Scientific Journal of Impact Factor(SJIF): 3.134

e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 2,Issue 2, February -2015

Effectiveness of Banana Peel and *Moringa oleifera* Seed Powders for the Treatment of Wastewater from an Institutional Kitchen

Mini Mathew[1], Anju Mathew[2], Jyothis G[3], Anjalathu V N[4], Christina S Alexander[5]

[1]*Department of Civil Engineering, Amal Jyothi College of Engineering, minimathew@amaljyothi.ac.in*

Abstract *— The demand for fresh water is continued to increase at a rapid pace due to the growing population, increasing urbanization and the constant economic growth. Fresh water scarcity can be overcome to an extent by using fresh water sources for drinking purposes and treated wastewater for various domestic purposes. Conventional treatment techniques are extremely expensive for developing countries like India. Therefore, an urgent need for cost effective methods of treatment and recycling of wastewater are highly desirable. Taking these into consideration, we have worked on the effectiveness of naturally available cheap materials as a coagulant and a bio-adsorbent. The treatment process is a two stage processes:, in the first stage Moringa oleifera extract was used as the coagulant or banana peel powder was used as the adsorbent and in the second stage coagulated water was filtered using constructed filter. The wastewater generated at campus hostel was used for the laboratory analysis. The jar test was used to determine the optimum coagulant dosage of banana peel powder and Moringa oleifera seed extract. The water quality analysis of raw water, treated water using M. oleifera and banana peel powder without and with filtration was carried out. It was observed that for both Moringa oleifera extract and Banana peel powder, there was 14 % increase in pH after coagulation and flocculation and pH increased to 100% after filtration, as well as 65% of tubidity, 58% of chlorides was removed during first stage , and followed by filtration has a percentage reduction of 95% and 93% respectively. The value of hardness showed an increase. Also first stage treatment led to 21% decrease in COD and 54% decrease in BOD and filtration led to 79 % removal of COD and 99% removal of BOD. The DO increased from 0 to 4.33 mg/l using Banana peel powder and 5.12 mg/l using Moringa extract. TDS of the sample remained stable and the TSS value of the sample decreased by 91%. The colour and odour of the wastewater was also completely removed. Most of the water quality parameters were within permissible limit for the irrigation requirements.*

Keywords- *Banana peel powder, Moringa oleifera seed extract, filter, water quality analysis*

I. I.INTRODUCTION

Banana peel is an agricultural waste that is being discarded all over the world as a useless material. They cause waste management problems although they have some compost and cosmetics potentiality [5]. The substance could be used for medicine as well as personal care and is known for anti-fungal and antibiotic properties, with lots of vitamins, minerals and fiber that benefit for skin care and for healing the wound [13]. Besides that, banana peels have adsorbent potentiality. It is very useful for purification and refining processes. It has adsorption capacities to remove chromium from wastewater, copper [8] and also some dyes.

Banana peel is a readily available, and eco-friendly bio-material. This agricultural waste is also inexhaustible and non-hazardous, specifically selective for heavy metals and can be easily disposed by incineration [4]. Banana peels are selected to be prepared as a bio-adsorbent and contain high organic carbon (41.37%) and have been subjected to bio-methanation and biogas production. Peels were also used as a material for charcoal and activated charcoal adsorbent. Banana peels were tested for the removal of total sulfide from spring water in Heet area, Iraq. The chemical composition of peels was investigated [17] and revealed that the treatment of water using the banana peel is most effective for removal of hydrogen sulfide from sulfur spring water.

Moringa oleifera tree is native to the southern foothills of the Himalayas in northwestern India, and widely cultivated in tropical and subtropical areas and its seed powder have been widely used as coagulant for water and wastewater treatment [9, 10, 18]. M. oleifera seeds protein extract has been demonstrated its effectiveness in wastewater systems and showed that the extract can be used to remove 99 % of the suspended solids without affecting the pH of the water [6]. M. oleifera coagulant was able to improve the turbidity from average of 320 NTU to 4 NTU [16]. M. oleifera seed coagulant increased the turbidity removal up to 96.23 % under a dosage of 0.4 mg/l and the extract reduced the hardness of water or wastewater [1]. M. oleifera seed powder leads to toxicity and mutagenic effect [11]. In order to reduce the toxity effect of` using M. oleifera seed as coagulate, a two stage filtration processes combined with the addition of powder was conducted [15]. The results showed that combinations of two stage filtration tank with natural filler media such as sand and charcoal gave a significant improvement than the earlier methods.

