BIO-COAGULANTss as Ecofriendly Alternatives in THE DAIRY WASTEWATER Treatment

Abstract

Coagulation is a simple and widely used method for water and wastewater treatment. Chemical coagulants, on the other hand, not only produce vast volumes of toxic sludge, but they also have negative impacts on living organisms. This study demonstrates the use of neem tree leaf and banana leaf powders as natural coagulants for the treatment of dairy effluent. The jar test was used to determine the pH, turbidity, and metal ion content of the treated samples. The biocoagulants were experimented at a rate of 100 mg/L, 200 mg/L, and 300 mg/L at pH of 5, 6, and 7. The levels of turbidity, sodium (Na), potassium (K), calcium (Ca), barium (Ba), lithium (Li), and copper (Cu) were measured after the treatment process. Turbidity was reduced by 52%, and coagulants at 200 mg/L and 300 mg/L were more successful at removing metal ions from dairy effluent except in copper, where 100 mg/L was shown to be more effective. In the scattering between adjacent, similarly charged particles, the zeta potential reveals the strength of repulsive powers. There are more dispersion and suspension rates in the treatment of dairy wastewater using banana and neem leaf biocoagulants. Neem tree leaf and banana leaf powders were efficient and cost-effective eco-friendly biocoagulants for the treatment of dairy effluent.

Keywords: *Banana leaf, Dairy Wastewater, Jar Test Apparatus, Neem leaf, Turbidity*.

1. Introduction

Water is ~~without a doubt~~ the most crucial normal asset~~. Water~~ and is a necessity for all living ~~things, including humans~~organisms [1]. ~~Water is the premise of life on the planet.~~ Non-industrial ~~nations~~ and third-world nations are confronting consumable water supply issues because of insufficient monetary assets. In non-industrial nations, 15 million newborn children bite the dust consistently due to tainted drinking water, helpless cleanliness, and lack of healthy sustenance [2]. Around 80% of illnesses in agricultural nations are straightforwardly associated with polluted drinking water [3]. Ground-water, surface water, and rainwater are frequently the major sources of water accessibility in a community. Consumable water ~~, which is good for drinking,~~ must be liberated from pathogenic ~~creatures~~microorganisms, harmful substances, and an overabundance of minerals and natural poisons [4]. It should be dull, tasteless, and unscented ~~in order~~ to be alluring to buyers [5].

Bio coagulation is used to eliminate turbidity from raw water sources before it is used in portable water [6]. The amount of drainage poured into water sources has contaminated the water quality because of the fast population increase and industrialization. Water quality can be improved using a variety of sanitation procedures. Primary coagulants are ~~primarily~~ aluminum and iron salt. However, these coagulants are harmful to both the environment and humans. Coagulation and flocculation processes are the most preferred among the large variety of available wastewater treatment technologies [7]. This therapy is widely utilized since it is cost-effective, dependable, easy, and considered to be a low-energy method [8].

This highlights the need to find ~~a~~ natural ecofriendly alternatives such as biocoagulant for easy and inexpensive wastewater treatment. Banana leaf and neem leaf powders are used as natural biocoagulants. Water treatment is very economical when using natural biocoagulants. The objective of the study is to measure the effectiveness of banana leaf and neem leaf powder as biocoagulants in dairy wastewater treatment using the ~~reduce~~ reduction in ~~the~~ turbidity ~~level~~ and ~~identify the~~ metal ion ~~concentration~~ levels as an indicator for the success of the treatment process. ~~in dairy wastewater collected from the dairy industry. This study aims to find out the effectiveness of banana leaf and neem leaf powder as biocoagulants.~~

2. Materials and Methods

2.1. Preparation of Biocoagulant

The neem leaves and banana leaves were collected from the UTAS-Salalah premises, ~~and~~ cleaned with distilled water, and sundried ~~in sunlight~~ for three days. ~~Then t~~The ~~dried~~ samples were granulated using a grinding tool ~~to obtain fine particles~~. The powder was ~~then~~ sieved through ~~the standard~~a ~~90~~ 90-micron sieve. ~~The dried powder is ready to be used as a biocoagulant.~~ The fine powder was collected and stored in an airtight container to protect it from moisture.

