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Treatment of Tannery Effluent from Challawa Industrial Estate in Kano Nigeria Using Aqueous Extract of *Moringa oleifera*

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Abstract: Tannery Liquid effluents collected from the Challawa Industrial Estate in Kano City were treated with aqueous extract of *Moringa oleifera* Lam seeds whereby 20gms of the seed powder was extracted with 250cm^3 of distilled water. Then 20cm^3 of the aqueous extract was used in the treatment of 100cm^3 of the effluent as the extract volume was found to be the optimum level that would provide the best treated effluent water quality. Some physicochemical and biochemical parameters of the treated effluent were measured using standard analytical techniques. When the results were compared with effluent samples treated with alum, remarkable improvement in the water quality was observed in favour of the samples treated with the plant extract. For instance, improved turbidity values on samples obtained from the production lines in one of the tanneries and other areas within the estate ranged between 54% and 79% above what was obtained using alum. The aqueous extract of *Moringa oleifera* was very effective in the removal of the solid matter in which 100 per cent effectiveness were obtained for the total, dissolved as well as suspended solids. The advantage of using the aqueous extract of the *Moringa oleifera* seed powder is the wide dose range over which effective treatment can be achieved and maintained without affecting the recycled water quality.

Keywords: *Moringa oleifera*, physicochemical, biochemical.

INTRODUCTION

The proper treatment and disposal of effluents has become an increasingly important aspect of the design and operation of all industrial plants. As industrial outfit rises, improvements are necessary in effluent treatment processes if the land, water and atmospheric environments are not to deteriorate [1]. A wide variety of technologies has been used depending on the raw water source, contaminants present, standards to be met and available finances. These include the use of natural materials and chemicals in clarifying water thus freeing it from any kind of contaminants or microorganisms. Tanneries are historically pollution – intensive industries generating large volumes of wastes, which are discharged into rivers, and farmlands with little or no purification. The effluents are usually materials that may be solids, liquids or gases. The solid wastes include hairs, precipitated chemicals and lime while liquid wastes include processed water, dissolved chemicals such as lime, sulfates, chlorides and dyestuffs. The gaseous wastes are mainly sulfides and ammonia [2]. With the modernization and expansion of the industry to highly mechanized factories in urban areas, the problem has become more acute as communities have started reacting [3].

The impact of the disposals of liquid effluents and solid wastes from tanneries on adjoining environment was investigated from the analysis of boreholes water samples using pH, temperature, alkalinity, total nitrogen and chromium (Cr) as pollution indicators. The efficiency of the primary treatment ranges between 52% – 95% on the total nitrogen, sulphides, solid and chromium. [4].

The use of cement dust, alum and kaolin dust in the primary treatment of tannery wastewater was reported by [5], where it was observed that addition of cement dust or Kaolin prior to treatment with alum led to the reduction of about 70% alum, if it is used alone while archieving the same efficiency. Kaolin was though more effective than cement dust in the removal of suspended solids and in the reduction of the COD of the treated effluents [6].

Natural polymers such as starch, sodium alginate, amylopectin, guar gum, xanthan gum Kendu gum, chitosan, okra mucilage and psyllium mucilage have found extensive applications as flocculants in waste water treatment programs. Thus, many starch based products have been used to remove toxic wastes like hexavalent chromium, cadmium and gallium present in many industrial wastewaters from textiles, tannery, electroplating and metal finishing industries [7].

The flocculation ability of *Plantago psyllium* seed has been studied on sewage and tannery effluents by varying its doses, the pH and contact time. From the result obtained *Plantago psyllium* seed extract was found to be quite effective. [2]. Increase in solid wastes removal was observed with increasing polymer doses to a certain level beyond which further increase in dosage shows a decreasing trend in solid removal. The maximum solid removal of 94.69% was obtained after 1hr within the pH range of acidic to neutral in the case of sewage treatment. Similarly the maximum solid removal of 87.03% was achieved after 1 hr but at pH range of neutral to alkaline for tannery effluents [2]. Latex of Calotro pisprocera has been used in the treatment of domestic and industrial waste water and has shown high reduction in the turbidity, colour, odour, pH, and microbial loads as well as the total coliforms of the samples [8].

