Treatment Of Waste Water From Food Industry Using Snail Shell

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Abstract. Waste water from a food- factory was characterized and treated using snail shell. The aim was to find out the effectiveness of snail shell as a coagulant in waste water treatment. The result of the parameter studied before and after treatment, shows a change in color from dark brown before treatment to light brown after treatment, there was reduction in turbidity values from 332 - 133NTU, conductivity 0.294 - 0.164mscm^{-1} , total suspended solids 0.814- 0.184mg/l, total dissolved solids, total solids from 15600-15200mg/l and 15600.2-15200.2mg/l respectively. There was decrease in BOD and COD values from 29.27-19.77mg/l and 872- 215mg/l respectively while the DO value increase from 1.14 - 2.16mg/l. Phosphate was completely removed. From the results, it shows that snail shell is effective in the treatment of waste water treatment. [Academia Arena, 2010;2(1):32-36]. (ISSN 1553-992X).

KEYWORDS: Mollusks, Colloids, Torsion, Surface area, Optimum dosage, Coagulation, Adsorption.

INTRODUCTION

Snails belong to the phylum molluscs and to the class gastropods; this class includes the gastropods, slugs and snails.

Most gastropods have a single usually spirally coiled shell into which the body can with drawn.

Gastropods are characterized by 'torsion' a process that results in the rotation of the visceral mass and mantle on the foot (Brunt.J, Engel.J, Rapp.G 1999).

The mantle cavity of the gastropod (including anus) lies in the anterior body. When the snail's body is drawn in to the shell, it is sealed by a Horney plate called the operculum.

The typical gastropod shell is a cone, coiled round a central axis as a spiral geometrically. The simple reason for this coiled shell is because an uncoiled shell would be impossible to carry its massive body because of its high centre of gravity (Mc, Graw Hill 1987).

Most shell coiled to right (dextral), although a few coiled to left (sinitral) (Abuoa F 1995). The central axis of coiling is called the columella and at the anterior end of the shell forms the inner lip of the mouth opening called the aperture (Linsley R.K, Franzi Y.B 1997).

The group of snails that is common in this part of the world belongs to the family
of the achatinadae, also known as the achatine snails. The family members include (i) achatina achatina (ii) achatina maginata (iii) achatina fulica (iv) linicolarial species (Mark J 2004).

The achatine snails are the largest terrestrial snails on earth. The largest achatina achatina may grow to a body size of more than 12 inches and length of the shell to 10 inches.

The shell has a brownish color with a characteristic stripe pattern.

The main constituent of the shell is calcium carbonates which are either of two crystalline forms calcite and aragonite. The remainder is organic matrixes which constitute a protein known as conchiolin that usually make up to 5% of the shell. The fine structure of mollusks shells has been studied by using various techniques including scanning electron microscope of broken surfaces. In each of them, blocks or stripe of calcium carbonate are separated by a thin layer of conchiolin.

The shell consists of long stripes of aragonite laid down in groups. It has a lot of several uses which could be as result of the hard nature of the shell. The shell protects the snail from physical damage and from predators; they are also use in the manufacture of buttons, jewels and art collections.

As a result of the chemical composition of the shell, it can be used in waste water treatment either as a coagulant or adsorbent.

As a coagulant, it helps to neutralize fine particles of suspended and dissolve matter in a water supply or sample to form flocs that settles and can be filtered out. The choice and dose rate of the coagulant will depend on the characteristics of the waste water to be treated.

Calcium the main composition of snail shell when in solution dissociates into calcium (ii) ion (Ca^{2+}) and various calcium complexes such as calcium hydroxide ion $Ca[OH]^{2+}$, the various positive species which are formed may combine with negative charges and form the colloidal particles, example Ca^{2+} +2(colloid) → [Ca(colloid)$_2$].

During coagulation, the colloidal materials will come together and become incorporated or adhere into the masses that can readily be precipitated.

Achatina snails are hermaphrodites, they can proliferate very fast, they usually reproduce several times per year under natural conditions, hence they are found every where in this part of the world and it serves as food. The shells are not consumed and deposited or it's allowed to liter the environment, it becomes undesirable and pollutes the environment as waste which can be converted to wealth by using it for water treatment among many other applications or uses (Gaman P.M, Sherington K.B 1977).

Waste water (effluent) can be described as water generated along process operation in any industry. Waste water is sometimes used to describe liquid waste (Ademoroti C.M.A 1996), the nature of the waste water produced depends on the activities and process technology which gives each industry a distinct profile of waste water or effluent. It ranges from saline water, run off, wash water, alkaline and acid waste neutralization water (Ademoroti C.M.A 1996).

