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Removal of nitrite, chloride and phosphate ions from hospital wastewater using Neem (*Azadirachta Indica*) activated carbon

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ABSTRACT

The present study was conducted to evaluate the adsorptive capacity of the neem (Azadirachta indica) seed and husk activated with $ZnCl_2$ and H_3PO_4 on hospital waste water. The wastewater was allowed to pass through the adsorbents (NSZ, NSH, NHZ and NHH) bed. The filtrates were analyzed to determine the amount of the wastewater components that have been adsorbed. The finding shows that the adsorbents had an excellent adsorption of nitrites (99.7%), chloride (100%) and phosphate (95%). The order of effectiveness of the adsorbent is as follows; NHH>NSZ>NHZ>NSH.

Keywords: Neem Seed activated with $ZnCl_2$ (NSZ), Neem Seed activated with H_3PO_4 (NSH), Neem Husk activated with $ZnCl_2$ (NHZ) and Neem Husk activated with H_3PO_4 (NHH)

INTRODUCTION

The use of activated carbon in its current form has only a short history. On the other hand, according to records, the use of carbon itself dates back to ancient times. The earliest known use of carbon in the form of wood chars (charcoal) by the Egyptians and Sumerians was in 3750 BC [8]. Ever since the relevance and importance of activated carbon cannot be over emphasis. Due to the increasing market demand for activated carbon, it is imperative to investigate alternative cheap and readily available precursors. A wide variety of carbons have been prepared from agricultural wastes; silk cotton ball, coconut tree sawdust, maize cob and banana pith [9] and [5] coconut husk and goat hair [1], bamboo dust, groundnut shell, rice husk and straw [10], Hazelnut shell [2], pecan shells [15].

The current tends to investigate the adsorption of nitrites, chlorides and phosphates from hospital waste using activated carbon prepared from neen (*Azadirachta Indica*) husk and seed. Neem (*Azadirachta Indica*) plant is wide spread in the tropical countries while in Nigeria it is common in the northern part of the country [13]. In the past, it has been used for pest harvest storage**,** neem biopesticide for pest control, neem cake as fertilizer**,** neem oil for skin infection, dandruff, eczema**,** organo-mineral compound as fertilizer for all crops**,** neem-coated with urea**,** bio-nimbecidine (Grains insects' control)**,** bio-Cure (fungicide)**,** bio-ant termites**,** alsoft neem oil (Braid spray)**,** repelling gel (Mosquito repellant)**,** neem active toothpaste, activated carbon and neem soap [16].

MATERIALS AND METHODS

The raw neem husks and seeds were collected from the National Research Institute for Chemical Technology (NARICT) Zaria while the waste water samples were gotten from University of Abuja Teaching Hospital. The following physic-chemical parameters were investigated in the waste water before and after sorption with the adsorbent using standard methods. For the waste water; Turbidity, total dissolved solids of the waste water, pH, BOD and COD, nitrite, phosphate and chlorides were investigated while for the adsorbents (NSZ, NSH, NHZ and

NHH) the following were determined; moisture content, dry matter, ash content, bulk density, volatile matter and fixed carbon.

Adsorption Studies

The wastewater (150cm^3) was agitated with each activated carbon from Neem husk and seed (1, 5, 10, 15, 20 and 25g) in 250 cm^3 Erlenmeyer flasks. The wastewater was then allowed to pass through the adsorbent bed. The filtrate was analyzed to determine the amount of the wastewater components that have been adsorbed. The process was repeated by varying the Activated Carbon type, time of adsorption and adsorbent.

RESULTS AND DISCUSSION

Table 1: Physicochemical parameters of the raw neem (*Azadirachta indica*) husk

Parameters	RNH	RNS	NSZ	NSH	NHZ	NHH
Moisture content (%)	4.45	8.95	3.62	3.67	3.05	3.02
Dry matter (%)	95.55	91.05	96.38	96.23	96.95	96.98
Volatile Matter Content (%)	54.44	53.10	9.81	10.14	12.06	3.89
Ash Content (%)	11.33	6.56	18.70	18.60	18.34	20.11
Fixed Carbon Content (%)	29.78	25.62	67.87	67.49	66.55	72.98
Particle size (µm)	400	400	350	350	350	350
Bulk density (g/cm^3)	0.95	0.87	0.77	0.83	0.76	0.82

