose and (20%-30%) lignin. According to (Taufik et al., 2021) Palm oil shells contain cellulose (38.52%), hemicellulose (33.52%), lignin (20.36%). According to (Riyanto et al., 2021) Rice husk has cellulose (38%), lignin (22%), hemicellulose (18%). According to (Ngakan et al., 2017) Bamboo contains cellulose (44.22%), hemicellulose (14.97%), lignin (22.99%). In this description, plants that have cellulose, hemicellulose and lignin levels that meet standards can be used to make active carbon.

Activated carbon is a product that can benefit society, so innovation is needed that can be used by society, which can be in the form of semi-solid cosmetic preparations such as body scrub from corn weevil activated carbon.

Materials and Methods

Tools

The tools used in this research are analytical scales, mortar, stamper, porcelain cup, glass beaker, Erlenmeyer, pipette, stirring rod, filter paper, funnel, object glass, hot plate, oven, pH meter, furnace, desiccator, titration tool, viscometer , spreadability test equipment and adhesion test equipment.

Material

The materials used are corn weevil, HCl, iodine, KI, H_2SO_4, KIO_3, Na_2CO_3, sodium thiosulfate ($Na_2S_2O_3$), starch, stearic acid, triethanolamine, propylene glycol, cetyl alcohol, methyl paraben, propyl paraben and distilled water.

Procedures

Manufacture of activated carbon

500 grams of corn weevil that have been dried and chopped are placed in the kiln at 600^0C for 1 hour, leave the corn weevil at room temperature for 24 hours. Then it is crushed or milled so that the size passes through a 100-mesh sieve then activated. Activated carbon is soaked in 500 ml 4N HCl solution for 24 hours, then filtered and washed with distilled water until neutral (pH 7). The resulting activated carbon is then dried in an oven at 110^0C for 3 hours then stored in a desiccator

Body scrubs

Samples with concentrations of 8%, 10% and 12% were respectively made into a body scrub formulation, melted the oil phase (stearic acid, cetyl alcohol) on a hotplate at a temperature of 70^0C, after the oil phase had melted, add methyl paraben. Dissolve triethanolamine and propylene glycol with heated distilled

water then add propyl paraben then stir until dissolved. Then add the water phase to the oil phase in the hot mortar little by little and grind until a creamy mass forms. Add corn weevil activated carbon and Amylum oryzae little by little while stirring into the crushed cream mass until homogeneous. The body scrub that has been formed is put into the cream pot

Physical Evaluation

Organoleptic

Organoleptic observations consist of color, texture (shape) and odor of the preparation

Homogeneity

The homogeneity test is carried out by spreading a thin amount of the preparation on a dry and clean glass object and then covering it with a cover glass. The homogeneity test is declared good if the preparation has an even texture and is not lumpy.

pH

Samples with concentrations of 8%, 10% and 12% of each formula were weighed as 1 gram of the preparation and dissolved in 100 ml of distilled water. Then dip it in the solution. Let the tool show the pH value until it remains constant. Based on SNI 16-4399-1996, the pH of cream preparations follows the pH of the skin, namely 4.5-8.0.

Spreadability

Samples with concentrations of 8%, 10% and 12% of each formula were weighed. 0.5 gram of body scrub was placed in the middle between 2 glass plates. The spreadability of the cream was measured by placing the cream in the middle of a transparent glass covered with millimeter block paper. Then the diameter is measured for one minute. The experiment was repeated by adding loads weighing 50 grams, 100 grams and 150 grams. Calculate the average diameter of spreading power. Good cream spreadability is between 5-7 cm

Adhesion

Samples with concentrations of 8%, 10% and 12% of each formula were weighed with 0.5 grams of body scrub then placed on a glass object, covered with another glass object, then a weight of 1 kg was placed on top for 5 minutes. Tie the top end of the object glass and then add an 80 gram weight to the other end of the rope. Calculate the time needed for the two object glasses to release their attachment. The requirement for good adhesion for topical preparations is more than 4 seconds

Viscosity

The viscosity test aims to determine the viscosity level of the body scrub. Good viscosity will have a high value because the higher the viscosity of a material, the more difficult it will be to move particles so that

the material will be more stable (Hardiyanthi, 2015). Based on SNI 16-4399-1996, the viscosity for skin cosmetic products is 2,000 cp – 50,000 cp (centipoise).