Alum $Al_2 (SO_4)_3 14H_2O$ is a common coagulant chemical used in water treatment worldwide and are marketed in various forms such as blocks, lumps or solutions with alumina (Al_2O_3) content ranging in grades of 14-18.6%. Aluminium sulphate works by using Al^{3+} ions to neutralize the negative charge on suspended and colloidal matter to produce compact floc suitable for easy removal by either settlement or floatation processes [9].

Moringa oleifera Lam was originally an ornamental plant in the Sudan but has found uses in water treatment processes [10]. The seeds have been used as a natural coagulant in household water treatment as well as in the community water treatment systems [11]. The seeds contain significant quantities of low molecular weight (water-soluble) proteins, which carry positive charges attracting the predominantly negatively charged particles (such as clay, silt bacteria and other toxic particles in the raw water). The flocculation process occurs when the proteins bind the negatively charged particles in the water forming flocs through aggregation [11].

This work is aimed at comparing the coagulative properties of the aqueous seed powder extract of *Moringa oleifera* with aluminium sulphate (alum) when used in the treatment of liquid tannery effluents with a view to designing a cost-effective treatment methodology for tannery liquid effluents.

EXPERIMENTAL SECTION

Cleaning of materials

All glass-wares and plastic containers were washed, soaked in 0.5M H_2S0_4 for four hours, thoroughly washed with detergent solution rinsed with distilled water and dried in the oven at 105^0C overnight.

Sampling

112 tannery effluents samples were collected from different sampling points in plastic containers of 3L capacity at different times within the year and at different intervals during the production periods. Three tanneries within an area in the estate with a common point of discharge into the public drain were chosen and the sample of collection points includes four within a given tannery designated as:

- Washing site – Washing
- Liming site – Liming
- The chrome site – Chrome

These three are the key activity points where effluents are generated within the tannery.

- The point of discharge of effluent from the factory - First Discharge Effluent Point. Another three site within the same area as above receiving effluents from other two tanneries designated as:
- The point of discharge forms the second tannery– Second Discharge Effluent. Point
- The point of discharge from the third tannery – Third Discharge Effluent Point.
- Point where the effluents from three tanneries met before getting into the public drains – All effluent Collection Point.

Determination of the minimum turbidity using *Moringa oleifera* seed extracts

1.0kg of *Moringa oleifera* seeds were purchased deshelled and ground into a fine powder. Then 2.5, 5.0, 10, 20, 25, and 30.0gms of the powder were weighed into appropriately labeled $500cm^3$ beakers and dispersed within $250cm^3$ distilled water. The powder was properly dispersed using a magnetic stirrer for 30 minutes. This dispersion was allowed to stand for another 1 hour and sieved into a 250 cm^3 beakers using Calico cloth [12].

$100cm^3$ of the effluent sample from the liming unit of the tannery was measured into six separate labeled beakers and $20cm^3$ of each extract were added to the appropriate beaker and stirred thoroughly for 5 minutes. The mixtures were allowed to stand for 2 hours and then filtered using whatman No. 42 filter paper. The turbidity of each filterate was then measured and recorded using a turbidometer [12].

Treatment of effluent samples using alum solution and *Moringa oleifera* aqeuous extract

80g of powdered alum was weighed and dissolved in $1000cm^3$ of water. The solution was then filtered and stored in plastic bottle whereby 20 cm^3 was measured and added with constant stirring to 100cm^3 of each of the effluent sample in 250cm^3 beakers. The mixtures were allowed to stand for 2 hours and then the supernatant solution was filtered using Whatman No: 42 filter paper. Similarly, 20cm^3 of the extract prepared using 20gm of the *Moringa oleifera* seed power and extracted with 250 cm^3 distilled water was used to treat 100cm^3 of effluents sample from the seven points. The filtrates were then analyzed for their physical and chemical properties [12].

Using standard analytical methods, turbidity, conductivity, total dissolved and suspended solids, the chemical and biochemical oxygen demands of the effluents were measured. The turbidity of the treated effluent samples were measured using a turbidometer and the readings recorded in triplicates.

Conductivity was measured using conductivity meter while total dissolved solid was determined as per the procedure [13]. The suspended Solids were determined by difference between total solid and dissolved solid [16].

Biochemical oxygen demand was determined using the method [14] while chemical oxygen demand was determined using another standard method [15].

