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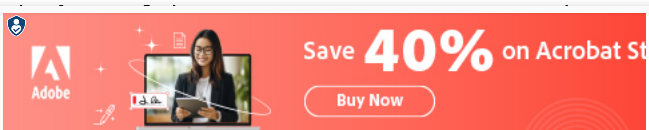

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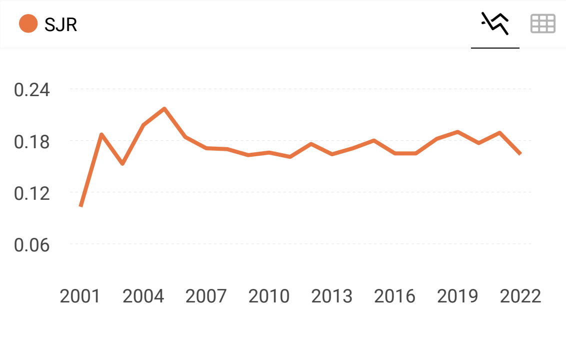


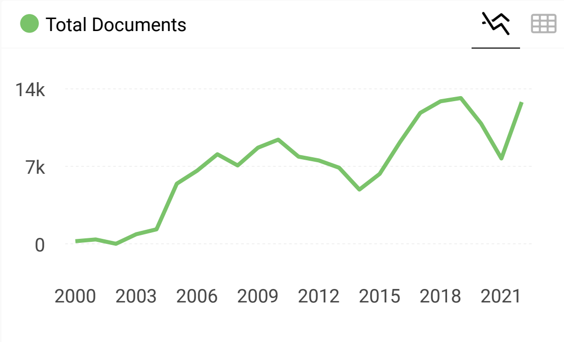


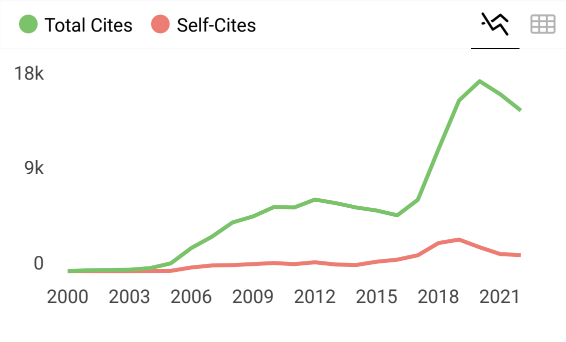


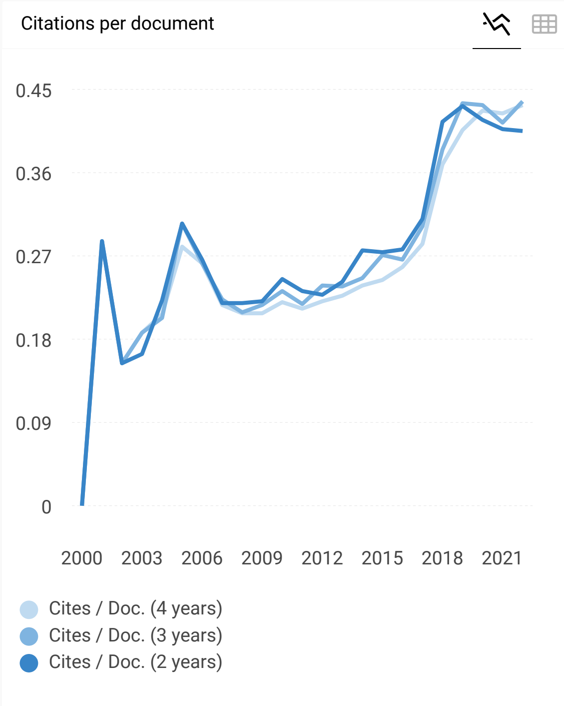


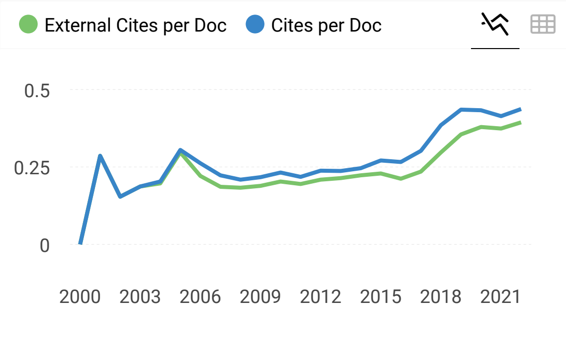


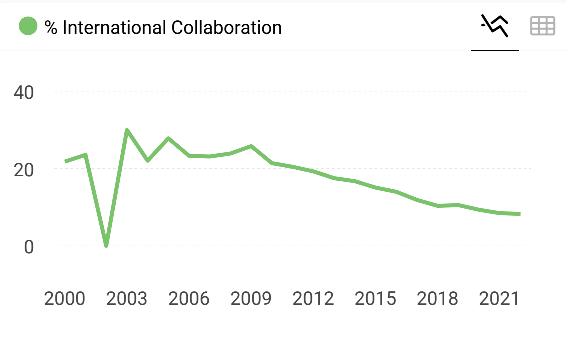


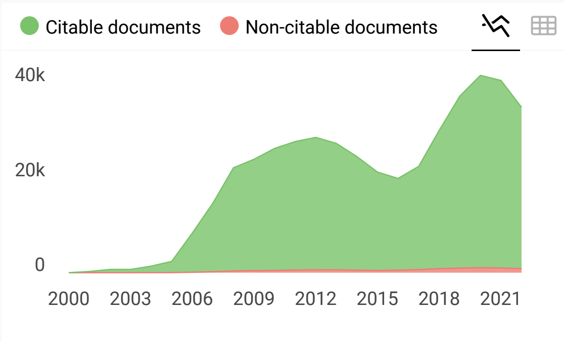


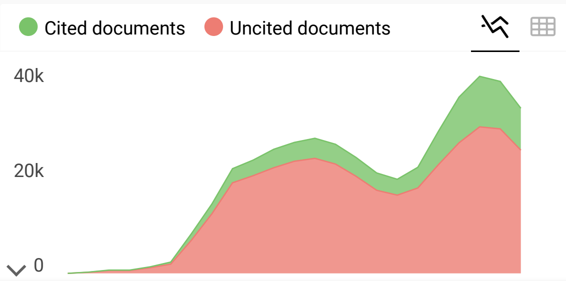



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# Brackish Water Treatment With Sustainable Local Materials

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**Abstract.** Water is a natural resource that has a very important function for all living things. However, 97.2% of the water on earth cannot be consumed. In 2019, according to the Central Statistics Agency, Indonesia reached 89.27% of access to clean water. It means that there are still some areas that still lack clean water. Likewise, the area of Tegal Sari, Kupang Village, Jabon District, Sidoarjo Regency, East Java Province, where the area is experiencing problems with brackish well water. This research aims to find the right sustainable material ratio that can be used at the research location as brackish water treatment. The research method used is the experimental method to determine the effect of treatment on the test object. The treatment carried out is by flowing water through activated carbon, kaolin, sand, or gravel with a certain ratio to make the power of hydrogen (pH), total dissolved solids (TDS), and electrical conductivity (EC) of water according to WHO standards. Based on the experiment, it is known that the use of the material can reduce the pH, TDS, and EC of brackish water. The best results from the experiments carried out were a decrease in pH from 8.18 to 7.77, TDS from 2870 ppm to 1389 ppm, and EC from 5790 ms/cm to 2770 ms/cm with a ratio of 1 tube of kaolin, 1 tube of activated carbon and gravel sand gravel ratio 1: 3: 1 in 1 tube and aquarium.