Raw Neem Husk (RNH), Raw Neem Seed (RNS), Neem Seed activated with $ZnCl_2$ (NSZ), Neem Seed activated with H_3PO_4 (NSH), Neem Husk activated with $ZnCl_2$ (NHZ), Neem Husk activated with H_3PO_4 (NHH),

The physicochemical parameters of the raw neem compared to the activated/treated neem shows that the activation process is effective. The above physicochemical parameters when compared with literatures shows that the activated carbons from neem seed and husk will compete favourably with commercial adsorbents. For instance, the moisture content of the raw neem and activated neem ranges from 3.02 – 8.95% which when compared with literatures [4]; [9]; [2] and [14] tend to falls within the recommended range from 3.80% - 10.01%. The ash content ranges from 6.56 – 18.70%, which is a measure of inorganic residue left after the organic matter has been burnt off. Other literatures reported ash content 7.6% [9] while ash content as low as from 0.29 - 2.49% for different particle sizes of coconut shell activated carbon were reported [5]. Bulk density is another important physical parameter especially when an activated carbon product is to be investigated for its filterability because it determines the amount of carbon that can be contained in a filter of given solids capacity and the amount of treated liquid that can be retained by the filter cake. The observed bulk density was in the range of 0.76 – 0.95g/cm^3.

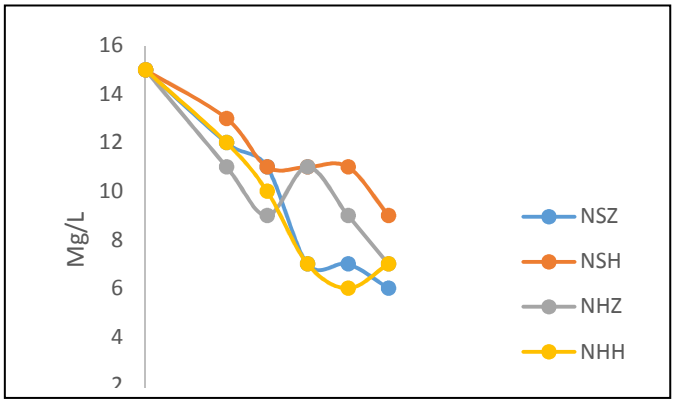

Figure 1: The effect of contact time on BOD

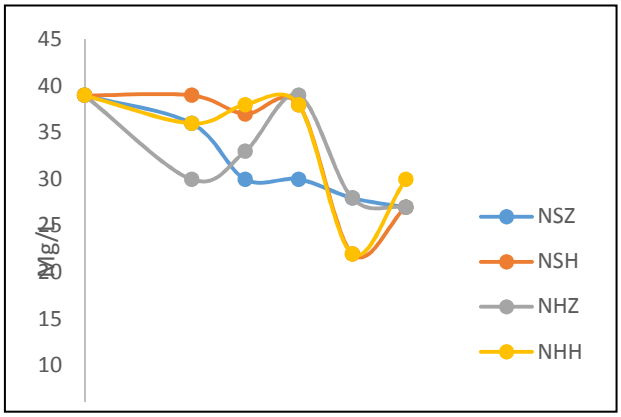

Figure 2: Effect of contact time on DO

Effect of time on Oxygen parameters

COD was used to determine the amount of organic pollutants found in water, making COD a useful measure of water quality and is helpful in indicating toxic conditions and the presence of biologically resistant organic substances [12]. The effect of contact time on COD of the wastewater was found to follow a similar pattern for all adsorbents except for the result of neem seed activated with $ZnCl_2$ (NSZ), the decrease in COD is significant at initial contact time of 10 minutes. After that the COD remains almost constant. This may be due to the fast attainment of equilibrium between the adsorbent and adsorbate [11].

The BOD values showed a constant decrease as time increases for the first 25 minutes as shown in Figures 1 below. This might be as a result of the consumption of oxygen by bacteria in the waste water to stabilize the decomposable

organic or biologically oxidizable matter [12]. The Dissolved Oxygen (DO) plot tend to have a similar pattern with that of COD which appears to be less steep compared with that of BOD as shown in the figures 1 to 3.