The main objective of this paper is to study the effectiveness of two stages and single stage wastewater treatment of campus hostel and kitchen wastewater using *M. oleifera* seed powder. Also the banana peel is an agricultural waste produced all over India, and is reported as an adsorbent. Potential of banana peel powder for the campus wastewater treatment is also studied under two stages. In the first stage the wastewater is coagulated and flocculated with banana peel powder or *M. oleifera* extract and in the second stage the water from the first stage is filtered through the filter. The effectiveness of with and without filtration using banana peel powder and M. oleifera extract is studied and analyzed.

II. MATERIALS AND METHODS

2.1. Preparation of banana peel powder

Banana peels were collected and dried in sunlight for 5 days. The peel was dried in an oven at a temperature of 115º C for 24 h and were finely powdered using electric grinder and then sieved through 2.36 mm IS sieves.

2.2. Preparation of *Moringa oliefera* extract

The seeds were collected and the shells surrounding the seed kernels were removed using knife, and the kernels were grounded using an electric mixer grinder into powder and sieved through IS sieve of 2.36 mm size. Stock solution was prepared by mixing 10, 20, 30, 40, 50, 60 g of seed powder in 1000 ml distilled water and the solution was then filtered.

2.3. Construction of filter

It was observed that after coagulation of wastewater with Banana peel powder, the colour of wastewater became dark brown. Also the treatment of wastewater with *Moringa* seed extract and Banana peel powder was not enough to increase the Dissolved Oxygen (DO), and the removal of odour. For this a simple and cheap filter was constructed using charcoal and sand. Fresh charcoal was obtained and crushed into small bits. In order to reduce the cost and also to save waste materials, two cylindrical plastic bottles of size 2 liters were taken, shown in

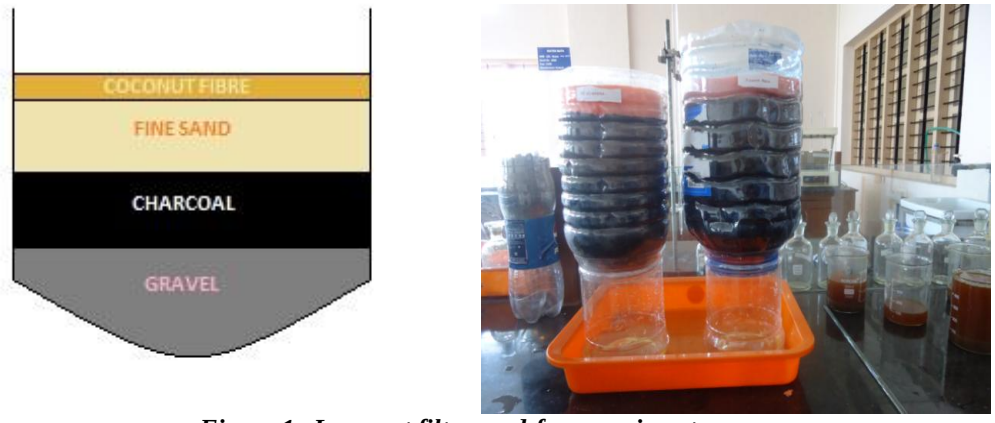

Figure 1. Low cost filter used for experiments

Figure 1. One of them was cut at the top and the other one at bottom. A wire mesh was placed at the mouth of the container. A layer of gravel was placed on top of the mesh, and was well compacted. Gravel was placed at the bottom to give a strength and support to the overlying layers. Further the charcoal bits were placed in a thick layer and compacted. Charcoal would act as an adsorbent which would remove colour and odour. This layer was followed by a layer of well compacted sand, for mechanical screening, coagulation flocculation and biological activity and coconut fiber for its anti-fungal nature. The filter was then saturated using tap water to remove all the dust and dirt components.

2.3. Wastewater

The wastewater for the experimental studies was collected from institutional hostel wastewater outlet (latitude: 9 ^{o} 31$^{'}$ 54.42$^{"}$ and Longitude: 76^{O} 49$^{'}$ 12.5") in Amal Jyothi College of Engineering, Kanjirapally, Kottayam, Kerala situated in the southern part of India

III. RESULTS AND DISCUSSION

The general water quality parameters like pH, turbidity, chloride, hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS) were tested for raw water and treated water. The treatment was done in two stages, namely, treated unfiltered stage, stage 1, i.e. water in which the optimum dosage of *Moringa oleifera* extract and Banana Peel powder was added, stirred to aid flocculation and then allowed to settle; and treated filtered stage, stage 2, i.e. the treated water was filtered through the

filter. The water quality parameters of raw water and these two stages treated water were checked. The results obtained in these two stages were compared with water quality parameters of raw water and permissible levels.

