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Mixed Characteristics Of Activated Charcoal Ori Bamboo And Red Ginger as Air Purifier On Food Cabinets

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ABSTRACT

ost of the community while preservation of food using refrigeration machines and chemicals, which l s attention to hygiene. The storage space made of wood, glass or plastic where are almost airtight except the refrigerators which have oor air circulation and it cause of cross-contamination and als riggers bacteria growth, virus and fungi that cause decay and also disease source. These problems ncourage the researchers to make a hygieni food storage space by consider the air circulation which is given an air purifier natural ingredients combinations that absorb pollutants, heavy tals, and nti-microbials. The ir purifier ingredients which expected are original bamboo charcoal active, and red ginger. To make the air purifier can work effectiv y, a certain balanced composition is needed. The research method ed is an experimental method where food ingredients are stored in a space where the air circulatio is coated with a article layer of original bamboo charcoal activate nd red ginger rhizome with different compositions. The material used are mixture of charcoal and ginger rhizome by making an air purifier derived from activated charcoal from ori bamboo aste at a certain percentage of charcoal maturity. After that the product will be tested in food storage space with tofu for the food sample. In this research, the comp ombination of ori bamboo charcoal active with red ginger extract was 4:0, 3:1, 2:2, 1;3, 0:4 where the ori bamboo charcoal active was used with a maturity percentage of 50%, 75%, 100 %. From the results of the research, it was found that the samples stored without using the filter grew with microbes after the econd day, the samples that were filtered with th composition of activated charcoal only grew microbes on the third day and there was a change in the shape of the filter, namely the aqueous filter. Samples with a composition of activated harcoal with varying maturity and ginger extract began to grow with microbes after the fourth day. The best filter results 100% mature ctivated charcoal with a omposition f activated charcoal and ginger extract, hich is 2:2. Microbes that can still grow in that osition are Bacillus substilis but in small quantities and n viruses or other icrobes are found.

Keywords Air Purifier, Food Storage Cabinet, Red Ginger, Ori Bambo
Paper type Research paper

INTRODUCTION (*HEADING 1*)

The foods variant in Indonesia can be classified n o wet food, semi-wet food and dry food with different resilience. These foods can be decay cause of chem cals, microbial growth, enzyme growth that eviates from normal nditions and the growth of micro-organisms mixed in food due to unhygienic food production and storage [1]. The an make trigger decay because the air can contain any microbes and pathogens. Food storage technology currently mostly uses refrigeration machines r airtight box s nd sterile rooms [2]. The latest air purifiers currently use a high efficiency particle air filter (HEPA) with a particle size of 0.01 microns but this type is not proven to kill SARS-CoV-2 so it must be combined with an ultraviolet germical irradiation (UVGI) system so arise the new technologies emerge with using plasma cluster ions which are still under re earch. Disease control and prevention in United States admit that the HVAC system also cannot improve indoor clean air [3], [4]. The development of a food storage space that can absorb oxins, odors, and anti-microbials by using an activated charcoal-based air purifier combined with natural ingredients accompanied by smooth air circulation settings can be used as an alternative solution [5]–[7].

An air purifier is the tool of indoor air purifier so that the inhaled air so can be cleaner and pollution free. Air purifiers that exist today have more complex functions such as being able to regulate humidity, smell and absorb air containing flower pollen by using a mixture of chemical compounds. There are three types of air purifiers currently used by the society, namely fan style air purifiers, electric type air purifiers and ion generators. Fan style air purifier has a fan inside the machine with functions to suck the urrounding air and push the air to be filtered through the filter. The weakness of this type are have a long time to change dirty air into clean and is it noisy because of the fan noise. Electric type air purifier be able to remove air dirt with use power static electricity, plasmacluster technology and is it quiet. Ion