Activated carbon body scrub detoxification

Preparation of 1% Starch Solution

1 gram of starch, then dissolved it in 10 mL of distilled water, then added 100 mL of distilled water while stirring and heating.

Standardization of 0.1 N Sodium Thiosulfate Solution

Preparation of sodium thiosulfate solution

26 grams of sodium thiosulfate and 0.2 mg Na_2CO_3 then put them in a beaker and dissolve in 100 mL of carbon dioxide-free water (Meika et al., 2021).

Preparation of KIO3 solution

3 grams of KIO_3 and heat it at 130-140^{0}C for 2 hours. Then cooled in a desiccator. 1.5 g of cooled KIO_3 and dissolve it with distilled water in a 250 mL volumetric flask (Maruni et al., 2022).

Standardization of sodium thiosulfate

20 mL of KIO_3 solution, put it in a 250 mL Erlenmeyer flask, then add 2 g of KI and 5 mL of $H2SO_4$, then cover and shake until the solution becomes dark yellow. The solution was left in a dark room for 5 minutes, then 100 mL of distilled water was added, then titrated with sodium thiosulfate until a thin yellow solution was formed, then added 1 mL of 1% starch indicator, then continued the titration until the color of the solution turned clear (Maruni et al., 2022) .

Standardization of 0.1N Iodine Solution

Preparation of idoine solution

1,800 mg of KI solid, dissolved using 10 mL of distilled water then put it in a 100 mL volumetric flask. Next, put 1,269 mg of iodine into the measuring flask and shake until it dissolves. Add distilled water to the mark, then store in a dark place (Maruni et al., 2022).

Standardization of iodine solution

25 mL of KI solution was titrated with 0.1 N Na2S2O3 solution until the solution had a light yellow color.1 ml of 1% starch solution was added as an indicator until the solution was blue. The iodine solution is titrated with $Na_2S_2O_3$ solution until the solution is clear (Maruni et al., 2022).

Detoxification test of activated carbon preparations

Samples with concentrations of 8%, 10% and 12% of each formula were weighed as much as 1 g of Body Scrub and put into an Erlenmeyer flask. Then add 25 ml of 0.1 N iodine solution and shake for 15

minutes. The mixture is filtered and take 10 ml of filtrate. Next, the filtrate was titrated with 0.1 N Sodium Thiosulfate ($Na_2S_2O_3$) solution until the color became light yellow. Then add a few drops of 1% starch indicator and titrate again until the blue color disappears. The amount of iodine absorbed by activated carbon can be calculated using the equation (Huda et al., 2020):

$$DSI=\frac{\left(\text{ml sampel} - \frac{T\times C1}{C2}\right) W1\times Fp}{\text{berat sampel karbon aktif}}$$

Information:

DSI : Iodine absorption capacity (mg/g)

ml sample : Sample filtrate titrated (ml)

Q : Na titration volume $Na_2S_2O_3$ (ml)

C1 : Na concentration $Na_2S_2O_3$ (N)

C2 : Iodine concentration (N)

WI : Iodine weight (12.693 mg/ml)

Fp : Diluting factor

Results and Discussion

Organoleptic

Table 1. Organoleptic

Formulas	Organoleptic			
	Form	Smell	Color	Flavor
I	Semi solid	Charcoal	Black	Fine grain
II	Semi solid	Charcoal	Black	Fine grain
III	A bit dense	Charcoal	Black	Fine grain