3.1. Optimum dosage of *Moringa* extracts and banana powder

In order to find the optimum dosage of *Moringa* extracts and Banana powder, Jar Tests were conducted. The jar test was conducted with 1 minute fast mixing and 9 minute slow mixing to assist the floc formation process. The turbidities of each of the samples of raw water and treated water were checked using Nephelometric Turbidity meter. The dosage corresponding to the minimum turbidity gave the optimum dosage.

In the case of M. oleifera, stock solutions with varying amounts of *Moringa* seed powder (such as 10, 20, 30, 40 g/l) was first prepared and then the stock solution was added in varying concentrations into the raw water and was subjected to Jar Test.

In the case of Banana peel, various amounts of Banana peel powder were added into the raw water (such as 5, 10, 15 g/l) and was subject to jar test. This was done because; basically Banana peel powder is a bio-adsorbant which is a surface phenomenon.

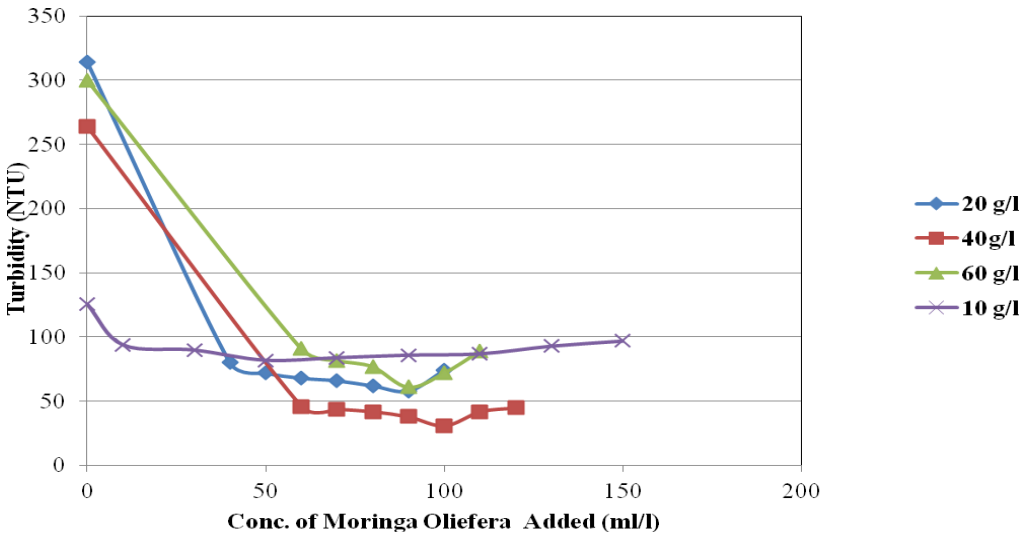

Figure 2. Optimum Dosage for Moringa Oliefera

Figure 2 shows the jar test results for *M. oleifera* extracts. The graph shows the relation between turbidity in NTU and concentration of stock solution added for different dosages of stock solutions. As in the case of the optimum dosage for alum, it was observed that the turbidity value first decrease with the increase in concentration of stock solution, but after attaining a minimum value, the value of turbidity goes on increasing with the increase in concentration of stock solution. This may be due to the fact that after a certain concentration the coagulant itself starts increasing the turbidity. The experiment for different concentrations of stock solution was done on different days and the properties of the raw water also differed daily. The optimum dosage was obtained at 40g/l stock solution with a dosage of 100 ml/l. The lowest obtained turbidity value is 31 NTU. This dosage was taken as optimum for all other tests.

Figure 3 shows the jar test results for Banana peel powder. The graph was plotted between turbidity and amount of Banana powder added. Here also, it was observed the turbidity decreases with the increase in the amount of banana peel added up to optimum dosage and then starts increasing with the increase in the amount of banana peel. This was so because after a certain amount, the banana powders itself starts increasing turbidity. The optimum was obtained at 30g/l and the lowest value of turbidity obtained was 15 NTU. This value was taken as optimum for all remaining experiments.