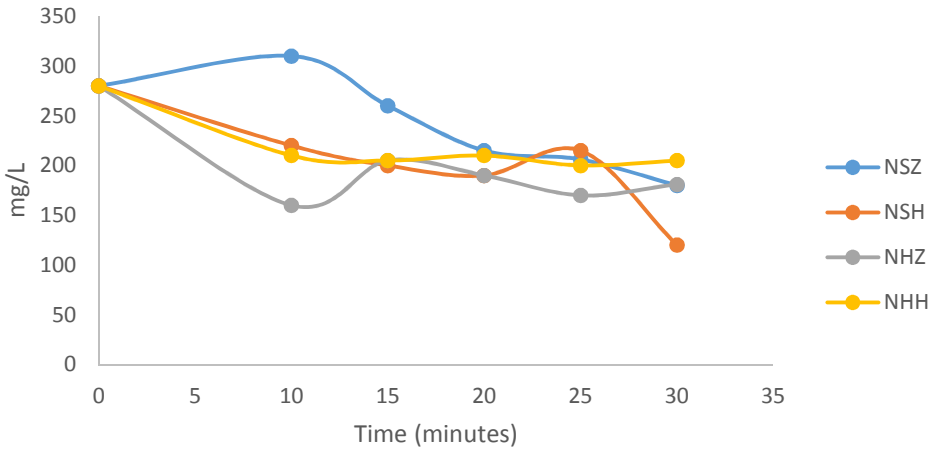

Figure 3: The effect of contact time on COD of treated wastewater

Effect of time on chemical and mineral parameters

The effect of time on the nitrite concentration was found to occur in the initial 10 minutes and thereafter it plateau for all four different adsorbents as shown in Figure 4 below while that of phosphate appears sinusoidal in shape as seen in Figure 5 below. The phosphate contents seemed to increase at the initial 10 minutes except for NSZ. The curves tend to have a similar pattern (sinusoidal pattern). It was also observed that all curves decline after 20 minutes except that of NHH. Samples NSZ and NHH had the best removal of the phosphate ions compared samples NSH and NHZ. The effect of time on chlorine removal followed a similar pattern with those of Nitrites as shown in figure 6 below. The rate of adsorption is fast and a significant drop was observed during the initial 10-15 minutes and thereafter, no significant change in the rate of removal was observed. This imply that time is very important in the adsorption of this ions. For instance, nitrite and chloride are adsorbed within a shorter time (10 minutes) while phosphate take longer time (20-30 minutes).