generator is produce the negative ions that can sterilize and neutralize smell of air. The negative ions can increase the body's immunity, reduce fatigue, and increase conc ntration power. These air purifiers are quite exp sive, so it cannot purchased by the middle to lower class society, even though these people actually live in the residential areas close to waste disposal sites or other areas that have quite dirty air quality. The basic ingredients of an air purifier from chemicals and natural ingredients. Natural-based air purifiers usually use activated charcoal made from wood, coconut shells and amboo. The results of the research show that the type of raw material, the activation process and the shape of the raw aterial affected the yield, the carbon content bound to the adsorption capacity of Iod [8], [9]. Bamboo charcoal is better than wood or coconut shells because bamboo charcoal can be naturally rejuvenated under the sun for 1 ur after a month of use and has a very high surface area, very irregular pore structure with a pore size of 5 - 500 Angstrom non-polar which allows the adsorption of various chemicals [10], [11]. Each part of the bamboo stem of the same speci has different specific gravity and yield. Charcoal from the bottom of the stem on all types of bamboo showed high specific gravity and more high is lower [12]. Air purifier from bamboo-based activated charcoal combined with ginger rhizome extract has the potential as an anti-microba and antioxidant so it is hope that the food is not oxidize naturally because the components in ginger extract contain g ngerol, shogaol, zingerone which have antioxidant, anti-carcinogenic, non-mutagenic effects even at high concentrations. The main component of fresh ginger is a homologous phenolic ketone ompound known as gingerol which is unstable when exposed to heat so that it turns into shogaol. The rate of degradation from [6]-gingerol to [6]-shogaol depends on the pH which is stable at pH 4 while at 100°C it is stable at pH 1 3]. The shogaol compound has the advantage of being an anti-virus [14]. Ginger rhizome extract, especially red has sesquiterpene secondary metabolite compounds that can inhibit the growth of avian influenza and influenza virus [15], [16].

During the post covid-19 pandemic, the air purifiers are currently quite expensive, for the middle and lower class society who are underprivileged to use a cooling machine or use a high-efficiency particle air filter (HEPA). Therefore, it is necessary to find solution using a air filter made from easily available so that the price is easy to reach. One way that can be done is to make an activated ch air filter made from ori bamboo combined with powder. The composition of these two materials will affect the quality of the filter, both in shape or function. So there is a need for further experiments in determining the right composition in the manufacture of air filters.

METHOD

original bamboo and red ginger filter materials were obtained from the Precet DAU Malang. The proces manufacture of this air filter consists of 3 stages, namely:

1. Making ori bamboo charcoal activated

   In the manufacture of activated charcoal, the original bamboo as the material for making charcoal is cut into ieces with a length of 20 cm, then dried in the sun for 10 days. The dried bamboo is put into a furnace which is equipped with a thermocontrol and blower. Composing this bamboo with a 100% maturity level using a temperature of 442 C for 2 hours. After reaching 2 hours the charcoal is cooled in the furnace for 24 hours. The c oling in the furnace is doing so the charcoals is still in high emperature conditions is not contaminated with air which causes the harcoals to turn to ash.

   The cooled original bamboo charcoal is then powdered with 100 mesh flour machine. After that, the charcoal ctivation process is carried out using chemical methods. In the chemical activation process, 1 kg ch rcoal is soaked 1800 ml of CaCl2 solution for 24 hours at room t mperature. Then the charcoal bath is drained and then put into the furnace.

   Charcoal immersion which is inserted into the furnace is reheated at a temperature of 500ºC for 2 hours and holding for 30 minutes. After reaching the temperature, the furnace is turned off and the activated charcoal is cooled in the furnace for 24 hours. And then the activated charcoal that has cooled is grinded until it becom s a powder with a size of 100 mesh. Then the activated charcoal powder is put into an airtight container.

2. Proces of making ginger powder

   Before making ginger powder, ginger as a raw material is cleaned of dirt. After that, the ginger is peeled and cleaned again. The next process is thinly sliced gi r and put into a grinder machine. Ginger that has been grinded, squeezed and separated between the liquid and ginger pulp. Then, the separated dregs were put into a dehydrator at 70ºC for 5 hours. The dried and cold ginger dregs are grinded until it becomes ginger powder. Then the ginger powder is stored in a sterilized place.

3. Filter Making Process

First step on the process of making filters are each material is weighed first. Then the activated bamboo charcoal, ginger powder and calcium food grade adhesive are mixed until evenly distributed. After that enter the distilled water, then stir until evenly distributed. The second step, the hydraulic press which is equipped with a heater is turned on. Set the hydraulic press machine heater temperature to 50 ºC. the mixture of activated charcoal ori bamboo with other ingredients placed into the mold, then pressed to a pressure of 100 bar for 10 minutes. After that the filter was cooled using free air at room temperature for 30 minutes. The cooled filter was put into a dehydrator at 40º C for 5 hours. Then the filter is packed using aluminum foil and sealed with vacuum plastic.