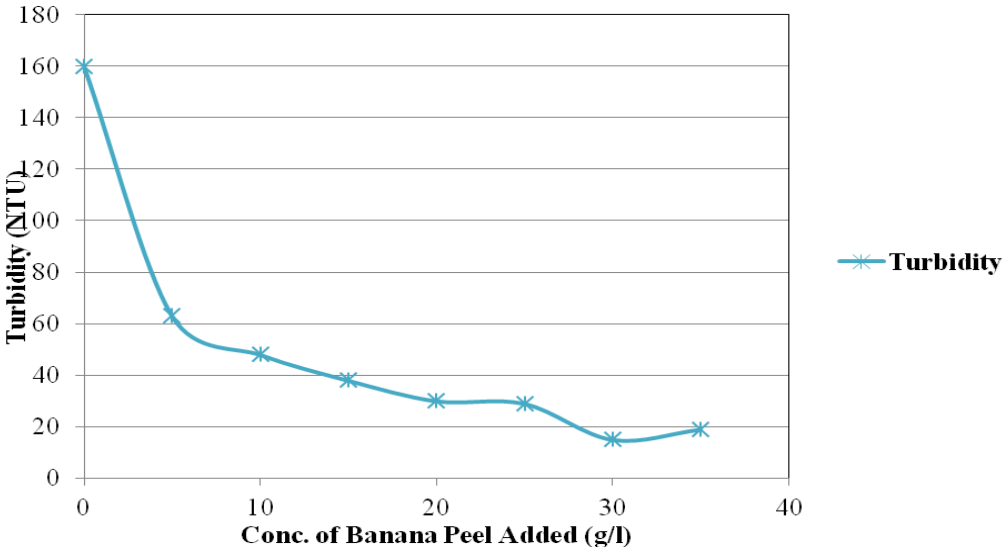

Figure 3. Optimum Dosage for Banana Peels

IV. VARIATION OF VARIOUS WATER QUALITY PARAMETERS

After obtaining the optimum dosages for Banana peel powder and *Moringa oliefera* extracts, the variation in various parameters like pH, chloride, hardness, DO, turbidity, COD, BOD in the raw water, treated unfiltered water and treated filtered water were identified. The obtained values were compared with the standards given in GSDEP (General Standards for Discharge of Environmental Pollutants) which gives the tolerance limits for disposal of wastewater into inland surface water, public sewers, and marine/coastal areas and for land irrigation.

4.1. Potential of Hydrogen (pH)

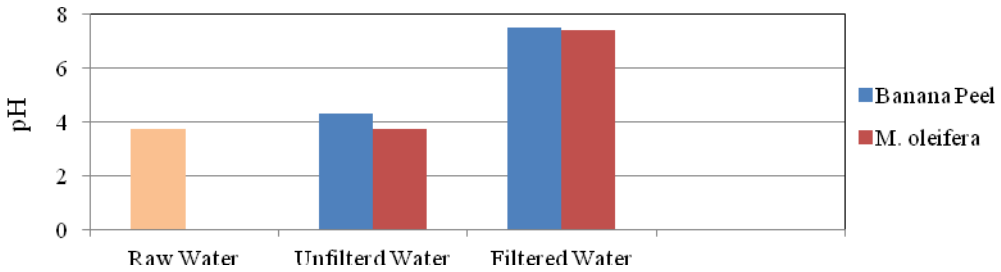

Figure 4. Variation in pH

Figure 4 shows the variation in pH of raw water, after treatment in stage 1(treated unfiltered) and stage 2(treated filtered). It was seen that the raw water is highly acidic in nature. This may be due to the fact that kitchen wastes contain high amount of organic acids like acetic acid, citrus acid, lactic acid etc. Also, with the passage of time, the wastewater becomes acidic due to the acids produced by bacterial action. Due to these reasons we obtain a very low pH value of 3.75 for raw water. It was observed that treatment with *Moringa* extract does not alter the pH. Treatment with banana powder increases the pH by 14%. But after filtration, in both the cases, it is observed that there is a tremendous increase in the value of pH to a value around 7.5 (twice the initial value). This may be due to the removal of organic matter after filtration. As per GSDEP, the pH value must lie within the range of 5.5 to 9 for irrigation purposes and for disposal into inland surface water, public sewers and marine/coastal areas.