RESULTS AND DISCUSSION

The plot of turbidity against the amount of *Moringa oleifera* seed extracted as shown in fig 1.0 was generated to determine the optimum level that would provide the lowest turbidity. The effluents from the chrome unit were used for the high turbidity value of 597 $\pm$ 97.0 when compared with the other six effluent collection points. From the plot generated the lowest turbidity values were achieved when 20gm extract were used. Generally lower conductivity values were obtained in the Moringa extract treated samples than those treated with alum as shown in fig 2.0. The results obtained were independent of the source of the effluent and the pH as shown in table 1.0., which is in agreement with earlier findings that changes in pH has no effect on the flocculation properties of *Moringa oleifera* extract [12]. Thus, the 20gm powder seed extract was used in the effluent waste water sample treatments.

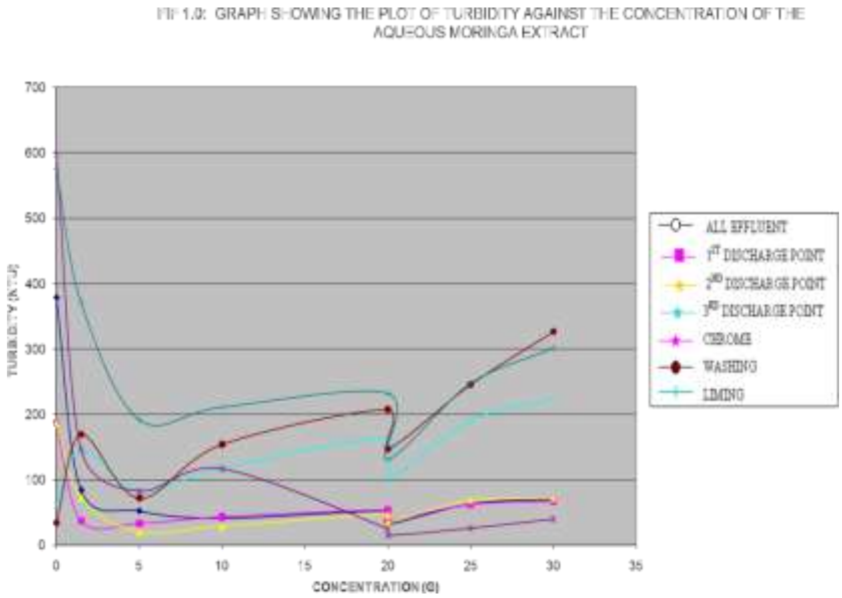

Fig-1: Graph showing the plot of turbidity against the amount of seeds extracted and used for treatment

Amount of *Moringa oleifera* seeds extracted (gm)

Table-1: percentage changes in effluent characteristics before and after treatment with aqueous extract of *Moringa Oleifera*

Characteristics	All effluent	Second Discharge point	Third discharge Point	Liming point	Chrome Point	First Discharge Point	Washing point
pH	6.7± 0.64	6.0±0.00	5.8± 0.21	6.1±0.22	5.7± 0.15	6.0±0.00	6.0±0.00
Turbidity (NTU)	65± 4.71	66± 7.35	71± 3.96	59± 6.25	63± 1.75	63± 3.86	54± 3.20
Conductivity (OHM/M)	24± 0.00	28± 0.00	43± 3.60	70.± 0.00	46 ±2.54	46± 5.7	40±2.1
Total Solid	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00
Dissolved Solid	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00
Suspended Solid	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00	100± 0.00
BOD	67± 2.77	61± 2.55	60±5.84	57± 6.43	72± 2.07	64± 7.00	66± 9.83
COD	59± 8.80	52± 2.12	49± 3.00	46± 2.37	54± 5.70	55± 6.12	49± 5.15

A comparison of the effectiveness of the aqueous *Moringa oleifera* extract to that of alum in the effluents samples properties with respect to conductivity and turbidity were in favour of the Moringa treated samples. From the plot fig 2.0, it can also be easily deduced that there is remarkable reduction in conductivity when *Moringa oleifera* is used instated of alum confirming that the seed extract is better than alum in waste effluent treatment.