An effluent may contain a great variety of chemicals whose nature, quantity and mix depends on the activities of the industries, such as its process technology, their concentrations through utility use, contaminants added in the process operation, nature of raw materials and process methodology (Ademoroti C.M.A 1996).

The objective of this research is to study the suitability of snail shell as an adsorbent or coagulant in waste water treatment. To do this, the stability of the snail shell at different pH was studied, followed by the optimum dosage (Asia I.O Oladoja N.A 2003) of the shell using turbidity and COD as the parameter and treating waste water from food industry.

MATERIALS AND METHODS

Snails (achatina achatina) shells were collected from various locations around Ekpoma, due to its naturally occurring and low cost.

The shells collected were washed, dried properly and homogenized to fine powder to ensure a large surface area. The ground snail shell was sieved using 0.1mm diameter sieve.

The stability of the snail shell in different pH was studied to know whether the snail shell will go into solution at any pH.

The pH of the snail shell was determined using the electrometric method.

The surface area was also studied using the iodine thiosulphate method; this was followed by the determination of optimum dosage using turbidity and COD analysis as parameters.

Waste water samples were collected from a food industry located in Edo state. The company specializes in the production of corn flakes and agricultural feeds.

Representative samples were insured by adequately flushing a service unit line; composite sampling was done by collecting samples obtained from a particular place on hourly basis over a period of 24 hours to avoid unpredictable changes in characteristic as per standard procedure (APHA, 1988).

The waste water was analyzed before and after treatment with snail shell as described in the standard methods for waste water and effluent analysis (Ademoroti C.M.A 1996).

Where analysis was not immediately possible the sample was preserved in a refrigerator at 4^{oc} at this temperature, bacterial are in active and biodegradation is inhibited (Ademoroti C.M.A 1996).

The analysis carried out on waste water sample before and after treatment were pH, using the electrometric method with the aid of a laboratory ph meter (Jenway model 3150) (Ademoroti C.M.A 1996). The temperature of the water was determined using the mercury in glass thermometer.

Electrical conductivity was measured by using HACH, TDS conductivity meter.

Nitrate was determined using the Brucine method (Ademoroti C.M.A 1996). Phosphate analysis was carried out using Kjeldahl method, sulphate ion was analyzed by turbidmetric method (Sheen R.T. Kahler H.L, Ross E.M 1935).

Dissolve oxygen (DO) was determined by alkaline –azide modification of Winkler' method (Winkler L.W 1988). Using dichromate reflux method (Dobbs R.A, Williams R.T 1963), chemical oxygen demand (COD) was determined. Biochemical oxygen demand (BOD) was measured using dilution method.

Nitrogen and turbidity were determined using different standard methods.

RESULTS AND DISCUSSIONS

RESULTS

pH of snail shell (achatina maginata) = 8.48.

Surface area = 40.29.

Table I: Result of optimum dosage of coagulant using COD

S/No	Mass of snail shell in grams.	Volume of sample used ml	COD mg/l	% reduction of COD
1	RAW	10	872	
2	3.1	10	392	53
3	3.2	10	408	55
4	3.3	10	403	50
5	3.4	10	312	64
6	3.5	10	448	48

Table II: Result of waste water analysis before treatment with optimum doses of snail shell

S/No	PARAMETERS	RESULT	UNIT
1	pH	5.42	_
2	Color	Dark brown	_
3	Turbidity	332	NTU
4	Temperature	20	O^c
5	Conductivity	0.294	$Mscm^{-1}$
6	Total suspended solid	0.814	Mg/l
7	Total dissolved solids	15600	Mg/l
8	Total solids	15600.8	Mg/l
9	Nitrogen (ammonium-nitrogen)	0.085	Mg/l
10	Nitrate	41.01	Mg/l
11	Sulphate	58.11	Mg/l
12	Phosphate	0.173	Mg/l
13	BOD	29.27	Mg/l
14	COD	872	Mg/l
15	DO	1.14	Mg/l

TABLE III: Results of waste water analysis after treatment with optimum doses of snail shell.

S/No	PARAMETER	RESULTS	UNITS
1	P^H	6.42	_
2	Color	Light brown	_
3	Turbidity	133	NTU
4	Temperature	20	^{oc}
5	Conductivity	0.164	$Mscm^{-1}$
6	Total suspended solids	0.184	Mg/l
7	Total dissolved solids	15200	Mg/l
8	Total solids	15200.2	Mg/l
9	Nitrogen(ammonium-nitrogen)	0.015	Mg/l
10	Nitrate	13.52	Mg/l
11	Sulphate	15.46	Mg/l
12	Phosphate	0.00	Mg/l
13	BOD	19.77	Mg/l
14	COD	215	Mg/l
15	DO	2.16	Mg/l

From the results of the analysis performed or carried out on the snail shell, the pH and surface area have values of 8.48 and 40.29 respectively.

