Journal of Experimental Research

December 2018, Vol 6 No 4

Email: editorinchief.erjournal@gmail.com editorialsecretary.erjournal@gmail.com

Received: *24th August, 2018*

Accepted for Publication: *20th Nov., 2018*

Study On The Coagulation Of Bakery Wastewater Using Bambaranut(*Vigna Subterranea*) Husk

[*]Ejikeme EM[1], Ejikeme PCN[1], Onyia OS[1].

[1]Department of Chemical Engineering,
Enugu State University of Science and Technology, Enugu.

***Author for Correspondence:** ebemoca@yahoo.com

Abstract

This research investigated the study on the coagulation of bakery waste water using bambara nut husk. It equally studied the effect of process parameters like temperature (30-36^{0}C), time (10-50mins), coagulant concentration (400-1000mg/l) and pH (2-8) on the total suspended solid content (TSS) of the bakery waste water. Proximate analysis of the coagulant and characterisation of the bakery wastewater were done. The coagulation study was done using the jar test method based on standard bench scale Nephlometric method for the examination of water and wastewater. It was observed that increase in temperature did not favour the coagulation process. Increase in time from 10 to 50mins decreased the TSS of the wastewater. Increase in coagulant concentration from 400-800mg/l decreased the TSS of the wastewater, but further increase to 1000mg/l increased the TSS. Increase in pH from 2-6 decreased the TSS, but further increase to 8 increased it. Characterisation of the wastewater after the coagulation shows that lead and nitrate were completely removed after the treatment, while chemical oxygen demand and biological oxygen demand were reduced. It was equally observed that dissolved oxygen which was 22.5mg/l before the treatment was increased to 55.1mg/l after the treatment.

Keywords: Bakery wastewater, Bambara nut husk, Coagulation, Total suspended solid, Turbidity

INTRODUCTION

Industrial developments have contributed immensely to environmental pollution. This is as a result of discharge of their waste water without treatment to the environment. This waste water tends to pollute water bodies when they find their way to water bodies (Rao and Rao 2006). Aquatic lives suffer as a result of decrease in dissolve oxygen contact of the water, while population that indirectly or directly uses the water suffers so many health problems (Kaushik et al 2009). Bakery water has so many suspended solids which are very difficult to sediment and seriously contribute to the turbidity of waste water. There are so many ways of treating waste water for safe discharge into the environment. One of the ways which has been proven to be efficient is coagulation process. Coagulation is the process of adding substances to waste water to bind the suspended particles together and subsequently aggregate them into visible flocs that settle out of the water (Menkiti et al. 2010. The process of binding the suspended particles together is called coagulation, while the formation of visible flocs is called flocculation. This process is achievable only when those suspended particles are aided to overcome their repulsive forces to form blocks of flocs (Edzwald, 1987; Diterlizzi, 1994; Ma etal. 2001). The repulsive forces result from similar electric charges in the suspended particles which cause the particles to naturally repel each other and hold small colloidal particles apart and keep them in suspension (Babayemi, 2013). The coagulants neutralise or reduce the negative charge in particle. Many coagulants are used in treating waste water such as inorganic coagulants [aluminium and iron salt], synthetic and natural organic polymers (Babayemi, 2013). Little attention has been given to coagulation potential of many animal derivatives. This

brought to our consciousness the need to study the efficacy of bambara nut husk as a coagulant. Bambara nut husk (*Vigna subterranea*) as a waste has been seen as a source of environmental pollution, thereby necessitating its urgent study as an alternative coagulant. There has been little or no work on the use of bambara nut husk as coagulant. Because of this, this work tends to study the efficacy of bambara nut husk as a coagulant in treating bakery waste water. Equally, the kinetics of the coagulation process was also studied.

MATERIALS AND METHODS

Collection of wastewater

The bakery wastewater was collected from Deking bakery at Abakpa Nike Enugu, Enugu State Nigeria.

Characterisation of Wastewater

The characterization of wastewater before and after coagulation was done according to standard method (APHA, 1998).

Jar test method

The jar test method was conducted based on standard bench scale Nephelometric method for the examination of water and wastewater using turbidimeter, magnetic stirrer and pH meter.