## INTRODUCTION

Water is a natural resource that has a very important function for all living things. As much as ¾ of the earth is covered by water, both on land and in the atmosphere. 97.2% of the water on earth is saltwater [1]. Due to the limited amount of freshwater, in 2012 as many as 748 million people in the world did not have access to drinking water and there were 1.7 million deaths each year due to lack of safe drinking water [2].

Indonesia itself in 2019 according to the Central Statistics Agency reached 89.27% of access to clean water, which means that there are still some areas that still lack clean water [3]. To deal with this problem, research was initiated to make a water treatment that utilizes local materials that are easy to obtain and inexpensive. The materials used are sand, gravel, activated carbon, and kaolin, which will convert brackish water into clean water that is suitable for daily life, especially for drinking water [4].

Since, sustainable development was inroduced and applying in this research area including Tegal Sari, Kupang Village, Jabon District, Sidoarjo Regency, East Java Province [5, 6, 7]. Thus, this research aims to find the right sustainable material ratio that can be used at the research location as brackish water treatment. The area to be reviewed in the area of

## LITERATURE REVIEW

Brackish water is water that has a salinity between 0.5 ppt to 17 ppt. Within salinity greater than 0.5 ppt, brackish water cannot be used as drinking water, nor can it be used for washing or bathing activities. Brackish water, which has a sodium content of greater than 200 ppm, will cause health problems if consumed continuously. For industrial activities, brackish water which has high salinity will cause corrosion of the equipment and pipes used [8]. To deal with these problems then research began by utilizing local materials as water filters. The materials used in this research are sand, gravel, activated carbon, and kaolin.

The materials used in this research are sand, gravel, activated carbon, and kaolin. The sand material used in this filter is Lumajang sand. This sand has a characteristic dark gray to blackish color and has a high degree of fineness [9]. In the sand water filter, the task is to reduce the content of mud and other solid materials. The finer the pollutants are filtered, the fine sand is also needed. The second material is Gravel. Gravel is a grain of rock that is larger than sand and smaller than the crust, it has a smooth texture and round in shape. The function of gravel in the water filter is to filter coarse dirt and as a gap, so that water can flow through the pipe under the filter [10]. The next material is activated carbon. It is charcoal that has been processed in such a way which has a high absorption capacity for materials in the form of solution or vapor. Activated carbon can be made from basic materials that contain carbon. In water purification, activated carbon has a role in removing / filtering odors, colors, pollutants in water, as protection and exchange of resins in water distillation tools or [11]. The last material is kaolin, which is a kind of clay mineral. Geologically, kaolin is formed by weathering processes and hydrothermal alteration in felspathic igneous rocks [12]. The function of kaolin is to remove disturbing minerals such as quartz sand, iron oxidant minerals, titanium oxide, and mica, besides that, the use of kaolin can also be used to get fine grains, high whiteness levels, certain water content, certain pH, and properties. others [13].

The indicators examined in this study were Power of Hydrogen (pH), Total Dissolved Solids (TDS), and Electrical Conductivity (EC). The first indicator is pH or degree of acidity, which is the level of acid or base of a solution. It has a scale of 0-14. In the United States Geological Survey (USGS) (2019) which is based on the book by Swenson and Baldwin, pHs have a value less than 7 categorized as acidic. Then, pH values greater than 7 are categorized as alkaline, and a pH value of 7 is neutral [14]. According to the standards of the World Health Organization (WHO) , the pH limit for drinking water is between 6.5 and 9.2 [15]. The second indicator is TDS which is an indicator of the number of particles or substances, both in the form of organic and non-organic compounds. The units used are usually ppm (parts per million) or equal to milligrams per liter (mg / l) [16]. According to the World Health Organization (WHO), the TDS contained in drinking water is less than 500 mg / l [12]. The last indicator is EC or conductivity which is a numerical representation of water's ability to conduct electricity. Water that has a high salt content has a higher EC value too. EC is expressed in units of ms/cm, which can be detected using an EC meter. EC measurements aim to predict the mineral content in water. Since the water has a conductivity value too high, it can settle in the body and damage kidney stones (Khairunnas & Gusman, 2018). According to the World Health Organization (WHO), the conductivity of potable water is less than 300 ms/cm [15].

