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Bacteria removal efficiency data and properties of Nigerian clay used as a household ceramic water filter

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ABSTRACT

The research was aimed at producing a cost-effective ceramic filter for the removal of bacteria in wastewater using locally sourced materials. Clay from several locations in Ekiti state, Nigeria was mixed with sawdust (combustible material) to form a ceramic filter. The results showed that the 50%–50% ratio of Igbara odo clay to sawdust was the most effective and optimum mix. This was in terms of a flow rate of 1.9 L/hour, removal efficiencies of 80% and 100% for coliform and *E. coli* bacteria respectively.

Introduction

Ceramic materials based on clay have been used in different parts of the world as a means of purifying and storing water at points of use. The application of ceramic filter isn't solely a brand new and trendy technique, but it reduces cost and the use of chemicals/coagulants in water treatment. The use of clay and sawdust from south-west Nigeria is worth researching upon for use as ceramic materials. Nigerian clay soils and sawdust had been used in previous studies for various waste containment purpose [1–3].

Methods

Clay soils sampled from different locations (Ara, Igbara Odo, Ikere, Ire and Isan) in Ekiti State, Nigeria were pulverized and sieved through the 0.25 mm sieve size. Sawdust from a hardwood (*Nesogordonia papaverifera* of Danta Specie) was sieved through the 0.075 mm sieve size. The sieved samples of clay and sawdust were mixed in various ratios with water to form a mouldable paste. These were aged to cause physical changes in the material over time. The aged moulded paste materials firing process was carried out in a traditional kiln (made of low-cost heat resistant brick made of Ball clay, sand and sawdust) after an air drying stage had been completed. The air drying was to prevent material from cracking due to rapid drying or heating during the firing process. Atterberg limit tests [4] were carried out on the clay samples. The ceramic filters were tested for its flow rate and its bacteria removal efficiency.

Results and conclusions

The Atterberg limits values and colour of the Ekiti clay samples are listed in Table 1. The flow rates were measured based on the reduction in the water column height over a period of time (Table 2). The removal efficiency of Coliform and *E. coli* from the wastewater was 100% for some of the fabricated ceramic filter samples (Table 3). From the results, Igbara odo clay and sawdust in 50%:50% ratio had the highest performance level in terms of flow rate and bacteria removal efficiency.

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Table 1
Physical properties of the Ekiti Clay Samples.

Clay Samples	Colour	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Shrinkage limit (%)
Ara Clay	Brown	43.79	34.47	9.32	5.00
Igbara odo Clay	Brown	41.06	32.63	8.43	2.14
Ikere Clay	Red	37.05	22.50	14.55	3.57
Ire Clay	Red	29.28	27.90	1.38	1.43
Isan Clay	Brown	48.40	35.37	13.03	3.57

Table 2
Flow rate data of various clay to sawdust mix ratios (ceramic filter).

% Clay to % sawdust mix ratio	Flow rate (litres/hour)				
	Ara Clay	Igbara odo Clay	Ikere Clay	Ire Clay	Isan Clay
100:0	0.000	0.000	0.000	0.000	0.000
90:10	0.003	0.340	0.035	0.035	0.025
80:20	0.014	0.550	0.050	0.060	0.060
70:30	0.085	1.290	0.080	0.190	0.085
60:40	0.185	1.450	0.195	0.200	0.145
50:50	0.600	1.900	0.200	1.750	0.199
40:60	1.475	2.300	0.800	2.025	0.775
30:70	2.000	6.000	ND	8.900	1.600
20:80	ND	ND	ND	ND	ND
10:90	ND	ND	ND	ND	ND
0:100	ND	ND	ND	ND	ND

Note: "ND" denotes "not determined" (because the combustible element burnt off during sintering, thereby disintegrating the materials).

Table 3
Bacteria removal efficiency data of various clay to sawdust mix ratios (ceramic filter).

% Clay to % sawdust mix ratio	Removal efficiency (%)									
	Ara Clay		Igbara odo Clay		Ikere Clay		Ire Clay		Isan Clay	
	Coliform	E. Coli	Coliform	E. Coli	Coliform	E. Coli	Coliform	E. Coli	Coliform	E. Coli
100:0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
90:10	100	100	100	100	100	100	100	100	100	100
80:20	100	100	66	38	100	100	100	100	100	100
70:30	100	100	55	58	100	100	100	100	100	100
60:40	100	100	27	79	100	100	100	100	100	100
50:50	52	46	80	100	100	100	74	83	100	100
40:60	64	58	60	17	98	15	60	92	41	46
30:70	33	38	47	26	ND	ND	12	29	41	4
20:80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10:90	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0:100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: "ND" denotes "not determined".

Conclusions

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

Conflict of interest

I declare that there is no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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