Fig.1. Neem (***Azadirachta indica)*** and Banana Leaf (***Musa acuminate*****)** Powder (Biocoagulants)

2.2. Chemicals

Wastewater from the local dairy industry was collected. The pH ~~of solutions~~ was adjusted with 0.1 N HCl and NaOH.

All the experiments were ~~carried out again~~repeated, as well as blank~~,~~ trials were also carried out and the average results were published. ~~Blank trials were also carried out to guarantee that no coagulation occurred on the walls of the apparatus.~~

2.3. Apparatus

The Jar test method was implemented to determine the best operating conditions for wastewater treatment. A flame photometer was used for the determination of Na, K, Ca, Ba, and Li concentrations, and for the copper concentration, a UV-Vis Spectrophotometer was used. The values of turbidity were measured by a digital turbidity meter.

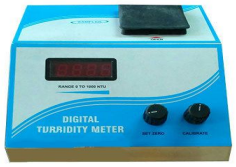
Formatted: Highlight

Formatted: Font: Italic

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight



(a) **(b)** **(c)**

Fig. 2. Apparatus used: (a) Jar Test (b) Turbidity Meter (c) Flame Photometer

2.4. Batch Coagulation Experiment

Color, turbidity, germs, suspended matter, and odor-producing elements ~~are~~ were all removed ~~using~~ during the coagulation process. The coagulant ~~is~~ was added to break down the small-destabilized particles into a big matter, which ~~is subsequently~~was decanted and separated from the effluent by gravity. Different doses of neem leaf powder/banana powder ~~are~~were added to the effluent. Rapid mixing for 3 min~~utes at~~/100 rpm ~~is done first~~was carried out, ~~followed by~~ gentle mixing for 25 min/~~utes at~~ 20 rpm, ~~.~~ a~~A~~llowing 30 min~~utes~~ ~~for the samples~~ to rest~~.~~. ~~The~~ the supernatant water was ~~then~~ filtered, and various turbidity, pH, and metals parameters were measured using a flame photometer and a UV Spectrophotometer.

~~The coagulant of banana powder solution is treated in the same way.~~

~~3.~~ Results and Discussion

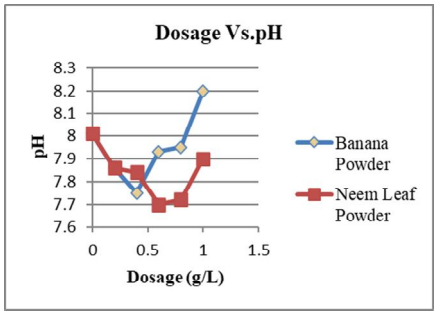
~~3.1.~~2.5. Effect of Biocoagulant Dosage on pH and Turbidity

The ~~outcomes of the jar test coagulation experiment~~results revealed that a dosage of 0.4 g/L of neem leaf and banana leaf powder ~~coagulant~~ was sufficient to maintain a pH of 7.8 (Fig. 3.a) and ~~a~~ turbidity of 34 nephelometric turbidity unit (NTU) (Fig. 3.b) [9,10]. It delivers that the pH ~~values~~ (8 to 7.84) and the turbidity values decreased ~~from 8 to 7.84~~ and then ~~started~~ increas~~inged~~ as the coagulant's dosage ~~of~~ was ~~coagulant~~ increased from 0 to 1 g/L. ~~Similarly, the turbidity values decreased up to the dosage of 0.4 g/L coagulant and then started increasing as the coagulant dosage was increased further.~~ Therefore, the optimum dosage of the biocoagulant was considered to be 0.4 g/L.