4.2. Turbidity

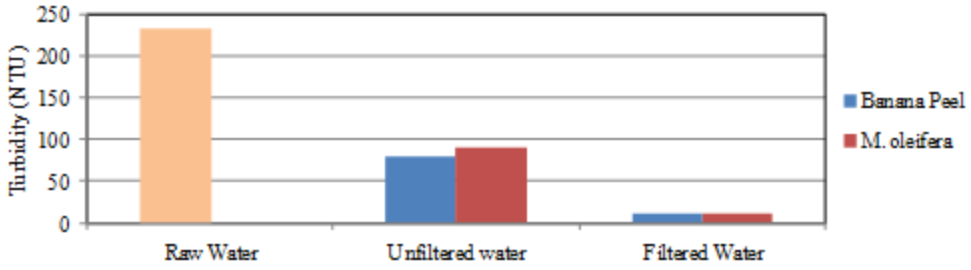

Figure 5. Variation in Turbidity

Figure 5 shows the variation in turbidity of raw water, after treatment in stage 1 and stage 2. The turbidity of raw water was found to be very high i.e. 232 NTU. The turbidity of source water may arise from starch, sugar, fats, oil, grease, animal and vegetable wastes, fatty acids, alcohol, sand, gravel, clay, debris, dissolved salts, chlorides etc. It was observed that after treatment with *Moringa* extracts and Banana powder there was a tremendous decrease in the value of turbidity. In the case of *Moringa* extract, the extract acts as coagulant and reduced the turbidity to 91 NTU (61 % removal). In the case of Banana peel powder, the powder acts as a bio-adsorbant and thus reduced the turbidity to 78 NTU (66 % removal). It was seen that after filtration, the turbidity further decreased to 12 NTU (95 % removal) in both the cases. As per GSDEP the maximum permissible value of turbidity of water intended for domestic purposes is 10 NTU. The obtained value lies very near to the range.

4.3 Chlorides

Figure 6 shows the variation in chlorides of raw water, after treatment in stage 1 and stage 2. The chloride content in our source water may be due to kitchen wastes, presence of water softeners in water. It was observed that there was a higher decrease in the chloride content to 40 mg/l (58 % removal), as compared to treatment with Banana peel powder. This might be because the *Moringa* extract is able to coagulate chlorides. After filtration it was seen that the chloride content reduced greatly to around 6.5 mg/l (93 % removal) in both cases. This is due to further mechanical filtration and coagulation through the filters. As per IS 10500, the maximum tolerable value of chlorides is 250 mg/l. The obtained value is much smaller than the range.

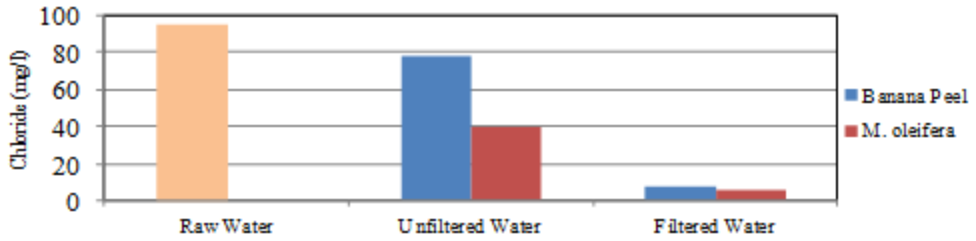

Figure 6. Variation of Chlorides

4.4 Hardness

Figure 7 shows the variation in hardness of raw water, after treatment in stage 1 and stage 2. Hardness generally occurs due to the presence of salts of calcium and magnesium. The source water had low hardness content i.e. 50 mg/l of $CaCO_3$. But after treatment and filtration, it was seen that the hardness increased in both the cases. In the case of *Moringa* extracts the value increases to 104 mg/l of $CaCO_3$

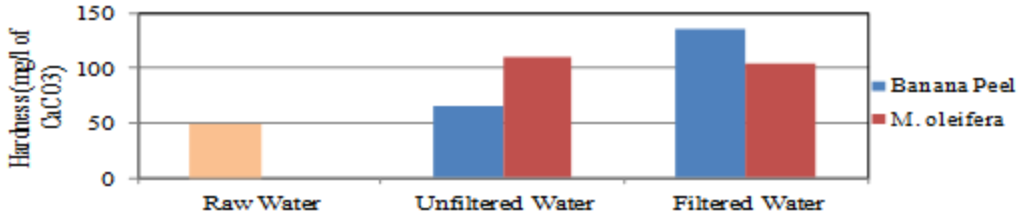

Figure 7. Variation of Hardness

and in the case of Banana peel powder it increases to 135 mg/l of $CaCO_3$. As per IS 10500 the maximum permissible value of hardness is 300 mg/l of $CaCO_3$and the obtained value lies within the range.

4.5 Dissolved Oxygen

Figure 8 shows the variation in DO of raw water, after treatment in stage 1 and stage 2. It was observed that the dissolved oxygen in raw water was zero. It is seen that after treatment also the DO of the water is negligible.