Homogeneity

Table 1. Homogeneity

Formulas	Homogeneity		
	Replication 1	Replication 2	Replication 3
I	Homogeneous	Homogeneous	Homogeneous
II	Homogeneous	Homogeneous	Homogeneous
III	Homogeneous	Homogeneous	Homogeneous

pH

Table 2. pH

Formulas	pH			Average	P-value
	Replication 1	Replication 2	Replication 3		
I	7.02	7,10	7.11	7.07	0.002
II	7.13	7.14	7.17	7.14	
III	7.26	7.31	7.37	7.31	

Spreadability

Table 3. Spreadability

Formulas	Diameter(cm)			Average	P-value
	Replication 1	Replication 2	Replication 3		
I	5.5	5	5	5.5	0.023
II	4.4	4.5	4.4	4.4	
III	3.6	3.7	3.7	3.6	

Adhesion

Table 4. Adhesion

Formulas	Time(seconds)			Average	p-value
	Replication 1	Replication 2	Replication 3		
I	4.49	4.21	4.60	4.4	0.027
II	5.55	4.89	5.20	5.21	
III	8.31	11.09	10.45	9.95	

Viscosity

Table 5. Viscosity

Formulas	Viscosity (cP)			Average	p-value
	Replication 1	Replication 2	Replication 3		
I	14219	15160	15360	14913	0.001
II	16380	17280	18080	17246	
III	18660	18300	18480	18480	

Activated carbon body scrub detoxification

Table 6. Detoxification

No.	N Sodium Thiosulfate (Na2S2O3) (N1)	V Sodium Thiosulfate (Na2S2O3) (V1)	N Iodine (N2)	DSI
F1(1)	0.101N	5.1ml	0.106N	1,478.385 mg/g
F1(2)	0.101N	5.1ml	0.106N	1,333.845 mg/g
F1(3)	0.101N	5.2ml	0.106N	1,333.845 mg/g
Average		1,461,045mg.g/g		
F2(1)	0.101 N	3.2 ml	0.106N	1,871.775 mg
F2(2)	0.101N	3.2 ml	0.106N	1,903.5 mg/g
F2(3)	0.101N	3.3 ml	0.106N	1,932.052 mg/g
Average		1,904,397mg.g/g		
F3(1)	0.101N	2.7	0.106N	2,204.887 mg/g
F3(2)	0.101N	2.8	0.106N	2,176.335 mg/g
F3(3)	0.101N	2.9	0.106N	2,144.61 mg/g
Average		2,176.454 mg.g/g		

Discussion

Body scrub corn weevil activated carbon is made into 3 formulas with different variations in active carbon concentration, namely 8%, 10% and 12%. The ingredients used include, stearic acid as an emulsifier, triethanolamine as an emulsifier, propylene glycol as a humectant, cetyl alcohol as an emollient, antimicrobial methyl paraben, propyl paraben as an antifungal, amylum oryzae as a scruber. All ingredients will be made into 3 formulas and physical evaluations of the preparations will be carried out, including organoleptic tests, homogeneity tests, pH tests, spreadability tests, adhesion tests and viscosity tests (Lilyawati et al., 2021).

Physical Evaluation

Organoleptic

The results of organoleptic observations in formulas I, II, and III have the same distinctive odor, black color, fine granular texture. In formulas I and II the preparation is in semi-solid form. In formula III, it is quite dense because with each formulation the charcoal concentration increases, which affects the shape of the preparation. It can be concluded that the third formula meets the standard body scrub requirements. The results of organoleptic observations are in line with research (Lilyawati et al., 2021) where it has a distinctive smell of activated carbon.