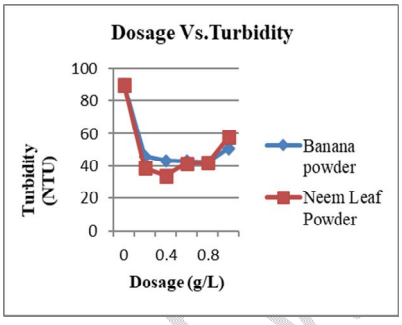
Formatted: No bullets or numbering

Formatted: Highlight

Formatted: No bullets or numbering



(a)



(b)

Fig. 3. Effect of Bio coagulant Dosage on (a) pH and (b) Turbidity

~~3.2.~~2.6. Effect of ~~Bio~~ Bio-Coagulant Dosage on Removal of Various Metals

~~It is understandable that~~Understandably, the effect of biocoagulant's ~~the~~ quantity ~~of bio coagulant~~ show~~s~~ed various effects on the removal of ~~various types of~~ metal ions. The initial concentrations of ~~the metal ions such as~~ Na, K, Ca, Ba, ~~and~~ Li, and ~~present in the dairy wastewater were found by using flame photometry, and the concentration of~~ Cu ~~was measured by UV-VIS Spectrophotometer~~were 152, 21, 10.3, 11.6, zero, and 1029 ppm, respectively. ~~The initial concentrations are 152, 21, 10.3, 11.6, 0 ppm and 1029 ppm, respectively.~~ It was found that the 100 mg/L (Fig. 4) of both neem and banana leaf powder coagulant at ~~a~~ pH ~~value of~~ 5 showed the highest removal of Na, K, Ca, Ba, Li, and Cu. Similar trends were observed at the bio coagulant dosage ~~values~~ of 200 and 300 mg/L (Fig. 5 and Fig. 6). It was found that the removal of ~~the above metals for~~ Na, K, Ca, Ba, and Li was found to be maximum at ~~the bio coagulant concentration of~~ 300 mg/L and 100 mg/L for Cu for both neem (Table 1, Fig.7) and banana leaf (Table 2, Fig.8) due to the mechanism of coagulation.

Neem leaf and banana leaf powder produced ~~The~~ absorption and neutralization actions of colloidal positive charges that attract negatively charged contaminants in water ~~are the functions of neem leaf and banana leaf powder~~ [11]. Coagulation is insufficient if the bio-coagulant quantity is too low, resulting in ~~a~~ reduced ~~coagulation impact~~efficacy. When the bio-coagulant concentration is too high, the particles in the ~~initial~~ wastewater are encased in too much bio

coagulant, and their surfaces become saturated, resulting in a decreased ~~in~~ particle coagulation and stability, making it difficult for the particles to coagulate [12,13].