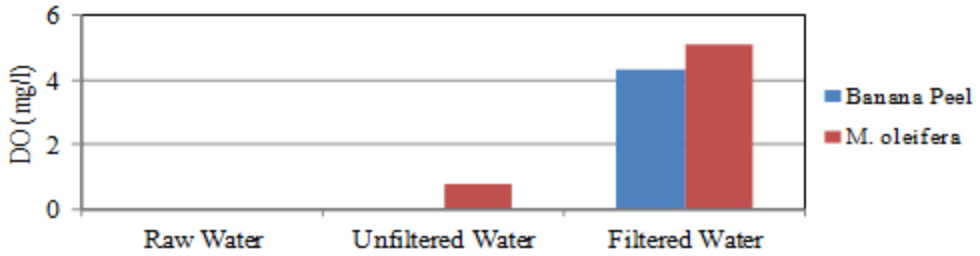

Figure 8. Variation of DO

But after filtration, the DO increases to 4.33 mg/l in case of Banana peel powder and to 5.123 mg/l in the case of *Moringa* extract. The minimum value, as per studies for DO is 4 mg/l for the survival of aquatic life. The obtained value is higher than this value.

4.7 Biochemical Oxygen Demand

Figure 9 shows the variation in BOD of raw water, after treatment in stage 1 and stage 2. It was observed that the BOD of raw water was very high, i.e. 549 mg/l. This is due to the presence of high amount of decomposable organic matter in our source water. After treatment, it is seen that the BOD decreased to 253 mg/l (54% removal) in the case of *Moringa* extracts. The might be due to the anti microbial properties of *Moringa oleifera*. After filtration the value of BOD reduced to 2 mg/l (99% removal), probably due to the removal of organic matter by the filter. As per GSDEP, the maximum permissible value of BOD for land irrigation is 100 mg/l. And the value obtained is much lower than the limiting value.

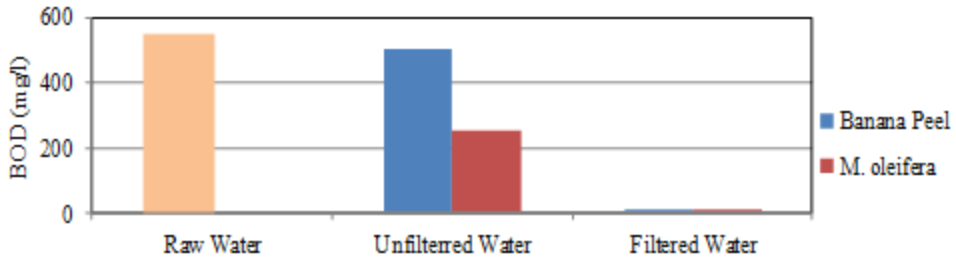

Figure 9. Variation of BOD

4.8 Chemical Oxygen Demand

Figure 10 shows the variation in COD of raw water, after treatment stage 1 and stage 2. The COD of raw water is very high, i.e. 1192 mg/l, due to presence of large amount of dissolved matter in it. It was seen that after

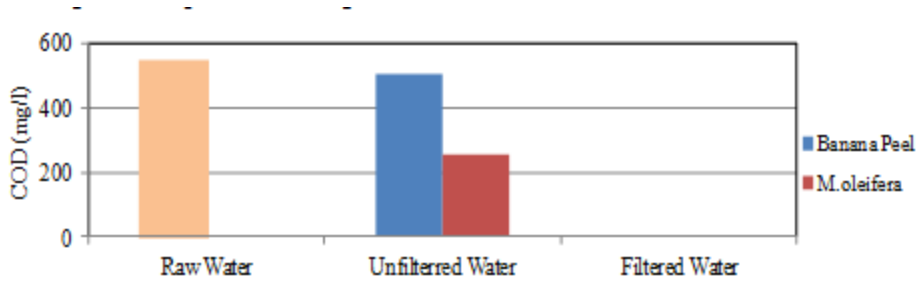

Figure 10. Variation in COD

coagulation and filtration, the COD of water decreased to around 250 mg/l (79 % removal) due to the removal of the oxidisable matter by filtration. As per GSDEP, the maximum limit of COD for disposal into sea is 250 mg/l. The obtained value lies very near to the range.