Homogeneity

Homogenization testing is carried out to determine the absence of lumpy particles in the body scrub preparation and the preparation of the preparation evenly. The observation results in formulas I, II and III, all three formulas are homogeneous and have fine grains that are evenly distributed in the activated carbon body scrub preparation. The results of observing homogeneity in the three formulas can be concluded to meet the standard requirements for body scrub preparations. This is in line with research (Lilyawati et al., 2021) where the preparation is homogeneous with good consistency and has fine grains.

pH

pH testing aims to determine the acidity or alkalinity level of the body scrub preparation. Topical preparations with a pH that is too acidic can cause skin irritation, but when the skin becomes scaly or dry it is caused by an alkaline pH (Hikma et al., 2022). The pH test results for formula I were 7.12; formula II is 7.19 and formula III is 7.31. This is in line with research (Lilyawati et al., 2021) where the pH of a good topical preparation is in the range of 4.5-8.0.

One way ANOVA parametric analysis was carried out, a significant value of p = 0.002 (>0.05) was obtained, which shows that there is a significant influence on the pH of the three formulas.

Spreadability

The spreadability test aims to determine the softness of the body scrub so that it can be seen how easy it is to apply the preparation to the skin. The average spreading power test results in formula I was 5.1 cm, formula II was 4.4 cm and formula III was 3.7. In formula I, the body scrub preparation meets the standards for good dispersion capacity, whereas in formulas II and III it does not meet the standards for good dispersion capacity. This is in line with research (Lestari et al., 2017) The higher the concentration of activated carbon in the body scrub, the smaller the spreading power, good spreading power in the range of 5 cm and 7 cm. The same is true with research (Ahadianti et al., 2020) says that the more liquid the cream preparation is, the wider the spread diameter of the cream preparation will be because the spreadability is inversely proportional to the viscosity of the cream so that a high spread value means a low viscosity value, so vice versa.

Then data analysis was carried out, a normality test was carried out, the significant value was p = 0.00 (<0.05), meaning the data was not normally distributed, followed by a homogeneity test, the significant value was p = 0.014 (<0.05), meaning the data was not homogeneously distributed. So that non-parametric data analysis will be carried out, namely Kruskal Wallis, which obtained a significant value of p = 0.023 (<0.05). It can be concluded that the three formulas have significant differences in the dispersion power test of the three formulas. It was stated that variations in the concentration of activated carbon on corn weevil had an effect on the spreadability of body scrub preparations.

Adhesion

Adhesion testing aims to determine the time needed for the preparation to stick to the skin. Good adhesion means that the active substance does not come off easily and sticks to the skin for longer, so that it can produce the desired effect. The requirement for good adhesion for topical preparations is more than 4 seconds (Lilyawati et al., 2021).

The average adhesion test results for formula I was 4.4 seconds, formula II was 5.21 seconds, and formula III was 9.95 seconds. So the results of the three formulas in the adhesion test meet the standard requirements, namely more than 4 seconds (Lilyawati et al., 2021). This is in line with research (Ahadianti et al., 2020) the increase in adhesion due to the addition of more and more active substance powder will make the body scrub denser and thicker, so that the adhesion lasts longer.

Stickiness is directly proportional to the viscosity of the body scrub, the higher the viscosity, the higher the stickiness.

Then data analysis was carried out, a normality test was carried out, the significant value was p = (>0.05), meaning the data was normally distributed, followed by a homogeneity test, the significant value was p = 0.029 (<0.05), meaning the data was not homogeneously distributed. So that non-parametric data analysis will be carried out, namely Kruskal Wallis, which obtained a significant value of p = 0.027 (<0.05). It can be concluded that the three formulas have significant differences in the adhesive strength testing of the three formulas. It was stated that variations in the concentration of activated carbon from corn weevil had an effect on the adhesive power of the body scrub preparation.

Viscosity

Viscosity testing aims to determine the viscosity level of the body scrub. A good viscosity will have a high value because the higher the viscosity of a material, the more difficult it will be to move particles so that the material will be more stable. The viscosity test results for formula I were 14913 cp, formula II was 17246 cp, formula III was 18480 cp. So the results of the three formulas meet the standard requirements for good viscosity, namely 2000-50,000 cp (Ledinasari et al., 2020). This is in line with research (Ahadianti et al., 2020) Increasing the concentration of active substance powder causes the viscosity of the body scrub to increase. This causes the body scrub to become denser.

