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EVALUATION OF CERAMIC WATER FILTER ABSORBENT POT PRODUCED FROM BLENDING GROUNDNUT SHELL AND RICE HUSK FOR RURAL WATER PURIFICATION

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ABSTRACT

Lack of portable drinking water in some rural areas remains a Borden issue, because of the health effects associated with contaminated water. With the help of clay and biomass samples from Kaura Namoda Zamfara, this study intends to produce a ceramic water filter pot blend biomass as a substitute water purifier for rural areas. The physical properties of clay, namely moisture content (11.55%), specific gravity (1.84%), dry density (1.41%), liquid limit (38.84%), and shrinkage (11.70%), were determined using standard analytical methods. The stream water from Yankaba village was filtered using the two ceramic pots made from various biomasses at varying clay to biomass ratios. Turbidity, conductivity, alkalinity, iron, sulfate, and silica have all been effectively reduced, with average reductions of 58%, 60%, 40%, 68%, 76%, and 81%, according to the data. When the two ceramic pots were compared statistically, it was found that the ceramic pot made from groundnut shell and rice husk in the ratios of 60:20:20 and 50:25:25 had significantly higher filtration efficiency. Consequently, it was determined that in order to stop the spread of waterborne illnesses in rural areas, it should be urged to use ceramic pot filters.
Keyword: Ceramic Pot, Stream Water, Filtration, Physicochemical Parameter

I.INTRODUCTION

In developing nations like Nigeria, the scarcity of clean drinking water and the frequency of waterborne illnesses are severe. Maintaining the public's health requires ensuring that substantial number of people has access to clean drinking water. More than 1.1 billion people worldwide do not have access to clean drinking water, which can result in serious health problems like diarrheal illnesses [1]. According to recent meta-analyses of field studies, the prevalence of diarrheal illnesses is considerably decreased by safe storage and household-based water quality treatment [2].[3]. Many organizations have started developing drinking water treatment methods that are suited to the tropical climates seen in poor nations as a reaction to these difficulties [4].

Ceramic water filtration has become a valuable among the other technologies in the fight against waterborne illnesses and poor access to clean drinking water and the communities trying to improved access to clean water sources and lower the prevalence of waterborne illnesses [5].

The ceramic pots filter (CPF), made from resources readily available locally, and are one such technique that is gaining popularity [6]. These filters are an affordable option for point-of-use water treatment in rural settings, as they have been demonstrated in literature to remove 99.88% of waterborne disease pathogens [7]. The application of CPF improves public health outcomes by addressing the cost-effectiveness and efficacy of water treatment in environments with limited resources [8].

The development and promotion of technologies like ceramic water filtration are crucial steps towards achieving access to clean water and better health outcomes, especially in vulnerable communities worldwide, given the ongoing challenges associated with waterborne diseases and limited access to safe drinking water [9]. Traditional water treatment methods, such as chlorine and activated carbon, can be costly and inaccessible to low-income earners [10]. As a more cost-effective substitute, the use of clay filters for water filtration has grown in popularity. Across the world, ceramic filtration—which uses filters made of clay—has become a popular technique for treating home water. Various studies have been conducted on the production and effectiveness of ceramics filter pot. But in Zamfara state where we have abundant agricultural waste such rice husk and groundnut shells, little or known research has been carried out on the use of clay blend with this biomass to produce ceramic filter pot. The findings of this research could have implications for improving access to clean and safe drinking water, ultimately reducing the burden of waterborne diseases among the underserved [11].