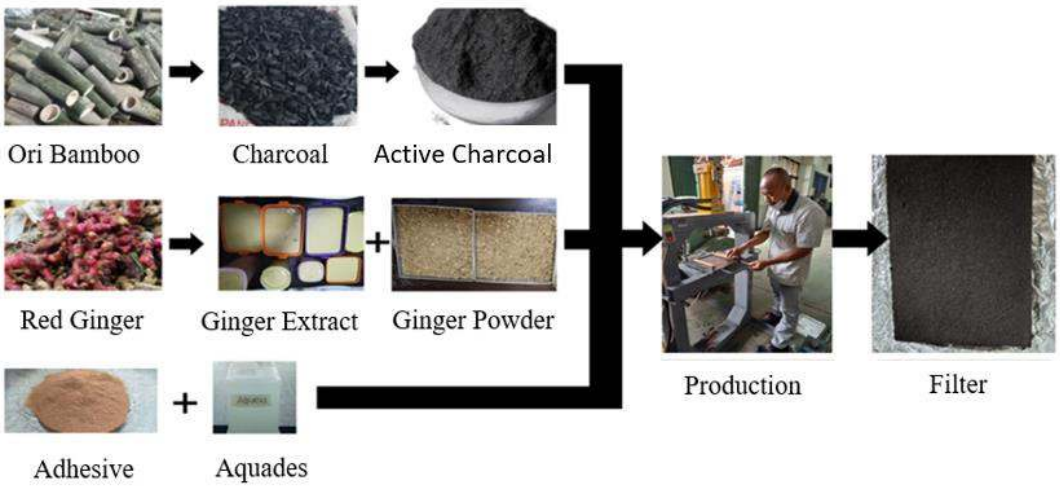


Fig. 1. Filter making process

The composition of the ratio of activated charcoal ori bamboo and ginger powder used in this research was 4:0, 3:1, 2:2, 1:3, 0:4. For the other mixed materials, it is assumed that the adhesive is calcium food grade 40 grams and aquades 100 grams. The filter mold used is 20 x 20 cm. The analysis carried out on the air filter to determine the effect of the composition of the alloy material and the condition of the activated charcoal material took SEM-EDX analysis, organoleptic analysis and microba analysis. The tools which used in this reseach are shown below.

(A) (B)

Fig. 2. (A) Furnace for Charcoal, (B) Furnace Activated Charcoal

(A) (B)

Fig. 3. (A) Press machine 5T, (B) Food storage cabinets with data logger

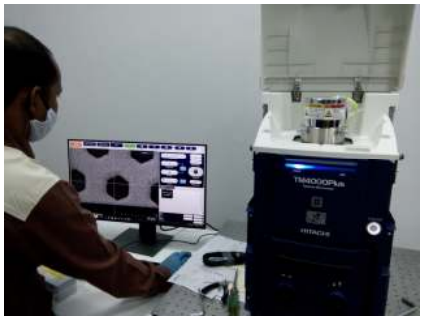


Fig. 4. SEM - EDX

DISCUSSION

Table 1. Filter Characteristics of Activated Charcoal and Red Ginger Extract before the trial

No	Filter Composition	Compound Mass (%)									
		C	O	Ca	Na	Cl	K	S	Al	F	Si
1	200 g Active Charcoal	32,66	59,67	5,67	-	19,59	-	0,54	16,72	0,57	
2	50% 1 Active Charcoal	55,08	35,31	3,68	0,90	3,70	0,52	0,81			
3	50% 100 g Active Charcoal	8,74	9,35	3,64	52	3,21	03	58	-	-	-
4	50% 50 g Active Charcoal	6,52	4,79	56	76	1,59	53	27	-	-	-
5	200 g Active Charcoal	65,50	25,09	2,58	1,83	2,31	0,52	1,61	-	-	0,57
6	50 g Active Charcoal	1,41	21,54	13,82	1,53	8,85	-	2,32	-	-	2,56
7	75% 100 g Active Charcoal	6,82	8,45	5,43	17	4,11	34	90	-	5	-
8	75% 50 g Active Charcoal	47,42	2,70	2,65	35	2,45	61	1,14	-	-	0,68
9	100% 150 g Active Charcoal	47,42	40,79	7,49	1,86	8,40	1,10	2,01	-	0,59	-