Preparation of bambaranut husk as a coagulant

The seed shell was collected from abakpa market in Enugu as a waste generated after grinding and sieving the seed. It was washed and dried to constant weight. The dried husk was ground to 600μm and then processed for further study.

RESULTS AND DISCUSSION

Table 1 shows the characterization of bambara nut husk used as coagulant in this study. The active ingredient responsible for coagulation is protein. It was observed that the bambara nut shell had 6.9% protein content, though lower than some coagulants studied in literature but were significant to initiate coagulation. It was equally observed that it has low moisture content which is capable of increasing the rate of coagulation.

Table 1. Characterisation of bambara nut husk

Parameters	Units	Bambara nut husk
Moisture	%	3.0
Ash	%	1.1
Crude fiber	%	78.8
Fat	%	1.2
Protein	%	6.9
Carbohydrate	%	9.0

Table 2 shows the result of the characterization of bakery waste water before and after treatment with bambaranut husk. The result confirmed the efficacy of the sample in treating waste water. It was observed that so many parameters were reduced as a result of coagulation. It was observed that lead which was 0.0107mg/l on the untreated sample was completely removed as a result of treatment with bambara nut husk. Iron which was 0.3789mg/l on the untreated sample was reduced to 0.07047mg/l.

Nitrate which was 6.2mg/l on the untreated sample was completely eliminated. The chemical and biological oxygen demands were reduced as a result of treatment with bambaranut husk. It was equally observed that the dissolved oxygen which was low on the untreated sample (22.5mg/l) was increased to 55.1mg/l as a result of treatment with bambara nut husk.

Parameters	Unit	Untreated Bakery wastewater	Treated bakery wastewater
Alkalinity	mg/l	Nil	150
Acidity	mg/l	1500	150
Hardness	mg/l	200	
Chloride	mg/l	1420	184
COD	mg/l	266	196
BOD	mg/l	44.43	15.1
DO	mg/l	22.5	55.1
Total suspended solid	mg/l	9500	1100
Total dissolved solid	mg/l	2350	700
Total solid	mg/l	11850	1800
Conductivity	mg/l	1010	280
Temperature	^{o}C	28.0	29.0
Lead	mg/l	0.0107	Nil
Copper	mg/l	18.481	0.9238
Iron	mg/l	0.3789	0.01047
pH	mg/l	5.6	7.0
Phosphorus	mg/l	0.3484	0.01047
Magnessuim/calcium	mg/l	100.928	20.1856
Sulphate	mg/l	418.46	92.6
Turbidity	mg/l	563.3	5.6
Nitrate	mg/l	6.2	Nil

The pH plays important roles in determining the ability of coagulants to remove collided particles.

Fig. 1 shows the plot of effect of pH at various coagulant concentrations on the total suspended solid concentration. The result shows that with an increase in pH from 2 to 6, there was a decrease in the Total Suspended Solid Concentration of the waste water. However, an increase in total suspended solid concentration was recorded at higher pH of 8. All the concentration had the same trend of having their lowest TSS at pH of 6 and highest TSS at pH of 8. This indicated that the effect of pH is independent of coagulant concentration.