## RESEARCH METHOD

The research was conducted in the Petra Christian University water laboratory. The research begins by preparing the tools to be used (Figure 1a). After the necessary tools have been obtained, we can assemble the tools according to the predetermined design as in Figure 1b.With the completion assembling the tools we can enter the next stage, namely the sampling process in Tegal Sari Hamlet, Kupang Village, Jabon District, Sidoarjo Regency, East Java Province. Water is taken from one of the residents' houses there (Figure 1c). After the sample is obtained, the sample can be tested for pH, TDS, and Ec values (Figure 1d).

a b c d

**FIGURE 1.** Research Method

After the sample test results are known, the sample can be tested according to the amount of material to be used (Figure 2. The order of materials that have been tested can be seen in Table 1. The experiment is continued by preparing the material to be tested. This material preparation step is carried out by washing materials such as sand and gravel so that they are clean from dust or dirt. After the material is washed, it is followed by drying the material. After the material is inserted into the filter tube, the filter tube will be installed on a device that has been made with the specified material order. After the filter is installed, brackish water can flow through the filters from the material. After the sample is tested, the test results obtained will be tested (Figure 2). It will be checked whether the results comply with the predetermined standards or not. If the test results are not according to the standard, the experiment will be repeated with a different number of independent variables and if it is according to the standard, the research is complete.

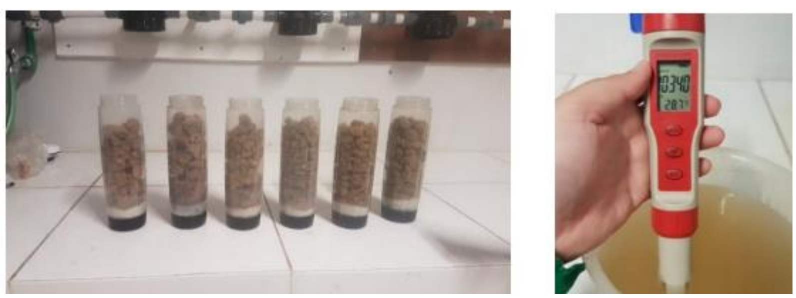

**FIGURE 2.** Testing and testing results

## RESULTS AND ANALYSIS

The indicators examined in this study were the pH, TDS, and EC values of each experiment. The data that has been obtained will be checked how much the material used affects the sample used. As well as comparing the results of this study according to WHO standard or not. The standard that is checked first is pH. Based on the World Health Organization (WHO) (1997), the pH of drinking water is 6.5-9.2. From table 2 it can be seen that the pH after the study has met WHO standards. The second standard examined is TDS. The TDS standard for drinking water according to the World Health Organization (WHO) (1997), is less than 500 ppm. From Table 2, we can see that the largest decrease occurred in the second experiment where TDS decreased by 1481 ppm. The last standard checked is EC.