As shown in Table 1.0, the effectiveness ranges between 54% (liming) and 79% (third discharge point).there is more than 50% improvement in turbidity in all the samples treated with the Moringa extract. The value of 79% obtained at the third discharge point shows that initial primary treatments carried out on the effluents before their discharge contributed in the reduction in the turbidity values obtained at that point. These values showed the effectiveness of the treatment with the plant extract independent of the nature of the effluents samples as well as the collection point in the discharge channels in the industrial estate. In the case of the total solid, suspended solid, and dissolved solid, 100% removal of these materials from the effluent samples were achieved by treating with the plant extract as shown in table 1.0. The effectiveness in reduction of the values of BOD and COD before and after treatment with the Moringa extract was in the range of 57% - 72%, and 46% - 59% respectively. This shows that the *Moringa oleifera* treated samples removed more of the dissolved and suspended materials than those of alum.

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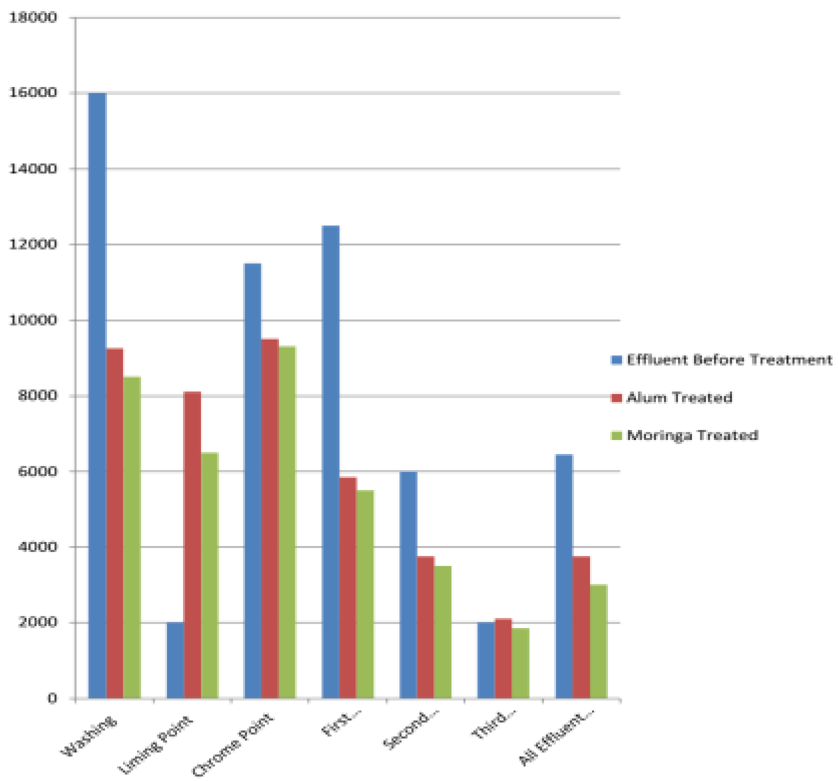

Fig-2: Plot showing the values of conductivity in relation to the point of collection

Table-2: Table showing the comparison of effectiveness of *Moringa oleifera* to alum in the effluent samples

	Characteristics	ALL EFFLUENT Point	Second discharge point	Third discharge point	LIMING Point	CHROME Point	First Discharge Point	Washing
Before treatment	Conductivity	6450±14	6000±40	2000±40	2000±0.00	11500±15	12500±25	16000±10
	Turbidity	379±10	186±12	187±12	61±50	597±97	34±10	574±11
20g alum	Conductivity	3750±75	3750±22	2100±40	8100±14	9500±50	5850±41	9250±25
	Turbidity	52±20	53±30	47±26	164±35	25±5.00	207±3.50	232±58
20g Moringa Oleifera	Conductivity	3000±0.00	3500±10	1850±15	6500±50	9300±50	5500±40	8500±50
	Turbidity	32±12	37±17	35±31	102±3.00	15±4.00	147±50	131±45
Difference between Moringa and alum values	Conductivity	750± 20	250±10	350± 00	1600±10	200±15	350±50	750±22
	Turbidity	20± 6.0	16±8.5	12±5.0	62±3.0	10±4.0	60±5.6	101±25

CONCLUSION

The study showed that *Moringa oleifera* is a better coagulant than alum in the purification of tannery effluent based on the remarkable changes in results of both the physical and chemical properties. The advantage of using the aqueous extract of the *Moringa oleifera* seed powder is the wide dose range over which effective treatment can be achieved and maintained without affecting the recycled water quality.

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