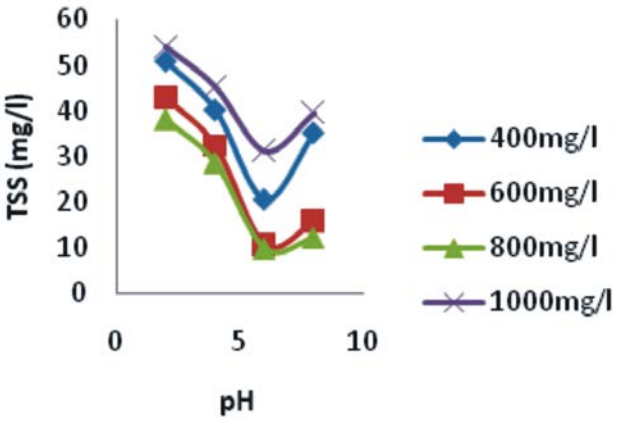

Figure 1. Effect of pH on total suspended solid concentration

From the result obtained, it was observed that coagulant concentration affects the rate of coagulation. Figure 2 shows the effect of coagulant concentration on the total Suspended Solid Content of the waste water. It was observed from the plot that increase in concentration from 400mg/l to 800mg/l decreased the TSS from 1239.2mg/l to 20.9mg/l using Baranut shell husk, while further increase of concentration to 1000mg/l increased the total suspended solid to 59.84mg/l. Increase in concentration of the coagulant can lead to particle enmeshment that can instantaneously sweep away the suspended solid from the suspension (Menkiti and Onukwuli, 2012). The increase recorded at high concentration can be attributed to the ability of the coagulant to re-turbidize the effluent when in excess.

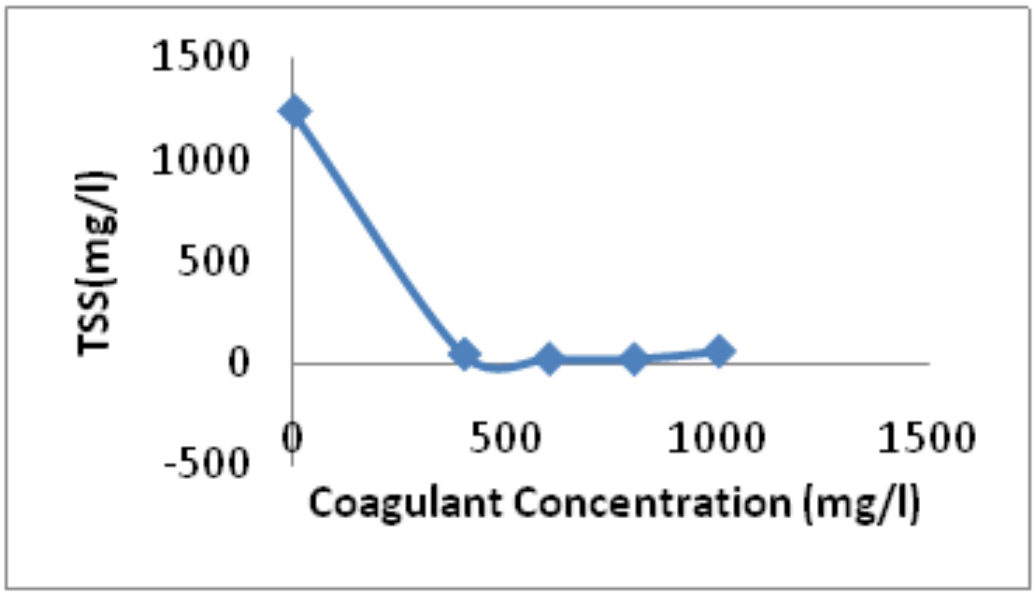

Figure 2. Effect of coagulant concentration on the total suspended solid.

Temperature has been known to affect coagulation process because of its effect on the floc size. Figure 3 shows the plot of effect of temperature on the total suspended solid of the wastewater. The temperature ranges selected were close (30 – 36°C) with 2°C differences because of the fact that high temperature has been known to have adverse effect on coagulation. It was observed from the result that increases in temperature did not favor the coagulation. As the temperature was increased from 30°C to 36°C, the total suspended solid content increased. In actual sense, lower temperature is favorable for coagulation process.

The effect of temperature on coagulation is most likely related to changes in coagulant Chemistry. Temperature affects flocculation by affecting floc size, strength and ability to reform after shear break-up. This affects clarification and filtration process, coupled with the effect of viscosity changes due to temperature. Higher temperature generally produces bigger flocs that break more easily and reform less well than at lower temperature (Fitzpatrick et al. 2004). Breakage in terms of floc size reduction is greater at higher temperature suggesting a weaker floc. Larger floc produced at low temperature aids sedimentation unlike small sized flocs produced at higher temperature.