II.MATERIAL AND METHODS

Samples Collection

Clay, Rice Husk, and Ground Shell were collected from a local rice milling site in the Kuriya area of Kaura Namoda, Zamfara state. Clay and water samples were also obtained from a village called Yankaba, as shown in the map. The clay samples obtained from Yankaba village, Kaura Namoda, Zamfara, are from the village where the majority of the local clay factories source their clay. The clay was dark brown and crystalline in color and c texture

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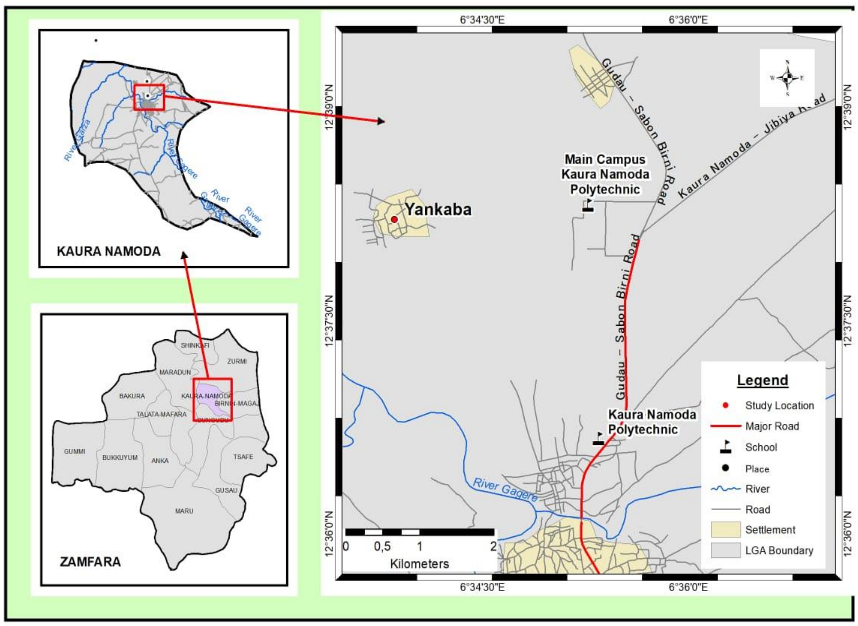

Sample Preparation and Analysis

The rice husk and groundnut shell samples were dried and filtered to remove all deities. The cleaned sample was stored in a polythene bag for the production of ceramic pots. The clay sample was also sieved to remove the particles.

Physical Properties of Clay

The following physical properties were carried out on the clay sample: moisture content, specific gravity, dry density, shrinkage, and liquid limit. The specific gravity and shrinkage limit of the clay samples was determined according to the analytical method described by [12] but slightly modified.

Production of Ceramic Water Filters

Ceramic filter pots were produced using local techniques and methods described by [13].Ground nut shell and rice husk were grated into powder and sieved then mixed with the clay samples in the following rations of clay to groundnut shells and rice husk: 60: 20 : 20, to obtained two different ceramic filter pot. (CFP). The bottom of the filter, which was affected by the mixture of clay, groundnut shell, and rice husk, was intended to have filtration capacity. In order to guarantee a precise flow rate, this was done. The pots was Each for air dried for ten days and the cracking of mold was taken care of by ensuring a homogenous mixture and air and air dried for another 10 days. The ceramic filter pot was heated at temperature of 800^{oC} to 1000^{oC} in a furnace for 8 hours [13].

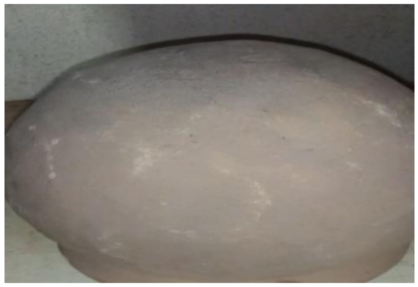
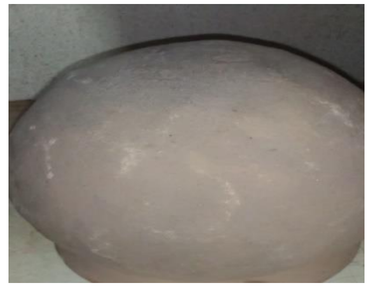

Figure 1 ceramic filter pot

Physicochemical Analysis of Open Stream Water before Filtration and After Filtration

Electrical conductivity, total dissolved solids, and pH of the stream water sampled were measured with a pH meter, the gravimetric method for total dissolved solids, and a conductivity meter, as described by [14]. Turbidity was carried out using the Nephelometric method. Bicarbonate; carbonate alkalinity as $CaCO_3$, total alkalinity, and total hardness were carried out by the titrimetric method as described by [14]. The spectrometry method was used for the determination of nitrate and nitrite in the water samples before and after filtration [5].