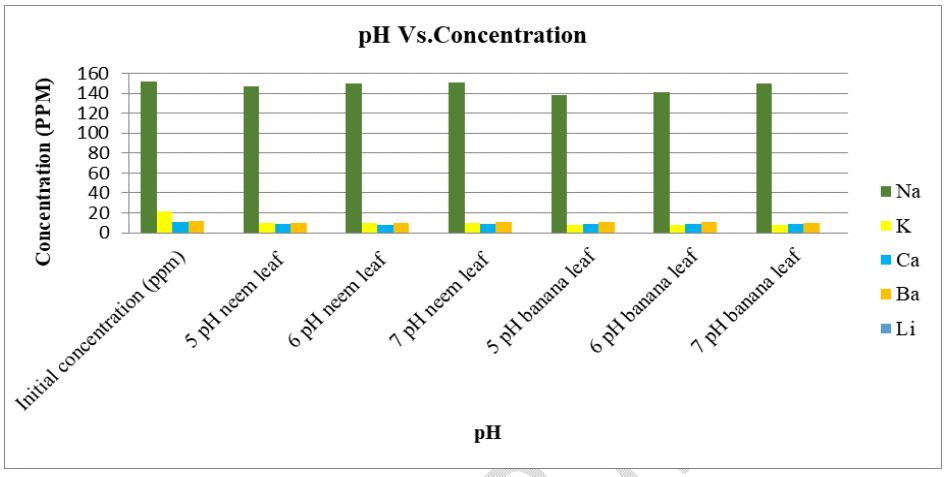


Fig.4. Flame Photometer Analysis for 100 mg/L of Neem and Banana Coagulants

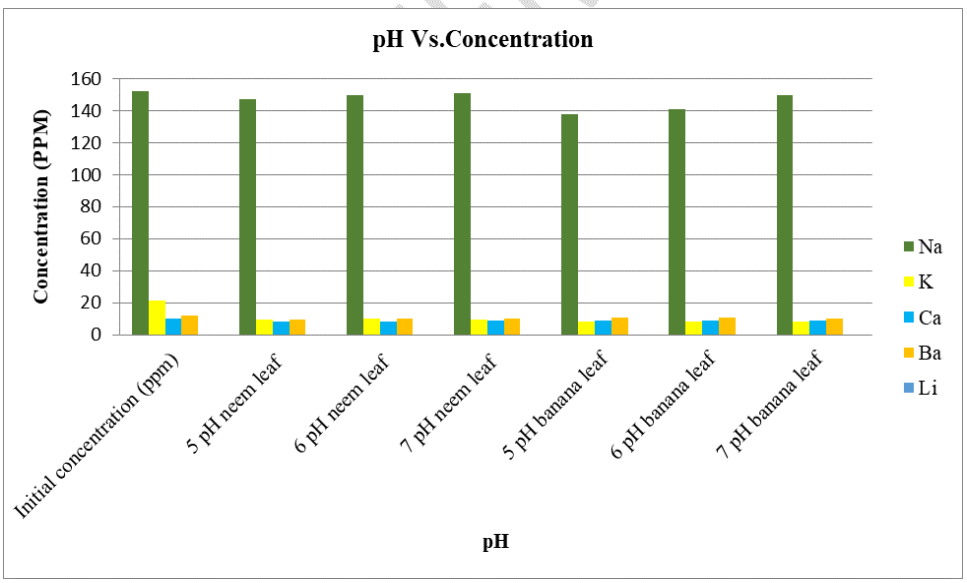


Fig.5. Flame Photometer Analysis for 200 mg/L of Neem and Banana Coagulants

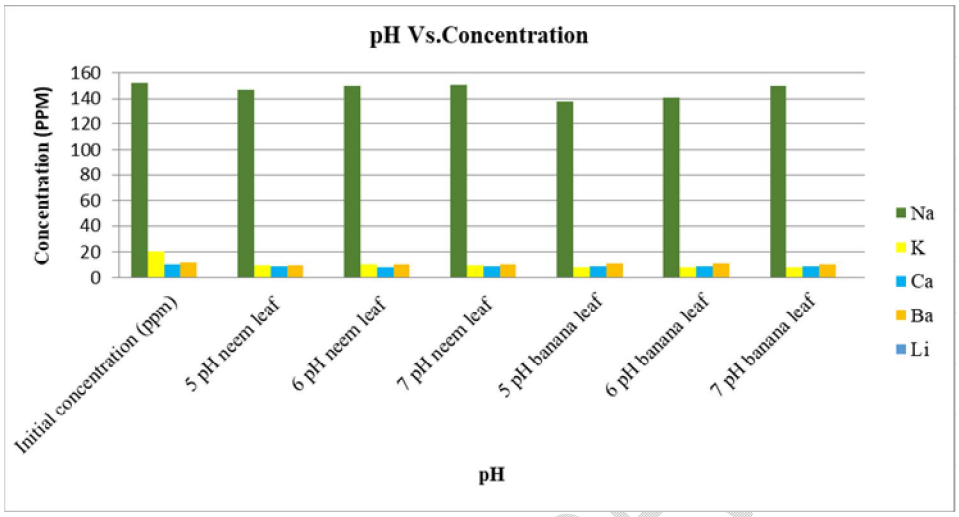


Fig.6. Flame Photometer Analysis for 300 mg/L of Neem and Banana Coagulants

Table 1. UV-Spectrophotometry analysis for the copper ion at 100, 200, and 300 mg/~~l~~L of neem leaf biocoagulant.