4.9 Total Dissolved Solids

Figure 11 shows the variation in TDS of raw water, after treatment in stage 1 and stage 2. The raw water does not contain very high content of TDS, i.e. 350 mg/l, but it was seen that after the addition of *Moringa* extracts, the value of TDS increased to 1720 mg/l and after the addition of Banana peel powder, the TDS increased to

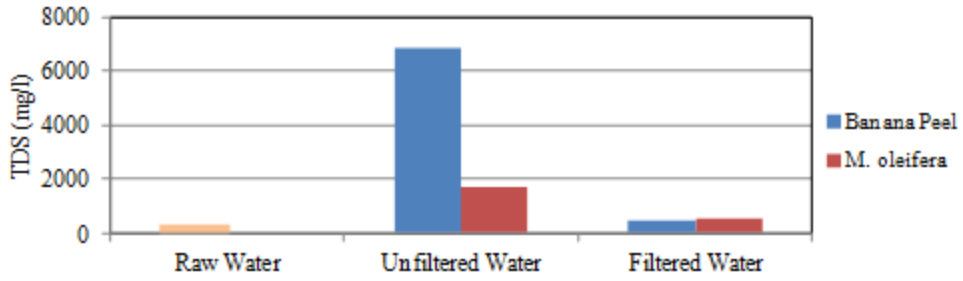

Figure.11: Variation of TDS

6880 mg/l. This increase might be due to the addition of the extract and the powder which gets dissolved in water. But after filtration, the TDS decreased to around 500 mg/l. This was due to the filtration of very fine particles. As per IS 10500 the maximum permissible value of TDS is 500 mg/l. The obtained value was very near to the limit.

4.10 Total Suspended Solids

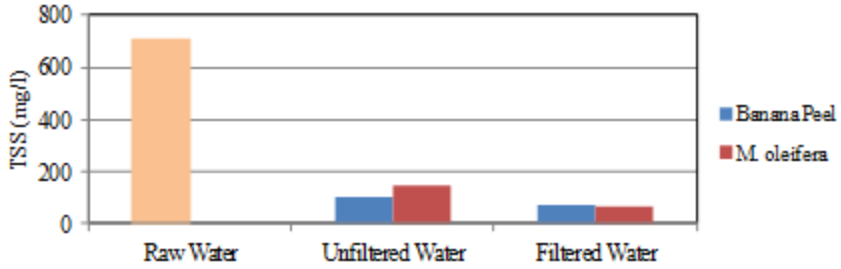

Figure 12. Variation of TSS

Figure 12 shows the variation in TSS of raw water, after treatment in stage 1 and stage 2. The TSS of raw water was very high as expected, i.e. 710 mg/l. After treatment the value reduced to around 100 mg/l (86 % removal) in both the cases mainly due to coagulation action of *Moringa* extracts and bio-absorption by Banana peel powder. After filtration the TSS further reduced to around 65 mg/l (91 % removal) in both the cases due to mechanical screening of finer particles. As per GSDEP the maximum permissible value of TSS for land irrigation is 200 mg/l. The obtained values lie within the range.

4.11 colour and odour

Figure 13. Variation in Colour

The raw water has got a very foul odour due to the anaerobic decomposition of various substances. The smell is chiefly due to the production of Hydrogen Sulphide gas. It is seen that the odour of the wastewater is completely removed after filtration.

The raw water as such had a light earthy colour. But after the addition of Banana peel powder into the wastewater, the water turns dark brown in colour. It might be due to the finer particles of Banana peel powder. But after filtration, the colour of the wastewater was completely removed. This was also because of the presence of charcoal in the filter, which acts as an adsorbent. Figure 13 shows the variation in colour.

V. CONCLUSION

The wastewater from the college campus was collected and treated with banana peel powder and *M. oleifera*. Then the treated water was further filtered using the simple filter constructed to remove the colour imparted by Banana peel powder and also to enhance the treatment efficiency. The water quality parameters of wastewater and the treated water were analysed and compared with the permissible limits.

It was observed that for both *Moringa oleifera* extract and Banana peel powder there was 14 % increase in pH after stage 1 treatment and increased 100% after filtration, as well as 65% of tubidity,58% of chlorides was removed during stage 1 , and followed by filtration has a percentage reduction of 95% and 93% respectively. The value of hardness showed an increase. Also first stage treatment led to 21% decrease in COD and 54% decrease in BOD and filtration led to 79 % removal of COD and 99% removal of BOD. The DO increased from 0 to 4.33 mg/l using Banana peel powder and 5.12 mg/l for *Moringa* extracts. TDS of the sample remained stable and the TSS value of the sample decreased by 91%. The colour and odour of the wastewater was also completely removed. From the results it is clear that most of the water quality parameters were within the limits.