The pH value shows that the solution of snail shell is slightly alkaline, this as a result of the presence of calcium carbonate and protein present in the shell (Aboua F 1995). It has a large surface area, it was easy to homogenize the snail shell into fine powder, due to this, there is a large surface area for reaction, and hence it serves as a good coagulant for the treatment of waste water.

The stability studies carried out on the snail shell shows that it was very stable in all pH values, only about 0.02g went into solution, hence it is very suitable for the treatment of waste water at any pH or medium.

Optimum dosage measurement using turbidity and COD as an index for measurement show that between the values of 3.4g per 100ml of the shell can coagulate or treat waste water effectively, that is a better result was obtained when 3.3g- 3.4g per 100ml 0f the shell was applied. However, the optimum dosage of 3.4g per 100ml of the shell was used because COD as a parameter has been found to have a high degree of relationship with other parameters such as BOD, DO, conductivity, turbidity etc (Ademoroti C.M.A 1996).

Analysis carried out on waste water sample before and after treatment showed that the values of the total solids (T.S), total suspended solids (TSS) and total dissolved solids (TDS) of the raw sample were 15600.8, 0.814 and 15660 mg/l respectively. This shows that the sample contains high solid concentrations, most of which were in the dissolve forms while some in suspended form. This is a result of the production processes or activities of the industry.

The conductivity and turbidity whose values were 0.294mscm^{-1} and 332NTU respectively is an indication that the raw sample (waste water) contains high amount of dissolved and suspended particles and ions (Hanson N.W 1973).

The temperature of the waste water sample is 20^{oc} and the dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) have values of 1.14, 29.27 and 872 mg/l respectively. The low value of dissolved oxygen and high values of BOD and COD show that there is a high competition for the DO at 20^{oc} by the suspended, dissolved substances and micro organism in the waste water, this is an indication of pollution.

Nitrate, sulphate, ammonia-nitrogen and phosphate values were 42.01, 58.11, 0.085 and 0.173mg/l respectively.

Nitrate ion in water is undesirable, this is because it can cause methaemoglobinamea in infants, the high amount of sulphate gives the waste water an offensive odor, the concentration of phosphate present in the raw waste water sample can cause algae growth and eutrophication when discharged into the environment and water bodies (rivers), this indicate strong pollution and therefore calls for treatment before disposal (Altman,S.J, Parizek, R.R 1995)

The results of the parameters studied after treatment of the waste water with snail shell, shows that for total solids (TS), total suspended solids (TSS) and total dissolved solids (TDS) were 15200.2, 0.184 and 15200mg/l respectively; there was a substantial reduction of these values in comparison to the values before treatment.

The dissolved oxygen (DO), Biochemical oxygen demand (BOD) and chemical oxygen demand (COD), values were 2.16, 19.77 and 215mg/l respectively. The increase in the value of dissolved oxygen and decrease in Biochemical and chemical oxygen demand is an indication of the improved quality of the water after treatment.

The quality of any water is high when there is increase in dissolved oxygen (DO) and decrease in Biochemical oxygen demand (BOD) after treatment. This improved quality of the water sample after treatment indicates the effectiveness of snail shell for waste water treatment.

Dissolved and suspended substances contribute to the high conductivity and turbidity values of any waste water, after treatment of waste water with snail shell, there was a drastic reduction in conductivity and turbidity values, these values were 0.164mscm^{-1} and 133NTU respectively, this correlates with the reduction in dissolved substances of the waste water (Rizwan Reza, Gurdeep Singh 2009).

Phosphate was completely removed. It was completely absent from the treated water sample. This is a result of the presence of calcium ion in the shell. Calcium has the ability to react with phosphate ion resulting in the formation of calcium phosphate and calcium hydrogen phosphate which can be removed by filtration.

The nitrate, sulphate, Ammonium-Nitrogen and phosphate values were 13.52, 15.46, and 0.00mg/l respectively. The reduction of values indicates that there is improvement in the quality of the water: hence it is safe for disposal.

The odor was removed after treatment due to the reduction in sulphate.

CONCLUSION

Snail shell as a coagulant is very effective in the treatment of waste water at any pH. A high level of success was achieved in reducing the dissolved solids, Nitrates, sulphate, and of removal phosphate completely from the waste water.

There was a reduction in COD, BOD, conductivity, turbidity values and increase in DO values after treatment, an indication that the snail shell is an effective coagulant and is economic viable in the treatment of waste water.

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