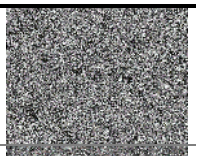
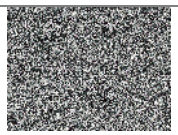
10	100% 100 g Active Charcoal	56,04	33,99	3,48	1,22	3,16	0,94	1,16	-	-	-
11	100% 50 g Active Charcoal	46,98	44,09	2,53	1,46	1,70	1,60	1,63	-	-	-
12	200 g Gingers	42,81	51,15	0,46	1,74	-	2,34	1,49	-	-	-

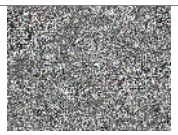
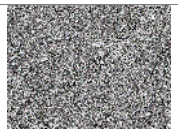
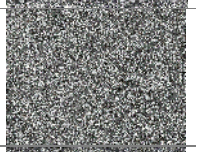
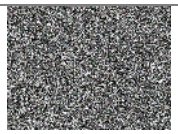
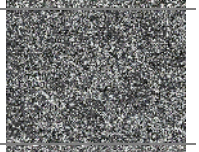
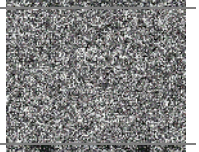
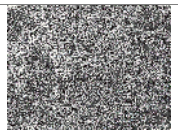
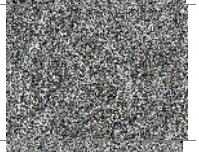
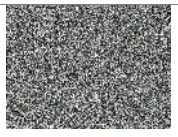
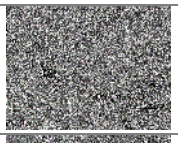
The results of the analysis characteristics filter blend of activated charcoal and red ginger extract in table 1 can be concluded that different filter compositions have different mineral content, especially in charcoal with 100% maturity. The SEM EDX results from the filter using charcoal with 100% maturity have more open pores than those using charcoal with 50% and 75% maturity as shown in table 3. It is expected that the filter using a mixture of 100% cooked charcoal and ginger extract can produce a filter with high absorption

Table 2. Filter Characteristics of Activated Charcoal and Red Ginger Extract after the trial.

No	**Filter Composition**	**Compound Mass (%)**									
		C	O	Ca	Na	Cl	K	S	P	Si	Fe
1	50% 200 g Active Charcoal	59,41	34,85	9,10	1,24	7,18	-	1,57	-	0,69	0,13
2	50% 150 g Active Charcoal	42,41	21,65	3,67	0,47	3,50	0,50	0,70	-	-	0,13
3	50% 100 g Active Charcoal	39,78	27,60	3,12	0,88	2,93	0,86	0,70	-	-	-
4	50% 50 g Active Charcoal	48,74	42,81	2,03	2,10	1,70	1,34	1,28	-	-	-
5	75% 200 g Active Charcoal	64,76	25,91	2,96	1,76	2,50	0,70	1,68	-	-	0,66
6	75% 150 g Active Charcoal	41,44	31,12	5,37	0,93	4,77	0,69	1,15	-	1,63	2,74
7	75% 100 g Active Charcoal	41,76	45,35	7,38	1,45	4,95	0,97	3,29	-	0,37	-
8	75% 50 g Active Charcoal	24,73	21,72	2,15	0,54	2,33	1,53	0,87	-	-	-
9	100% 150 g Active Charcoal	40,80	50,58	10,82	0,96	4,50	0,68	4,28	-	1,28	2,52
10	100% 100 g Active Charcoal	28,25	21,82	3,75	0,45	2,39	0,73	0,88	-	-	-
11	100% 50 g Active Charcoal	49,67	40,85	2,27	1,91	1,97	1,62	1,71	-	-	
12	200 g Gingers	30,94	35,63	0,43	1,95	-	2,46	1,57	0,58	-	0,42

Table 3. The photos results of SEM before and after the trial

No	**Filter Composition**	**The image SEM before trial**	**The image SEM after trial**
1	50% 200 g Active Charcoal		
2	50% 150 g Active Charcoal		

