International Journal of Research in Chemistry and Environment
Vol. 2 Issue 3 July 2012(199-203)
ISSN 2248-9649

Research Paper

The Use of *Jatropha Gossypifolia* Stem Latex and Chitosan in the Treatment of Brewery Sludge

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Available online at: www.ijrce.org

(Received 25th April 2012, Accepted 10th June 2012)

Abstract: *Sludge, the settleable solids separated from liquids during various processes was collected by composite sampling method from the Brewery. Locally sourced natural coagulants, jatropha gossypifolia stem latex and chitosan were also collected. The collected sludge sample was characterized physicochemically according to standard procedures and was found to have high pollution potentials on the basis of some parameters determined. The values of some of the parameters were found to be 1034.00NTU, 640.00mg/l and 2072.19mg/l for Turbidity, BOD and COD respectively. The Total Solids (TS) and Suspended Solids (SS) were 7307.50mg/l and 2067.50mg/l respectively. Optimum dosage determined for the combined/mixed coagulants was 1.10ml of jatropha gossypifolia stem latex and 1.10ml of 1% chitosan solution respectively per 100ml sludge at pH of 6.7. On the basis of this, the sludge was treated and the treated sludge sample, characterized. Triplicate determinations were done in each case and the mean values and standard deviations obtained from statistical evaluation using the Tukey-Kramer multiple comparison tests. From the results obtained, there were significant reductions ($p<0.05$) in pollution with over 90% reduction in the COD, BOD and Turbidity in the treated sludge sample. The total and suspended solids expectedly, increased by 34.24% and 19.98% respectively. The synergistic effects of the combined coagulants were very evident in the results obtained. The coagulants are readily available, biodegradable, therefore more environmental friendly. The use of the coagulants for the treatment of sludge can be so recommended.*

Keywords: Sludge, *Jatropha gossypifolia*, Chitosan, Exoskeleton, Pollution, Synergistic.

Introduction

Population increase is one of the major factors responsible for increased generation of wastes of diverse compositions from different sources. The environment and its components were created pure for man's use. They are indispensable to man because he carries out virtually all his activities on it.

However industrial/technological activities for the provision of food, goods and services, healthcare etc. generate wastes, no matter the controlled measures that are put in place. The increasing global concern on the environment demands that waste should be properly managed in order to reduce their potential harm to public health and the environment. One of such wastes if well treated/managed and their resource tapped is sludge. This has led to intense discussion about what to do with sludge as defined by several authors. Sludge, according to Eddy and Metcalf[1] is the settleable solids separated from liquids during processing, the deposited foreign materials on the bottoms of streams or other bodies of water. Sludge is a semi-solid or liquid waste derived from municipal, commercial or industrial treatment facilities, wastewater treatment plants and air pollution control[2]. Sludge was also defined as an accumulation of solids removed from sewage during waste treatment[3]. The treatment of sludge renders it less of environmental nuisance, more amenable and of beneficial use to mankind exploiting its nutrients, soil-enhancing and fuel properties etc. There are known methods of treating sludge, one of which is coagulation/flocculation. Sludge treatment by coagulation method using synthetic coagulants is not entirely new, however the need to find sustainable alternative to these synthetic coagulants will be of immense benefits. The alternative is the locally sourced coagulants that are as effective as the synthetic ones. Having other advantages like bring readily available, easier and cheaper to source and handle and more environmental friendly. The safe use of *jatropha gossypifolia* stem latex as a haemostatic agent was reported by Oduola et al[4] . and is commonly used by people in this part of the country to stop bleeding from minor cuts, injuries and bruises, while chitosan gotten from chitin is found present in the exoskeleton of common seafoods available and consumed here in Nigeria.

Material and Methods

The materials used for the analysis are the locally sourced (natural) coagulants, *Jatropha gossypifolia* stem latex, Chitosan and the sludge sample from the Brewery.

Sampling Locations and Extraction/Collections: The natural coagulants were from:

1. The Crawfish was bought from the Royal main market, Ekpoma, Esan West local government area of Edo State, Nigeria. The procedure adopted for the conversion of chitin to chitosan was that by Hong and Meyers [5].
2. *Jatropha gossypifolia* stem latex was from many locations around Ekpoma, Esan West local government area of Edo State, Nigeria. The stem latex of the *jatropha gossypifolia* plant was extracted from the stem and stalk of the plant

Sampling Techniques/Preservation: Composite sampling technique was used in the collection of the sludge from the sedimentation tank and the bottom of the storage vat in the brewhouse.

Methods of Analysis (Physicochemical Characteristics of the Raw Sludge): The sludge samples from the brewery were analyzed as described in APHA[6] and Ademoroti[7]. Where analysis was not immediately possible, the samples were preserved as contained in Sample Preservatives and Holding Periods for Selected Parameters, Manual of Practice[8] and Ademoroti[7].