Initial concentration (ppm)	100 ppm			200 ppm			300 ppm		
	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7
1029	139.5	204.7	238.5	349	395	445.6	307.8	338	379

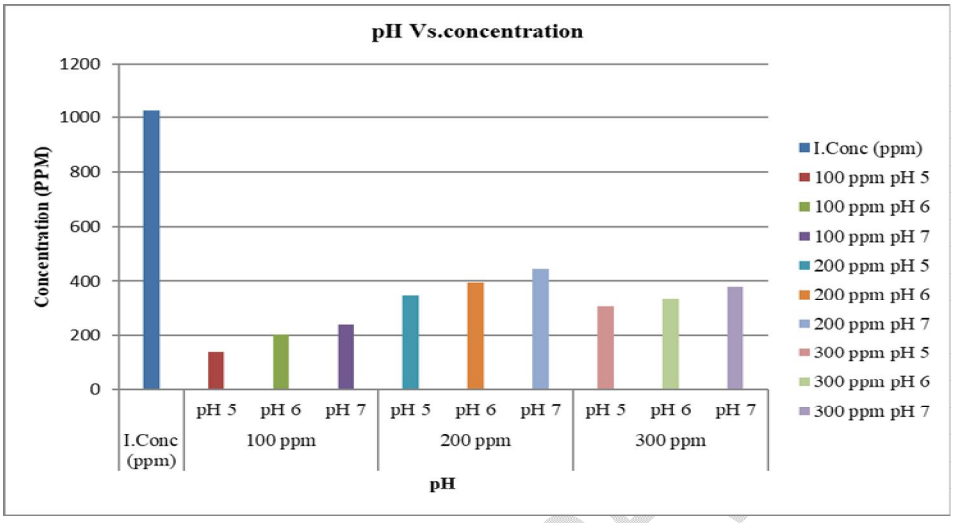


Fig.7. UV-Spectrophotometry analysis for the copper ion at 100, 200, and 300 mg/~~l~~ L of neem leaf biocoagulant.

Table 2. UV-Spectrophotometry analysis for the copper ion at 100, 200, and 300 mg/~~l~~ L of banana leaf biocoagulant.

Initial concentration (ppm)	100 ppm			200 ppm			300 ppm		
	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7	pH 5	pH 6	pH 7
1029	206.7	208	238.5	354.2	382.7	422.2	314.9	352.9	505.8