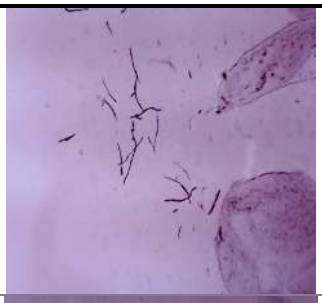
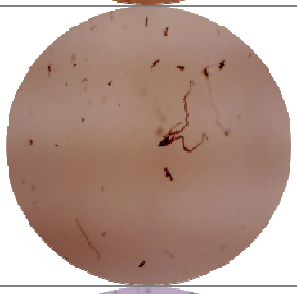
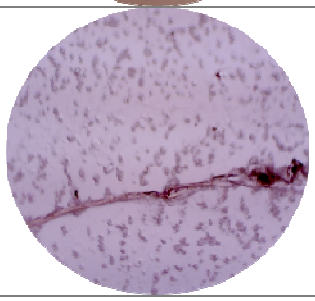
3	50% 100 g Active Charcoal		
4	50% 50 g Active Charcoal		
5	75% 200 g Active Charcoal		
6	75% 150 g Active Charcoal		
7	75% 100 g Active Charcoal		
8	75% 50 g Active Charcoal		
9	100% 150 g Active Charcoal		
10	100% 100 g Active Charcoal		
11	100% 50 g Active Charcoal		
12	200 g Gingers		

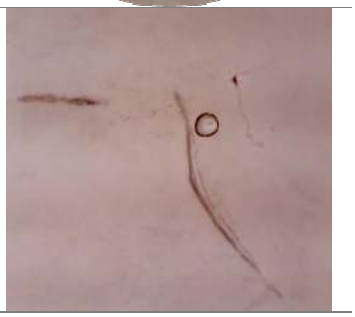
results of SEM-EDX test, there are metal compounds that appear after the filter was used. One of the heavy metal compounds is ferrous metal (Fe). This is due to the metal ion adsorption process carried out by activated carbon which is a non-polar adsorbent due to the Van Der Waals force. The unbalanced forces at the filter pha boundary because of strange molecules to be attracted to the filter surface, so that making a single layer on the adsorbent surface. Metal ions diffuse to the pores of the activated carbon due to differences concentration of the adsorbate and the pores of carbon [17]–[19].

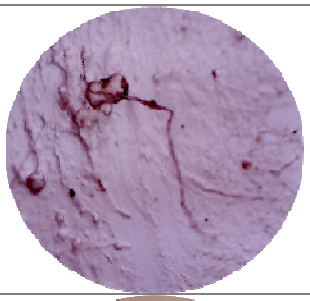
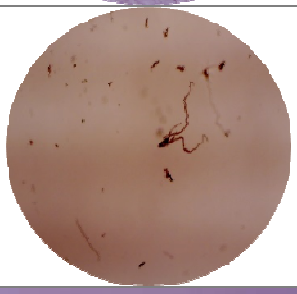
The trial results of the filter blend of activated charcoal and red ginger extract in table 2 can be concluded that in ddition to increasing filter weight, the filter is also getting more humid. The test food material has physical changes due o the growth of microbes. After microbiological analysis, it turned out that the average growth was B cillus Substillis, was only one sample that contained Staphylococcus and Rhizopus while other microbes including viruses were not detected. The cabinet does not bad smell, the test sample doesn't bad smell either. It means that the filter can be used as an odor remover and anti-microba, especially virus. In the food storage cabinets, Bacillus substilis can grow because there is charcoal (carbon) in the filter which can accelerate its growth and these bacteria are always in the air [3]. Red

ginger has shogaol compound that functions as an antiviral but cannot kill Bacillus substilis bacteria, because of that even though it has been mixed with Bacillus anti-virus, it is still present [4]. According to research results Bacillus Substilis is not a harmful microbe. In another observation if the filter made is not added with ginger extract (pure activated charcoal) the air in the cupboard also does not bad smell but the filter becomes moist and eventually at a certain time will be destroyed and liquid comes out of the filter so that the air filter in the food cupboard can not only made of activated charcoal only.