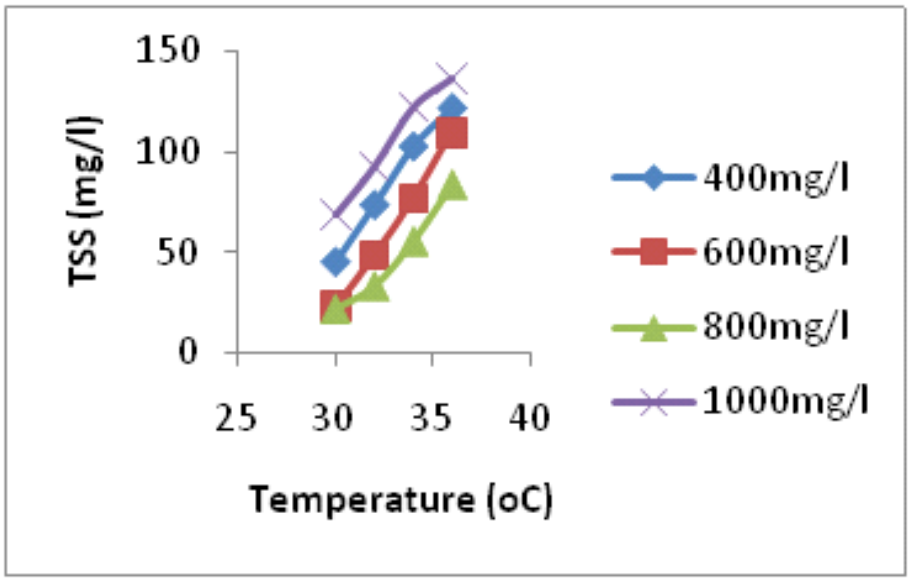

Figure 3. Effect of temperature on the total suspended solid

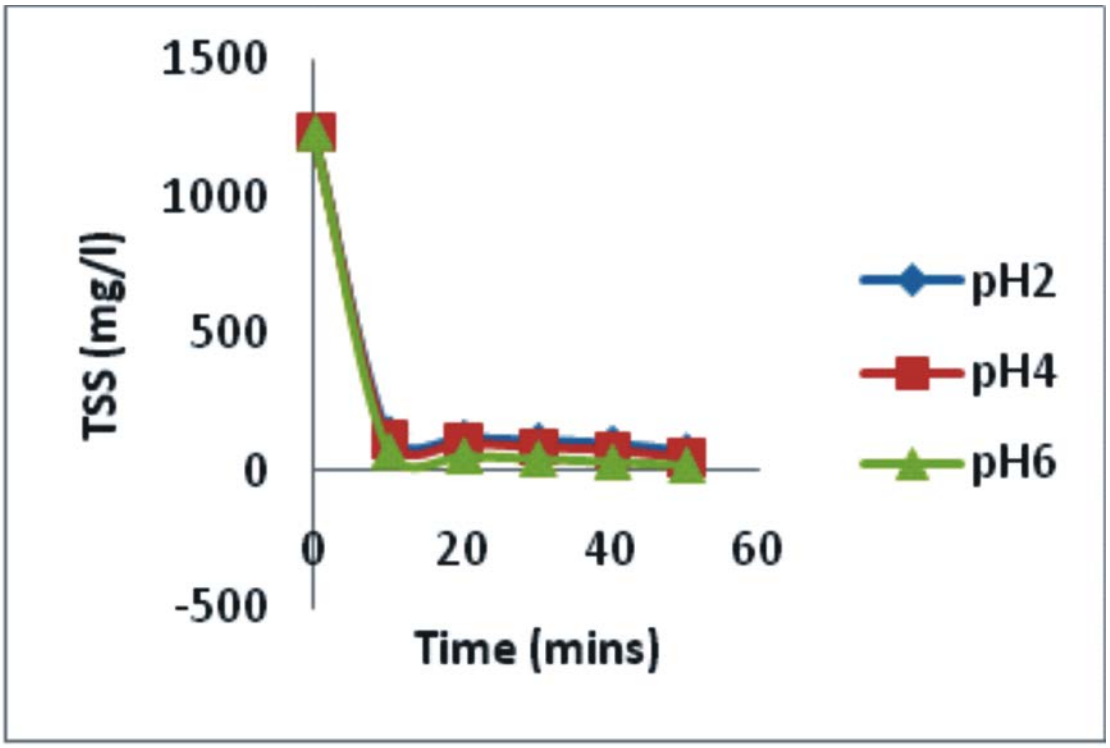

Figure 4. Effect of time on the total suspended solid

Effect of time on the total suspended solid removal was studied at different pH of 2, 4, 6 for 400mg/l coagulant concentration. The result is shown on Fig. 4. It was observed from the result that total suspended solid content decreased as time was increased. The decrease of turbidity with time reflects the fact that as the reaction proceeds, the amount of particles available for the coagulation decreased (Menkiti et al. 2008). The sharp decrease in total solid content between 0 and 10 minutes is a product of either floc sweep mechanism or combination of entrapment-bridging mechanism (WST 2005). It was equally observed that lowest total solid concentration was recorded at pH of 6.

CONCLUSION

It can be concluded from this study; that bambaranut husk can be used as a coagulant in the treatment of bakery waste water using coagulation process. Coagulant concentration, pH, time and temperature had effect on the total suspended solid content of bakery waste water. It was equally concluded that coagulation is more efficient at pH of 6 owing to the lower concentration of TSS obtained.

REFERENCES

APHA (1998). Standard Method for the Examination of water Effluent, New York, USA.

Babayemi KA, Onukwuli OD, Okewale AO. (2013). Coag-Flocculation of Phosphorus Containing Waste Water Using Afzella-Africana Biomass. International Journal of Applied Science and Technology 3;(6):43-51

Diterlizzi SD. (1994). Introduction to coagulation and flocculation of wastewater. Environment system project, USA.

Edzwald JK (1987). Coagulation-sedimentation-filtration process for removing organic substances from drinking water. Control of organic substances in water and wastewater. Noyes Data Corporation, Park Ridge, New Jersey.

Fridkhsberg DA. (1984). A course in Colloid Chemistry. Mir Publishers Moscow, Russia. 266-268