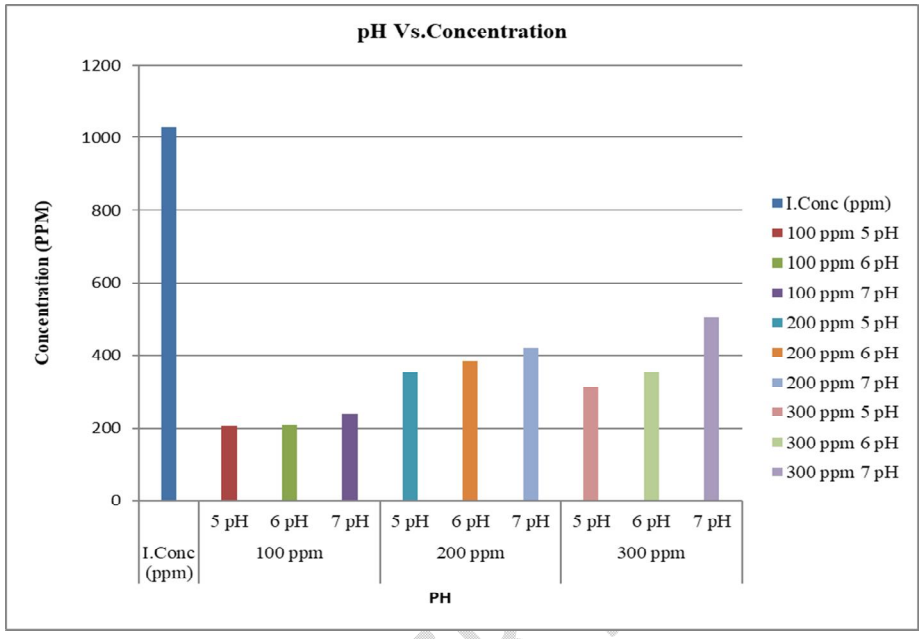
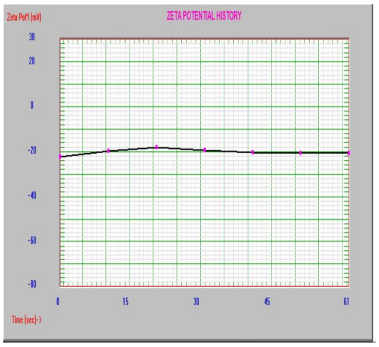


Fig.8. UV-Spectrophotometry analysis for the copper ion at 100, 200, and 300 mg/~~l~~L of banana leaf biocoagulant.

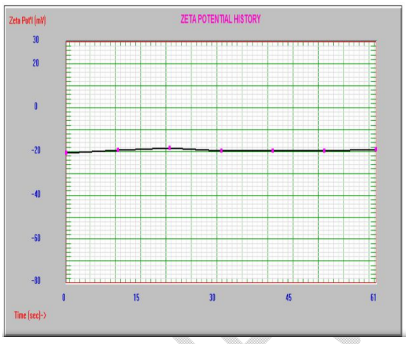
~~3.3.~~2.7. Zeta Potential of Banana and Neem Leaf Coagulant

The stability of colloidal suspension was investigated using zeta potential analysis ~~for banana and neem natural coagulants~~ to measure the degree of electrostatic repulsion in the dispersion between the natural coagulants nearest equally charged particles, as illustrated in Figure 9. The zeta potential of particles ~~typically~~ ranges from +100 mV to -100 mV. Well-scattered NPs have a Zeta potential of greater than +30 mV or less than -30 mV. The zeta potential of neutral NPs ranges from -10 to +10 mV. The zeta potential of banana and neem is (-20.77 mV and -19.22 mV, respectively) [14].

Dispersions, emulsions, and suspensions are frequently improved using zeta potential analysis. The zeta potential ~~value~~ of both ~~natural coagulants (~~banana and neem~~)~~ coagulants describes the degree of repulsive forces in the dispersion between contiguous, equally charged particles [15]. Its findings disclose detailed diffusion, aggregation, and flocculation principles that can be used to improve dispersions, emulsions, and suspension formulations between dairy wastewater pollutants and natural coagulants [16].



(a)



(b)

Fig. 9. Zeta potential of (a) *Banana leaf powder* and (b) *Neem leaf powder*

~~4.~~3. Conclusion

T~~From the foregoing experiment, we have concluded that t~~he turbidity levels were reduced by a rate of 55 and 65% ~~reduction by the usage~~using ~~of~~ neem and banana biocoagulants ~~is 55% and 65%~~, respectively. ~~When it comes to metals, t~~The amount of Na and Ca increased as pH decreased, but there was a minute change in the case of K and Ba, and there was no change in the case of Li. ~~In the case of c~~Copper ~~removal, it was found that the removal was high~~was greatly reduced at ~~a~~ pH ~~of~~ 5 with ~~a biocoagulant concentration of~~ 100 mg/L for both the bio-coagulants and the~~. When using banana leaves as a coagulant, we noticed that the~~ lower the pH, the lower the copper percentage concerning banana leaf powder.