The treated water, though it cannot be used for drinking purpose, can be used for domestic purposes like watering of plants, irrigation, flush water etc. It is clear that when properly designed and applied, *Moringa oleifera* and banana peels can be certainly play a key role in minimizing the impact of the imminent global clean water shortage that are faced by the society. Also the banana peel can be substituted for alum as the coagulant.

VI. REFERENCES

[1] Ali EN, Muyibi SA, Salleh HM, Alam MZ, Salleh MRM (2010) Production of natural coagulant fromMoringa oleiferaseed for application in treatment of low turbidity water. J Water Resour Protect 2:259–266.
[2] Ayotunde EO, Fagbenro OA, Adebayo OT (2011) Toxicity of aqueous extract of Moringa oleiferaseed powder to Nile tilapiaOreochromis niloticus(LINNEI779), fingerlings. Int Res J Agric Sci Soil Sci 1:142–150.
[3] Bina B, Mehdinejad MH, Dalhammer G, Rajarao G, Nikaeen M, Attar HM (2010) Effectiveness ofMoringa oleiferacoagulant protein as natural coagulant aid in removal of turbidity and bacteria from turbid waters. World Acad Sci Eng Technol 43:618–620
[4] Das, Nilanjana, R Vimala, P Karthika, 2008, Biosorption of Heavy Metals: An Overview Indiana Journal of Biotech, 7, pp: 159-169.
[5] Hossain M.A., H Hao Ngo, W.S. Guo, T.V. Nguyen, 2012, Removal of Copper from Water by Adsorption onto Banana Peel as Bioadsorbent, 2, pp: 227-234
[6] Katayon S, Johari MMNM, Ghani LAA (2006) Preservation of coagulant efficiency of Moringa oleifera,a natural coagulant. Biotechnol Bioprocess Eng 11:489–495.
[7] Kavitha C, Ramesh M, Kumaran SS, Lakshmi SA (2012) Toxicity ofMoringa oleifera seed extract on some hematological and biochemical profiles in a freshwater fish, Cyprinus carpio. Exp Toxicol Pathol 64:681–687.
[8] Ndabigengesere A, Narasiah KS, Talbot BG (1995) Active agents and mechanism of coagulation of turbid waters usingMoringa oleifera. Water Res 29:703–710.
[9] Nkhata D, "Moringaas an alternative to aluminium sulphate", Paper presented at 27th WEDC conference: people and system for water, sanitation and health. , Lusaka, Zambia, 2001.
[10] Ndabigengesere A, Narasiah KS, "Quality of water treated by coagulation usingMoringa oleiferaseeds", Water Res 32:781–791, 1998.
[11] Oluduro AO, Aderiye BI (2009) Effect ofMoringa oleiferaseed extract on vita organs and tissue enzymes activities of male albino rats. Afr J Microbiol Res 3:537–540
[12] Rolim LADMM, Macêdo MFS, Sisenando HA, Napoleão TH, Felzenszwalb I, Aiub CAF, Coelho LCBB, Medeiros SRB, Paiva PMG (2011) Genotoxicity evaluation ofMoringa oleiferaseed extract and lectin. J Food Sci 76:T53–T58.
[13] Satalkar and Bhakti, 2011 (http://www.buzzle.com/ariticles/banana-peels-uses.html)

[14] Sri Suhartini, Nur Hidayat and Esti Rosaliana, "Influence of powdered Moringa oleifera seeds and natural filter media on the chracteristics of tapioca starch wastewater", International journal of recycling of organic waste in agriculture, 2:12, 2013.
[15] Sutherland JP, Folkard GK, Mtawali MA, Grant WD (1994)Moringa oleiferaas a natural coagulant. Paper presented at 20th WEDC conference: affordable water supply and sanitation. Colombo, Sri Lanka
[16] Tahseen Zaidan, 2013, Banana Peel as Removal Agent for Sulphide from Sulphur Springs Water, Civil and Environmental Research, Vol 3, No. 10.
[17] Ubuoh EA, Akhionbare SMO, Onifade AO (2013) Potential of Moringa oleifera seed powder as a coagulation agent for refinery wastewater treatment in Warri, Delta State, Nigeria. Int J Adv Biol Res 3:17–20.
[18] Vieira AMS, Vieira MF, Silva GF, Araújo ÁA, Fagundes-Klen MR, Veit MT, Bergamasco R (2010) Use ofMoringa oleiferaseed as a natural adsorbent for wastewater treatment. Water Air Soil Pollut 206:273–281, 2010.