Determination of Optimum Dosage Of The Combined Coagulants (*Jatropha gossypifolia* Stem Latex and Chitosan) Needed For The Sludge Treatment.

COD determinations were carried out severally with same/equal amount/quantity of the sludge sample (100ml) but with varying amount/quantity of *Jatropha gossypifolia* stem latex and chitosan (the combined coagulants). The optimum dose was the dose that gave the highest %COD reduction, obtained from the following relation

$$\%\ \text{COD reduction} = \frac{\text{COD raw} - \text{COD treated}}{\text{COD raw}} \times 100$$

COD raw = COD of the raw (untreated) sludge,
COD treated = COD of the repeated determinations with the different coagulant dose.

Treatment of the Samples

The method of coagulation and flocculation described in Eddy and Metcalf[1] and Ademoroti[9] using 1Litre of the brewery sludge and a mixture of equal amount (11.00ml) of *Jatropha gossypifolia* stem latex and of 1% chitosan solution. After the treatment, the physicochemical parameters of the treated sludge were determined.

Results and Discussion

Table1 presents the result of the characterization of the sludge samples from the Brewery. Triplicate determinations were done in each case and the mean values and standard deviations obtained from statistical evaluation using the Tukey-Kramer multiple comparison tests.

Table 1
The Table below Presents Results Obtained from Triplicate Characterization of the Untreated/Raw Sludge Samples from the Brewery

Parameters	Mean ± S.D (From Triplicate Determinations)
pH	6.7 ± 0.10
Turbidity NTU	1034.00 ± 4.10
Suspended Solids (SS) mg/l	2067.50 ± 5.20
Volatile Solids (VS) mg/l	5242.00 ± 5.45
Total Solids (TS) mg/l	7307.50 ± 7.60
DO mg/l	2.65 ± 0.04
BOD_5 mg/l	640.00 ± 6.00
COD mg/l	2072.19 ± 6.55
HCO_3 mg/l	47.00 ± 2.00
Ca mg/l	26.85 ± 1.25
Mg mg/l	27.80 ± 1.20
K mg/l	12.80 ± 0.55
PO_4 mg/g	14.05 ± 0.48

NH_3-N mg/l	56.00 ± 2.78
NO_2-N mg/l	12.60 ± 0.60
NO_3-N mg/l	15.50 ± 0.42
Fe mg/l	0.91 ± 0.02
Zn mg/l	3.20 ± 1.00
Cr mg/l	ND
Pb mg/l	0.29 ± 0.01
Elect. Conductivity µs/cm	154.00 ± 3.20
Temperature ^oC	30.5 ± 0.20
Total Coliform Count TCC	3.90×10^8 ± 60.00

S.D = Standard Deviation.

Table 2
Coagulants' Optimum Dosage Determination for the Treatment of the Sludge Sample

COD raw = 2072.19mg/l. Sludge pH=6.7

Coagulants' Dose (ml/ml)	COD(mg/l)	% COD Reduction
0.60/0.60	392.47	81.06
0.70/0.70	344.19	83.39
0.80/0.80	234.36	88.69
0.90/0.90	200.38	90.33
1.00/1.00	155.60	92.49
1.10/1.10	**110.45**	**94.67**
1.20/1.20	184.22	91.11
1.30/1.30	226.70	89.06
2.00/2.00	607.77	70.67
3.00/3.00	990.71	52.19

Table 3
The Table below Presents Results Obtained From Triplicate Characterization of the Treated Sludge Samples from the Brewery with *Jatropha Gossypifolia* Stem Latex and Chitosan

Parameters	Mean ± S.D (From Triplicate Determinations)
pH	6.6 ± 0.1
Turbidity NTU	60.29 ± 2.30
(SS) mg/l	2480.50 ± 6.55
(VS) mg/l	4220.50 ± 4.55
(TS) mg/l	9809.50 ± 5.10
DO mg/l	3.04 ± 0.10
BOD_5 mg/l	46.06 ± 1.60
COD mg/l	178.75 ± 7.00
HCO_3 mg/l	33.70 ± 0.90
Ca mg/l	19.85 ± 0.60
Mg mg/l	19.50 ± 0.55
K mg/l	7.60 ± 0.23
PO_4 mg/g	18.46 ± 0.50
NH_3-N mg/l	39.40 ± 1.12
NO_2-N mg/l	8.45 ± 0.25
NO_3-N mg/l	13.05 ± 0.30
Fe mg/l	0.75 ± 0.03
Zn mg/l	1.28 ± 0.03
Cr mg/l	ND
Pb mg/l	0.17 ± 0.01
Temperature ^oC	30.5 ± 0.2
T C C/100ml	1.17×10^4 ± 46..80

SD = Standard Deviation.