Table 4. The results of microba growth analysis on material test day 5

No.	Filter Composition	The Microba species	Day in	The Microba amount	Pictures
1.	No filter	Bacillus Cereus	2	47	
2	50% 200 g Active Charcoal	Bacillus Subtillis	3	16	
3	50% 150 g Active Charcoal	Bacillus Subtillis	4	6	
4	50% 100 g Active Charcoal	Bacillus Subtillis	4	9	
5	50% 50 g Active Charcoal	Bacillus Subtillis	4	10	

6	75% 200 g Active Charcoal	Bacillus Subtillis	3	11	
7	75% 150 g Active Charcoal	Bacillus Subtillis	5	16	
8	75% 100 g Active Charcoal	Bacillus Subtillis	5	20	
9	75% 50 g Active Charcoal	Bacillus Subtillis	4	8	
10	100% 200 g Active Charcoal		3	11	
11	100% 150 g Active Charcoal	-	3	0	

12	100% 100 g Active Charcoal	Bacillus Subtillis	5	9	
13	100% 50 g Active Charcoal	Bacillus Subtillis	5	15	
14	200 g Gingers	Bacillus Subtillis	3	4	

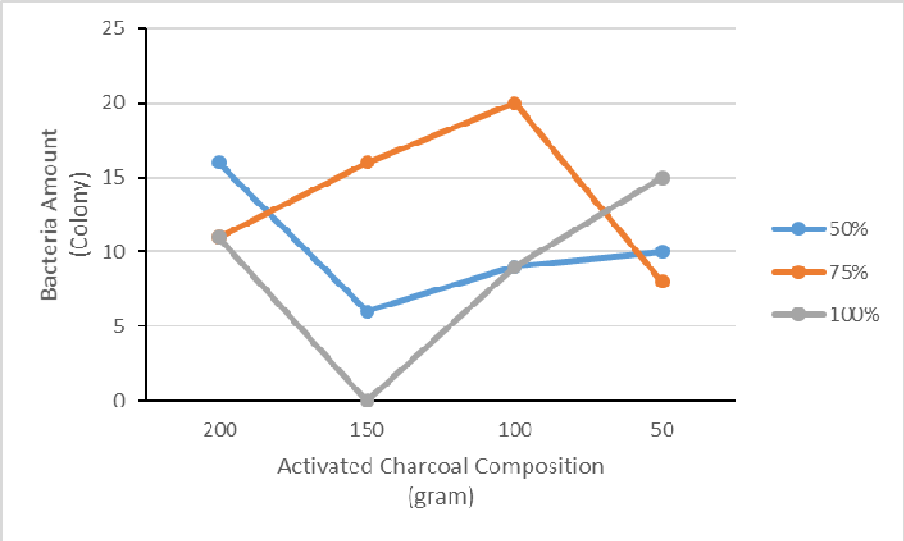


Fig. 5. The graph of the activated charcoal composition on the bacteria amount at the level of charcoal maturity

In the cabinet which use air filtered, microbes began to grow in the test material on day 3 (three) with different numbers of colonies, while the test material placed in the unfiltered cabinet began to grow on day 2 (two). From these observations it can be concluded that the filtered food cupboard is in better condition than without he filter. Although re are bacteria that grow on food, Bacillus Subtillis bacteria are still classified as harmless bacteria. From the results of these research, it can be concluded that the addition of an air filter with a 100% maturity percentage can slow down the growth rate, this can be proven by observations on the 3rd day of bacteria still not appearing. Bacillus Subtillis bacteria will appear on day 5 with a small number of colonies compared to other air filter compositions. This is because Bacillus subtillis bacteria can survive at a temperature of -5ºC - 75ºC with a pH of 2-8 and grow 2 times at a temperature of 40ºC

20]. According to the moisture logger data in food storage cabinets, during the trial the average hum dity in the storage cabinet was 65% - 75% at room temperature 27ºC - 28ºC. The average humidity is still relatively high when compared to humidity outside the food storage cabinet, which is 85%. That is causes the bacteria Bacillus subtillis grow in the sample. The results of previous research, it was stated that bacteria will thrive in conditions of high humidity [21]. In the rial in this study, the food sample used was tofu. Tofu is a carbon source, so the growth of bacteria will increase in tofu. This is because the carbon source is the most important factor in bacterial growth [22].

CONCLUSION

From the final results of the research it can be concluded that different filter compositions have different mineral content lso, especially in charcoal with 100% maturity. SEM EDX results from filters which used charcoal with 100% maturity have more open pores than those using charcoal with 50% and 75% maturity. With apply 100% charcoal maturity level and 100 grams composition of activate charcoal bamboo, be able to delay the growth rate of bacteria and viruses. It be evidenced with this composition, the bacteria on tofu which become sample test grow after 5th day after the compared test with other compositions, where bacteria could grow on the 4th ay.

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