The zeta potential also showed that ~~the degree of repulsive forces in the dispersion between contiguous, equally charged particles. It was identified that~~ the more dispersion and suspension rates in the treatment of dairy wastewater by banana and neem leaf bio coagulants, the better. Neem and banana powder were found to be non-toxic and eco-friendly ways for the treatment of wastewater and can be used as an alternative coagulant in water treatment plants.

References

1. Chauhan S. and Gupta K.C. Purification of drinking water with the application of natural extract. Journal of Global Biosciences, 4(1): (2015) 1861 – 1866.
2. Deshpade L., Water quality analysis laboratory methods. National Environmental Engineering Research conference, New Delhi. pp. (2010)137 – 139.
3. WHO, Guidelines for drinking water quality 3 rd Edition vol. 1 (2004) pp 371 – 372.
4. Environmental Protection Agency,. Effects of Acid Rain: Lakes and Streams. Washington D.C. (2003) pp. 81 – 85.
5. Yongabi K.A. Bio-coagulants for water and wastewater purification: a review. International review of Chemical Engineering., 2(3): (2010) 444 – 458.
6. Coleman J., Hiench K., Garbutt K., Sexstone A. and Skovsen J,. Water, Air and pollution. J. Bio Res. Technology 10(1): (2001)2167 – 2172.
7. Adejumo M., Oloruntoba, E. O. and Sridhar M. K Use of Moringa Oleifera seed powder as a coagulant for purification of water from unprotected sources in Nigeria. European Scientific Journal 9(24): (2013). 241 – 253.
8. Mann A.G., Tom C.C., Higgins C.D. and Lodrigues L.C., The association between drinking water turbidity and gastrointestinal illnesses: a systematic review. BMC Public Health 7(256) (2007) 1 – 7.
9. Bratby J., Coagulation and flocculation in water and wastewater treatment. IWA publishing, Seatle, London. (2006). pp. 81 – 86.
10. Zhang B.J., Cui C.U., Xiao F. and Huang J. H,. Effect of low temperature on coagulation kinetics and floc surface morphology using alum. Desalination, 237: (2009) 201 – 213.
11. Laeli .K, Suwardiyono, Renan.S, Indah Hartati., Process Optimization of Microwave Assisted Lime Pretreatment on Ramie Decortication Waste Using Response Surface Methodology, International Journal of ChemTech Research, , 9(2): (2016) 272-277.
12. Ahmad M.A.,Afandi N.S. and Bello O.S., Optimization of process variables by response surface methodology for malachite green dye removal using lime peel activated carbon, Appl Water Sci., (2015) 1-11.

Comment [es1]: MUST BE UPDATED as zero% (0 out of 16) of the listed references were published in the past five years. The percentage has to increase to 30-40%. The old reference indicates less interest in the study field.

13. Othman Z., Bhatia S. and Ahmad A.L. Influence of the settleability parameters for palm oil mill effluent pretreatment by using MoringaOleifera seeds as an environmentally friendly coagulant, Interference conference on Environment, Malaysia (2008) 1 – 9.
14. John .A, Jayanthi.G, Lakshmipathy.R, Kulasekaran.A, Andal.V., , Colour removal studies on treatment of textile dyeing effluent by Chitosan modified Watermelon rind Composite (CWR), International Journal of Chem Tech Research, 8(5), (2015) 10-15.
15. Yildiz S, Değirmenci M., Estimation of oxygen exchange during treatment sludge composting through multiple regression and artificial neural networks. Int J Environ Res. ;9(4):1173-1182. (2015) DOI: 10.22059/IJER.1007.
16. Enayatollahi I, Bazzazi AA, Asadi A. Comparison between neural networks and multiple regression analysis to predict rock fragmentation in open-pit mines. Rock Mech Rock Eng.; 47:799-807. (2014) DOI: 10.1007/s00603-013-0415-6.