III.RESULT AND DISCUSSION

Table 1 Physical properties of clay

Properties	**Amount**
Moisture %	11.55
Specific gravity %	1.84
Dry density g/cm	1.41
Liquid limit %	38.84
Shrinkage %	11.70

The table above presents the results of physicochemical properties of the clay sample. The physical properties of the clay analysis are moisture content, specifics gravity, dry density, liquid limit and shrinking percentage. This is important properties to determine the quality and absorption capacity of the clay. According to [7] stated that the composition of the clay is mainly affected by the minerals and chemical properties of the parent materials. The moisture content of the clay sample, which is 11.55%, specific gravity 1.84 g/cm, dry density 1.41 %, liquid limit 38.844%, and shrinkage 11.70 %, is almost lower than the value of clay properties reported by [13] in Borno State and that of the value reported in the work of [6]. The variation in the value of the clay properties may be a result of the parental materials and geological location.

Table 2 Campactability Properties of Ceramic Pot Produced

% Ration of clay to GNS/RHS	%Moisture of GNS	%Dry density GNS
60:20:20	15.60	1.60
50:25:25	20.50	1.63
100:0	10.50	0.98

Key: GNS = groundnut shell, RHS = Rice husk shell

The compaction of clay soil is the ability of the soil particles to press together. This is done to reduce the pores spaces because highly compacted clay soil contains smaller pores and a higher density. The table above shows the results of the campactability of the ceramic pot produced using groundnut shell and rice husk in different ratios of clay to biomass. The trend of moisture content to dry density shows that dry density decreased with an increase in moisture content. Also, the rice husk compactable moisture content is lower than that of groundnut shell compatibility with soil. This trend of results was also recorded in the work of [13]. However, it was also reported by [6] compacted clay soil always reduced rate of water filtration.

Table 3: Physicochemical Analysis of Water before Filtration and After Filtration

Parameters	Before filtration	CFP 1	% Reduction	CFP2	% Reduction	NSDWQ/ WHO-2015
Turbidity (NTU)	3.42	0.98	70	1.38	59	0.5 NTU
pH	6.5	6.5	-	6.5	-	6.5-8.5
Conductivity (μS/cm)	1200	630	47	570	53	1000
Nitrate (mg/l)	2.20	0.24	80	0.8	64	10
Nitrite (mg/l)	0.98	0.02	97	0.06	93	0.2
Carbonate Alkalinity (mg/l)	90.40	20.30	77	26.0	71	100
Bicarbonate alkalinity (mg/l)	Nil	Nil	-	Nil	-	100
Total hardness (mg/l)	37.0	19.50	47	26.0	30	150
Total iron Fe^{2+} (mg/l)	50.30	20.50	59.24	34.0	32	0.30
Magnesium (mg/l)	0.89	0.02	87	0.04	95	30
Sulphate SO_4 (mg/l)	19.20	10.20	46	12.0	37	100
Silica SiO_2 (mg/l)	20.50	4.30	79	7.0	66	9.2
Free Carbon dioxide(mg/l)	0.83	Nil	-	-	-	500
Total dissolved solid (mg/l)	650.20	100.80	83	148.5	77	500
Calcium (mg/l)	15.0	9.8	34	12.0	20	75

Key: CFP 1 = Ceramic filter pot made in ratio 60; 20; 20, CFP2 = ceramic filter pot made in ration 50; 25; 25 and NSDWQ= Nigeria standard for drinking water quality

Table 1 summarizes the results of the physicochemical properties of stream water before and after the ceramic pot filter produced. The electrical conductivity (EC) as defined by [1] shows a strong relationship with other physicochemical parameters of water. In this present study, the conductivity of the water samples before the filtration process was 1200 us/cm, but the ceramic pot showed the ability to reduce the value by 47% and 53% for the two ceramic pot for the groundnut shell blend with rice husk in different ration.. This value obtained after the ceramic pot filter (CPF) is within the standard value of 1000 us/cm of NSDWQ 2015. This also indicated that the flow rate of the ceramic pot has a strong correlation to the filtration absorption capacity because the flow rate of the ceramic pot of ratio 60; 20;20 is less than the other ratio [15].