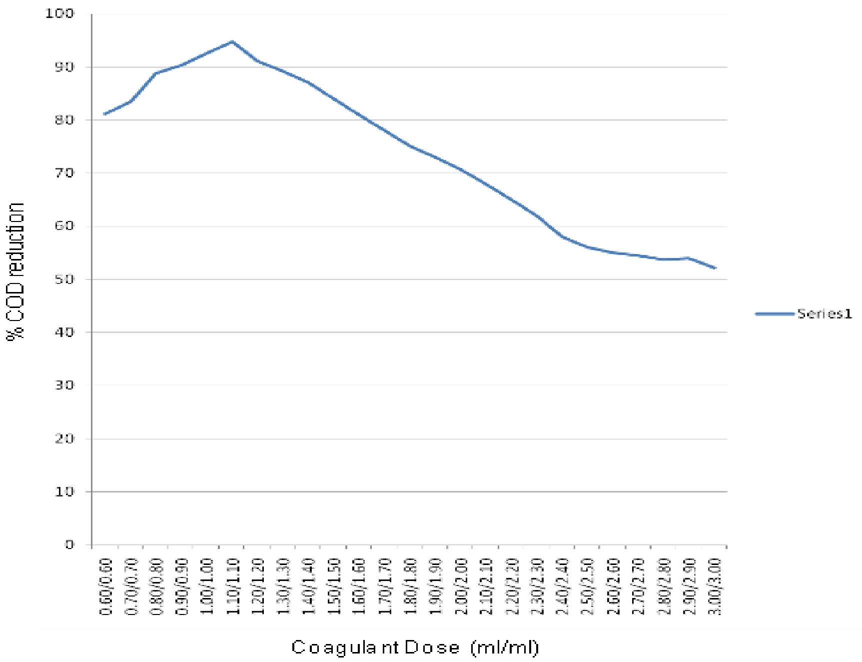

Figure 1: Optimum Dosage Determination of Chitosan/*Jatropha gossypifolia* stem latex for the Treatment of Brewery sludge

Table 3 presents the results when the combined coagulants of *jatropha gossypifolia* stem latex and chitosan was used to treat the sludge sample. From the results, there were significant reductions ($p<0.05$) in pollution in some of the measured parameters, thus, an improvement on the quality of the sludge samples with over 90% reduction in the COD, BOD, Turbidity and the microbial load in the treated sludge sample.

From table 1, the pH was weakly acidic. The high values of the most parameters showed that the sludge has high pollution potentials and should be properly managed.

From the Electrical Conductivity value, it indicates that the sludge sample contains ions, consequently coagulation and flocculation method can be very suitable for the sludge treatment.

Figure 1 and Table 2 show the coagulants optimum dosage determinations for the treatment of the brewery sludge. The optimum dosage at pH of 6.9 was 1.10ml per 100ml of sludge.

There was a reduction in the heavy metal levels. The Total Solid (TS) and Suspended Solids (SS) expectedly increased by 34.24% and 19.98% respectively while the Volatile Solids (VS) reduced by 19.49% in the treated sample, this undermine the use of the sludge as a source of biogas, as the reduction in VS is an indication of loss organic matter, as the VS is an approximate measurement of methane gas present[10]. The slight increase in the pH of the treated sludge is inconsequential, being locally sourced coagulants, as they are known to be independent on pH[5, 11].

There was reduction in the NH_3-N levels, this could be due to the conversion to nitrite and nitrate by some bacteria present in the sludge, It has been reported that some groups of bacteria, Nitrosomonas and Nitrobacter do bring about such conversion[1,9].

As a consequence, an improvement on the nutrients levels of the sludge for use as soil conditioner, as nitrate is a valuable plant nutrient[1,9,12]. The phosphate level also increased by 31.39% thus enhancing the fertilizer value rendering the sludge more useful for agricultural practices. The high solid contents make the sludge available for use for land filling/reclamation and also could be used in addition with other components for block making. The sludge can contribute to the firmness and consistency in bricks. Treated sludge with aluminium salt has been reported to have generated firmer and larger flocs[13]. The synergistic effects were evident from the results obtained.compared with when chitosan and *jatropha gossypifolia* stem latex were used independently[11,14].

Conclusion

The disposal or reuse of sludge is a very important aspect of wastewater treatment program. Apparently treated sludge is a resource that can be beneficially used in more than one way, such use options might include agricultural or industrial reuse by the discharging community as direct is change to support the aquatic environment of the receiving water. Processing and disposal of sludge that is economic and environmental friendly is currently of great importance to local authority and industry. In the recommendation use of locally sourced coagulant proved efficacious and as good as the synthetic ones as earlier reported by Ize-Iyamu et al[11,14]. The advantages of the locally sourced coagulant over synthetic ones include, their effectiveness in very low dosage, they are easy to handle and safe to use, they are generally biodegradable and hence more environmentally friendly and lastly, they are cheap and readily available locally. Consequently they could be used alongside synthetic coagulants and in the very near future be possible replacement for the synthetic ones whenever coagulation and flocculation is desired.

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