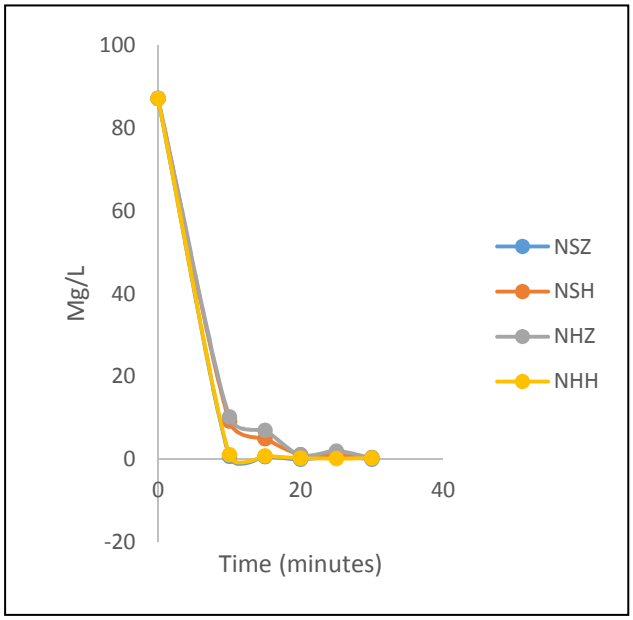

Figure 4: The effect of contact time on Nitrite

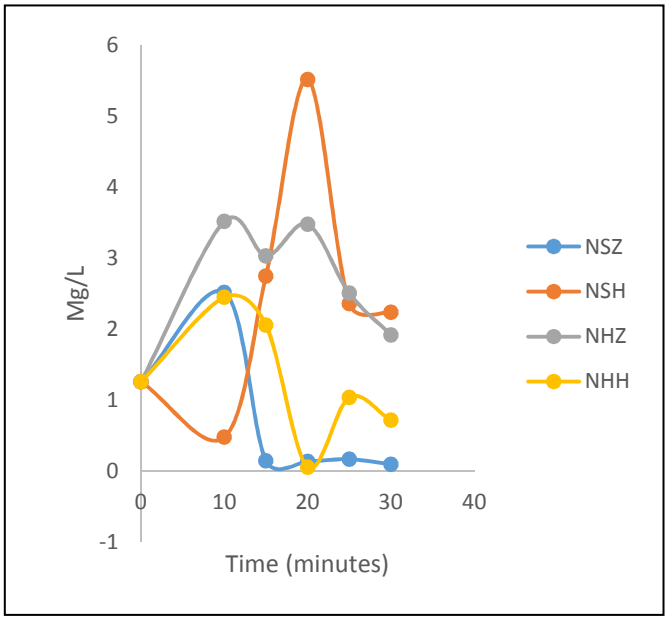

Figure 5: Effect of contact time on Phosphate

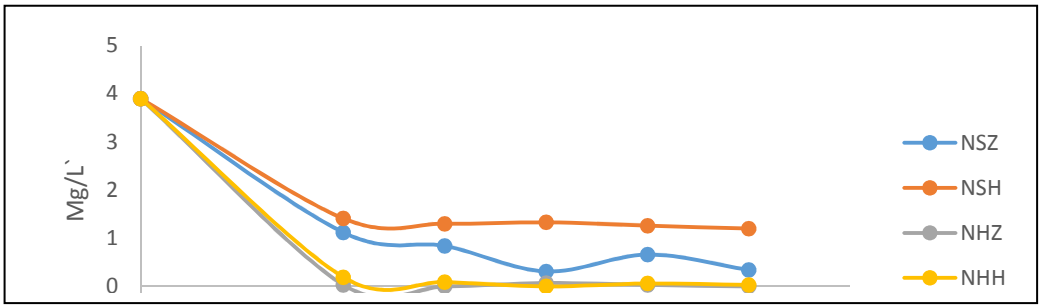

Figure 6: Effect of contact time on Chloride ion content of treated wastewater

Table 2: Properties of Hospital wastewater before and after treatment with adsorbents

		After treatment with				
Parameters	**RWW**	**NSZ**	**NSH**	**NHZ**	**NHH**	**DWS**
pH	6.4	5.78	5.74	5.27	5.07	7
TDS (g/L)	40.36	30.9	8.78	10.22	15.75	500
Turbidity (NTU)	56	0	5	5	0	5
Nitrite (mg/L)	9.72	0.006	0.118	0.108	0.033	0.5
Phosphate (mg/L)	1.26	0.14	7.52	3.48	0.06	0.1
Chloride (mg/L)	1.76	0.31	1.33	0.07	0	5
COD (mg/L)	280	215	190	190	210	255a
BOD (mg/L)	15	7	11	11	7	4b
DO (mg/L)	39	30	38	39	38	-

RWW represents Raw Wastewater; *NSZ* and *NSH* values are the values of the parameters in wastewater after treating with Neem carbon activated with $ZnCl_2$ and H_3PO_4 respectively; *NHZ* and *NHH* are the values of the parameters treated of the tested parameters in wastewater after treating with Neem carbon activated with $ZnCl_2$ and H_3PO_4 respectively; C*OD* represents the Chemical Oxygen demand; *DO* is the dissolved Oxygen and *BOD* is the Biological Oxygen Demand: *DWS* represent Drinking Water standard [17]; [3] and [12].

Table 2 shows the effectiveness of the treated neem husk and seed on the waste water before and after adsorption compared with the drinking water standard. The four different adsorbents (NSZ, NSH, NHZ and NHH) had an excellent removal of the waste water coluration. It adsorbed the highly turbid waste water from 56 NTU to 0 NTU for NSZ and NHH which is below the drinking water standard of 5NTU [17]. The adsorbents from neem also had 99.7% adsorption of nitrite from 9.72mg/L to 0.006mg/L which is below the drinking water standard of 0.5mg/L [17]. The same was observed for phosphate, 95% adsorption was recorded from 1.26mg/L in the waste water to 0.06mg/L when treated with NHH, which is also below the drinking water standard of 0.1mg/L. Same was recorded for chloride, which had a concentration 1.76mg/L in the initial waste water but was completely adsorbed when treated with the neem carbon activated with NHH.

CONCLUSION

The physicochemical properties of the adsorbents show that the activation process was successful and that the adsorbent can compete favourably with other prepared adsorbents as reported in literatures. The adsorption studies depicted that the adsorbents showed excellent adsorption for nitrites (adsorbed by 99.7%), chloride (adsorbed by 100%) and phosphate (adsorbed by 95%) and turbidity (adsorbed by 100%). For the oxygen demand parameters, it was observed that BOD was adsorbed by 53% while COD was adsorbed by 32%. The studies shows that the prepared adsorbent is effective and could be used to adsorbed chemical, biochemical and microbial effluents in a multi-component systems such as hospital and industrial waste.

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