The turbidity of raw water was reduced by 70% and 59%. This indicated that Ceramic filter pot made in ratio 60; 20; 20, has a higher capacity to reduce turbidity than the ceramic filter pot made in ration 50; 25; 25. This value also correlated with the value reported by [13]. The trend of turbidity reduction in substantial proportions was also recorded in the work of [16]. Turbidity is one of the parameters used to determine the quality of water. It measures the clarity of the water and its optical characteristics. Bacteria such as algae and other organic compounds cause water to be turbid; however, this ceramic filter may

IV.CONCLUSION

also affect the reduction of microscopic organisms.

The alkalinity of water is predominantly composed of carbonate and bicarbonate. The preliminary study shows that carbonate alkalinity is 30.4 mg/l before filtration, and after filtration, the average reduction of carbonate alkalinity is 71%. The present results of the reduction of alkalinity were also recorded in the work of [3]. However, the percentage of reduction is lower than in the present studies; this may be a result of the different biomass used. Alkalinity stabilizes the PH value of the water and is also an indicator of the level of toxicity of other substances in the water.

The nitrate and nitrite values determined in stream water are 2.20 mg/l and 0.95 mg/l. After filtration with both ceramic pots, the average reduction by both are 80 % and 67% The percentage reduction is 11.2%; this is very important because the stream water nitrite level was higher than the value (0.2) of **NSDWQ-2015.** The percentage reduction of these present studies is lower than the percentage reduction of [3] Nitrate (NO_3) and nitrite (NO_2) are found in water through human activities. It was reported that a large amount of nitrate has health effects such as increased heart rate, nausea, headaches, and abdominal cramps [7]

Iron ($Fe3^+$), sulfate (SO4), and silica (SiO) are determined in the stream water; while the sulfate is within the NSDWQ value of 100 mg/l, the iron and silica are above the recommended values of NSDWQ (9.5 and 0.3 mg/l). After the ceramic pot filter, there was a significant average percentage reduction in silica (79%), sulfate (52%), and iron (41%), on average, with both ceramic filters. The average percentage reduction of these present studies is higher than the value recorded in the work of [3].

There is no substantial reduction in the magnesium content of the stream water samples after filtration, but the value of total dissolved solid reduction was substantial enough, with an average 89% reduction after filtration. This value is also consistent with the value recorded in the work of [3,13].

Comparison of the ceramic pot mixed with ground shell and rice husk

Using statistical tools (T-test), we compared the efficiency and capability of the two ceramic pots produced using clay to ground nut shell, and rice husk in the two different ratios. The data obtained before and after filtration and flowing rate in consideration of the two ceramic pots The results show that there is a significant difference in the level of absorption of contaminants or reduction of contaminants by filtration between the ceramic pot produced by blending the ground nut shell and rice husk in the different ratio.

The two ceramic filter pots produced from groundnut shells blend with rice husk in different ratio were subjected to different tests, and their respective properties were determined. The suitability and efficacy of each ceramic filter pot were determined by subjecting the stream water samples to filtration and analysis before and after filtration. It was deduced that the ceramic filter pot produced with groundnut shell blend with rice husk in ratio 60: 20: 20 has a greater filtration and absorption capacity and efficiency than the other ratios. However, both ceramic filter pots have greater efficiency in the reduction of some physicochemical parameter that determines the quality of water. Therefore, ceramic filters have proven to be an effective alternative to water purification in rural areas.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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