Then parametric data analysis was carried out, namely one way ANOVA, which obtained a significant value of p = 0.001 (<0.05). It can be concluded that the three formulas have a significant influence on viscosity testing. It can be concluded that variations in the concentration of corn weevil activated carbon influence the viscosity of the preparation so that it can influence the spreadability and adhesiveness of a preparation.

Detoxification

The absorption capacity of iodine is determined with the aim of knowing the adsorption capacity of the resulting adsorbent against odorous solutions. The absorption capacity of iodine is the number of milligrams of iodine adsorbed by one gram of activated carbon according to SNI 06-3703-1995. The absorption capacity of activated carbon for iodine is at least 750 mg/g. The absorption capacity of activated carbon becomes stronger as the active carbon concentration increases (Sulaiman et al., 2018).

From the results obtained, the absorption capacity in formula I for iodine is an average of 1,382.025 mg/g. In formula II, the absorption capacity for iodine is 1,902.442 mg/g and in formula III the absorption capacity for iodine is 2,175.277 mg/g. It can be concluded that these three formulas meet the requirements according to SNI 06-3703-1995, the absorption capacity of activated charcoal for iodine is at least 750 mg/g. This shows that the corn weevil activated carbon body scrub has the ability to act as a detoxifier where the absorption capacity of activated charcoal becomes stronger along with increasing concentrations of activated charcoal.

Detoxification of activated carbon body scrub preparations can be determined using the iodine absorption test. To see the effectiveness of detoxification in the activated carbon body scrub preparation, an irritation test can be carried out on the skin directly by applying the preparation to the surface of the volunteer's skin. Applying the preparation to the surface of the skin if the surface of the volunteer's skin looks smoother, cleaner and there are no black spots or spots on the skin. has faded compared to the skin before the preparation was applied, this shows that the preparation has the ability to detoxify or absorb toxins and dirt (Lestari et al., 2017).

Precision is the variability of several measurements or tests which describes the accuracy of the data and is related to random error. This research carried out a validity test by titrating the iodine absorption capacity three times to ensure the precision of the data obtained with an RSD value of ≤ 2%, which indicates that the titration results are valid (Ganjar & Rohman, 2007). The research results obtained from the precision in formula I were 1.19%, formula II was 1.59%, formula III was 1.39%. So it can be concluded that the precision results from the three formulas are acceptable because the RSD ≤ 2%.

Conclusion

In the physical evaluation of corncob activated carbon (zea mays) body scrub preparations, all formulas met the physical evaluation requirements, but formula I was better because they all met the physical evaluation test standards. Judging from the activity of activated carbon formula III with a concentration of 12%, it is better with an iodine absorption capacity of 2,175.277mg/g so that the corncob activated carbon body scrub preparation has the potential to be a detoxifier.

References

Ahadianti, KM, Wrasiati, LP, & Men's Doubles, GP (2020). Effect of Added Percentage of Gourd (Luffa acutangula) Fiber Powder and Stirring Time on the Characteristics of Body Scrub Cream. Journal of Agro-Industrial Engineering and Management, 8(3), 472. https://doi.org/10.24843/jrma.2020.v08.i03.p15

Hikma, N., Rachmawati, D., & Ratnah, S. (2022). Formulation and Physical Quality Test of Papaya (Carica papaya L) Peel Extract Body Scrub Preparations with Varying Triethanolamine Concentrations. Mandala Pharmacon Indonesia Journal, 8(2), 185–195. https://doi.org/10.35311/jmpi.v8i2.218