Golder AK, Samanta AN, Ray S (2006). Anionic reactive dye removal from aqueous solution using a new adsorbent—Sludge generated in removal of heavy metal by electrocoagulation. Chemical Engineering Journal 122: 107–115

Holthof H, Egelhaaf SU, Borkovec M, Schurtenberger P, Sticher H. (1996). Coagulation Rate Measurement

of Colloidal Particles by Simultaneous Static and Dynamic Light Scattering. Langmuir 12: pp:5541.

Kaushik CP, Ravinder T, Namrata K, Sharma JK. (2009). Minimization of organic chemical load in direct dyes effluent using low cost Adsorbents. Chemical Engineering Journal 155: 234–240

Ma J, Li G, Chen GR, Xu GO, Cai GQ. (2001). Enhanced coagulation of surface waters with high organic content by permanganate preoxidation. Water Science and Technology, Water supply. ;(1): 1: 51-61

Menkiti MC, Nnaji PC, Onukwuli OD. (2008). Coag-flocculation, kinetics and functional parameters response of Periwinkle shell coagulant (PSC) to pH variation in organic rich coal effluent medium. Nature and Science. 7;(6):1-18

Menkiti MC, Nnaji PC, Nwoye CI, Onukwuli OD. (2010). Coag-Flocculation Kinetics and Functional Parameters Response of Mucuna Seed Coagulant l of Minerals & Materials Characterization & to pH Variation in Organic Rich Coal Effluent. Medium Journal of Minerals & Materials Characterization & Engineering. 9;(2):89-103

Rao VVB, Rao RMR (2006). Adsorption studies on treatment of textile dyeing Industrial effluent by flyash. Chemical Engineering Journal. 116:77–84

Smoluchowski M. (1917). Verscuheiner Mathematischen Theories der koagulations kinetic kolloides lousungen. Phs. Chem. 92: 129-168

Water Specialist Technology (WST) .(2005). About Coagulation and Flocculation. Information Bulletins, U.S.A. pp: 1-10

Yates P, Yan Y, Jamson GJ, Biggs S. (2001). Heteroaggregation of particle system: Aggregation Mechanisms and aggregate structure determination..6th World Congress of Chemical Engineering, Melbourne. pp: 23-27