**TABLE 1.** Experimental and result of the brackish water treatment

| Trial | Test of the Material Combination | | | | | | | Result of the Water Sample | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pH | | TDS | | EC | |
| | | | | | | | | Before | After | Before | After | Before | After |
| 1 | KAO | KA | KPK | | | | | 8,18 | 7,84 | 2870 | 2810 | 5790 | 5630 |
| 2 | KAO | KA | KPK | | | | A | 8,18 | 7,77 | 2870 | 1389 | 5790 | 2770 |
| 3 | KAO | KAO | KA | | | | | 8,18 | 7,56 | 2870 | 2850 | 5790 | 5190 |
| 4 | KAO | KAO | KA | | | | A | 8,18 | 7,67 | 2870 | 2640 | 5790 | 5290 |
| 5 | KA | KA | KPK | | | | | 8 | 8,04 | 3200 | 3030 | 6400 | 6060 |
| 6 | KA | KPK | KA | | | | | 8 | 7,96 | 3200 | 3010 | 6400 | 6070 |
| 7 | KPK | KA | KA | | | | | 8 | 8,04 | 3200 | 3050 | 6400 | 6110 |
| 8 | KPK | KPK | KA | | | | | 8 | 7,9 | 3200 | 3020 | 6400 | 6080 |
| 9 | KPK | KA | KPK | | | | | 8 | 7,9 | 3200 | 3140 | 6400 | 6190 |
| 10 | KA | KPK | KPK | | | | | 8 | 8 | 3200 | 3100 | 6400 | 6200 |
| 11 | KA | KA | KA | | | | | 8 | 8,1 | 3200 | 2970 | 6400 | 5970 |
| 12 | KA | KA | KA | KA | KA | KA | | 8 | 8,1 | 3200 | 2980 | 6400 | 5980 |
| 13 | KAO | KAO | KA | KA | KA | KA | | 7,9 | 7,9 | 3520 | 3430 | 7050 | 6940 |
| 14 | KAO | KAO | KA | KA | KA | KA | | 7,9 | 8 | 3520 | 3760 | 7050 | 7580 |
| 15 | FILTER | KA | KA | KA | | | | 8,2 | 8,1 | 4390 | 4350 | 8860 | 8730 |
| 16 | KAO | KA | KA | KA | FILTER | | | 8,2 | 7,7 | 4390 | 4400 | 8860 | 8800 |
| 17 | KAO | | | | | | | 8,1 | 7,9 | 5060 | 5060 | 10150 | 10020 |
| 18 | KAO | KAO | | | | | | 8,1 | 7,9 | 5060 | 5020 | 10150 | 10020 |
| 19 | KAO | KAO | KAO | | | | | 8,1 | 7,9 | 5060 | 5100 | 10150 | 10220 |
| 20 | KAO | KAO | KAO | KAO | | | | 8,1 | 7,9 | 5060 | 5020 | 10150 | 10160 |
| 21 | KAO | KAO | KAO | KAO | KAO | | | 8,1 | 7,9 | 5060 | 5130 | 10150 | 10280 |
| 22 | KAO | KAO | KAO | KAO | KAO | KAO | | 8,1 | 7,9 | 5060 | 5150 | 10150 | 10320 |
| 23 | P | | | | | | | 8,1 | 7,7 | 5330 | 5250 | 10670 | 10500 |
| 24 | P | P | | | | | | 8,1 | 7,5 | 5330 | 5230 | 10670 | 10480 |
| 25 | P | P | P | | | | | 8,1 | 7,6 | 5330 | 5230 | 10670 | 10480 |
| 26 | P | P | P | P | | | | 8,1 | 7,5 | 5330 | 5210 | 10670 | 10420 |
| 27 | P | P | P | P | P | | | 8,1 | 7,5 | 5330 | 5160 | 10670 | 10350 |
| 28 | P | P | P | P | P | P | | 8,1 | 7,5 | 5330 | 5280 | 10670 | 10570 |
| 29 | KA | | | | | | | 8,1 | 8 | 5330 | 5200 | 10670 | 10400 |
| 30 | KA | KA | | | | | | 8,1 | 8 | 5330 | 5170 | 10670 | 10340 |
| 31 | KA | KA | KA | | | | | 8,1 | 8 | 5330 | 5150 | 10670 | 10300 |
| 32 | KA | KA | KA | KA | | | | 8,1 | 8 | 5330 | 5250 | 10670 | 10500 |
| 33 | KA | KA | KA | KA | KA | | | 8,1 | 8 | 5330 | 5230 | 10670 | 10460 |
| 34 | KA | KA | KA | KA | KA | KA | | 8,1 | 8 | 5330 | 5260 | 10670 | 10520 |

Remarks:

KAO: Kaolin; KA: Activated Carbon; KPK: Gravel, Sand, Gravel; FILTER = Filter 10 micron; P: Sand; A : Aquarium containing small sand gravels in the ratio 1: 3: 1; pH = Power of hydrogen; TDS :Total Dissolved Solids; EC : Electrical Conductivity

The EC standard for drinking water according to the World Health Organization (WHO) (2003) is less than 300 ms/cm. As in TDS, the largest decrease in EC occurred in experiment 2 where the EC decreased by 3020 ms/cm.