Huda, S., Ratnani, RD, & Kurniasari, L. (2020). Characterization of Activated Carbon from Ori Bamboo (Bambusa Arundinacea) which is activated using hydrochloric acid (HCl). Journal of Chemical Engineering Innovation, 5(1). https://doi.org/10.31942/inteka.v5i1.3397

Kanengoni, A.T., Chimonyo, M., Ndimba, B.K., & Dzama, K. (2015). Potential of using maize cobs in pig diets - A review. Asian-Australasian Journal of Animal Sciences, 28(12), 1669–1679. https://doi.org/10.5713/ajas.15.0053

Ledinasari, Putri, Y, D., & Lestari, T, D. (2020). Base Optimization and Physical Evaluation of Gombong Bamboo Charcoal Bodyscrub Cream (Gigantochloa Pseudoarundinaceae) as a Detoxifier with Triethanolamine Emulgator. Indonesian Journal of Pharmaceutical Science and Technology, 9(1), 61–74.

Lestari, U., Farid, F., & Sari, PM (2017). Formulation and Test of Physical Properties of Activated Charcoal Body Scrub from Palm Shells (Elaeis Guineensis Jacg) as Detoxification. Journal of Pharmaceutical Science and Technology Vol. 19, 19(suppl1), 74–79. jstf.ffarmasi.unand.ac.id

Lilyawati, SA, Fitriani, N., & Prasetya, F. (2021). Formulation and Physical Quality Test of Body Scrub Preparations from Rice Husk Activated Charcoal (Oryza sativa). Proceedings of Mulawarman Pharmaceuticals Conferences, April 2021, 213–217. http://prosiding.farmasi.unmul.ac.id/index.php/mpc/article/view/416/399

Ngakan, D., Putra, K., Gde, T., Nindhia, T., Surata, IW, & Subuat, M. (2017). Potential of swat bamboo (gigantochloa verticillata) as an active carbon material for adsorbed natural gas (ANG). Journal of Energy and Manufacturing, 9(2), 174–179.

Novita Rachmawati, K., Badriyah, L., Eko Pujiono, F., Wiyata Kediri, B., Chemistry Study Program, D., Science Technology and Analysis, F., & Health Sciences Bhakti Wiyata Kediri, I. (2018) . Synthesis of Activated Carbon From Corn cobs Activated HCl. Proceedings of the National Seminar on Science, Technology and Analysis, 1, 107–110.

Riyanto, CA, Kurniawan, E., & Aminu, NR (2021). Effect of NaOH and Activation Temperature on the Characteristics of H3PO4 Activated Rice Husk Activated Carbon. Rafflesia Journal of Natural and Applied Sciences, 1(2), 59–68. https://doi.org/10.33369/rjna.v1i2.16864

Rostini, T., Jaelani, A., & Ali, M. (2022). Effect of Fermentation Time on Characteristics, Protein Content and Crude Fiber of Corn Cobs. Ziraa'Ah Agricultural Scientific Magazine, 47(2), 257. https://doi.org/10.31602/zmip.v47i2.7302

Sulaiman, NH, Malau, LA, Lubis, FH, Br Harahap, N., Manalu, FR, & Kembaren, A. (2018). Processing of Candlenut Shells as Activated Carbon with Variations of Phosphoric Acid Activator. EINSTEIN E-JOURNAL, 5(2). https://doi.org/10.24114/einstein.v5i2.11841

Suwantiningsih, S., Khambali, K., & Narwati, N. (2020). Absorption Power of Corn Cob Activated Charcoal as a Filter Media in Reducing Iron (Fe) Levels in Water. Ruwa Jurai: Journal of Environmental Health, 14(1), 33. https://doi.org/10.26630/rj.v14i1.2170

Taufik, M., Suci, T., Kasih, D., & Khair, M. (2021). Making Activated Carbon from Palm Oil Shells (Elaeis Guineensis) using a Microwave Activator. Chemistry Journal of Padang State University, 10(1), 40–44.