To see the development of pH, TDS and EC during the study can be seen in Figure 3. The same way and the same method for TDS and EC. Apart from being compared with the WHO standard, the experimental results will also be compared with the Reverse Osmosis (RO) tool sold in the market. Where the results obtained from the RO tool are pH of 8.4, TDS of 435 ppm and EC of 870 ms / cm.

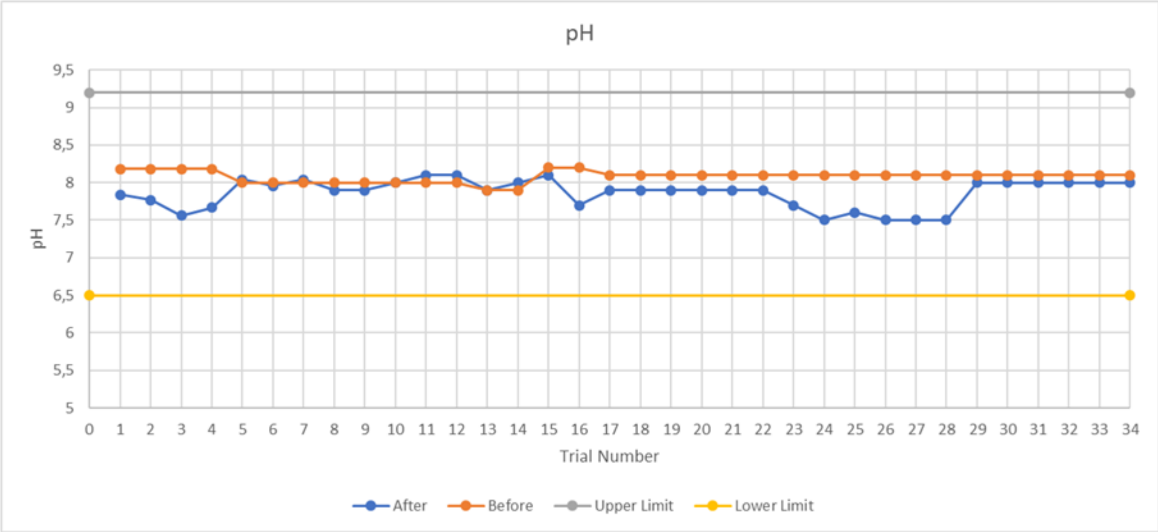


**FIGURE 3.** Improvement of pH Before and After the Experiment

## CONCLUSION

Regarding the research that has been done, it can be concluded:

1. The most optimum material ratio in this research is 1 tube of kaolin, 1 tube of activated carbon, 1 tube of 1: 3: 1 ratio of crust, sand, gravel. And through the aquarium with dimensions of 30x60x31 cm which contains gravel, sand, and gravel with a ratio of 1: 3: 1. Where pH decreased by 5.01%, TDS fell by 51.60% and EC fell by 52.16%.
2. To make this water treatment work, preparatory steps are needed for the material that has been selected. This preparation step is a material activation step both chemically and physically which can increase the absorption of the material.
3. The selected material can be used as a brackish water purifier, but the use of this material is not yet optimum due to inaccurate preparation steps. Therefore, this experiment still cannot replace the water treatment on the market where the reverse osmosis device on the market can reduce the TDS and EC of water by up to 91.7% and increase the pH by 6.3%.

## SUGGESTIONS

Regarding this research, it can be suggested for further research that the properties of brackish water should be examined in more detail. Thus, it can find materials that can handle the problem appropriately.

## ACKNOWLEDGMENTS

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