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Effects of *Moringa oleifera* Lam. and *Azadirachta indica* A. Juss. leaf extract in treatment of tannery effluent

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Abstract

The effect of leaf extracts of *Moringa oleifera* and *Azadirachta indica* using ethanol as solvent on tannery waste water treatment was investigated for a period of five days and their phytochemical constituents were analyzed. All the extracts were found to be efficient in the clarification and sedimentation of total solids in the tannery waste water sample. On the 5th day, sample treated with 10 ml of extract showed higher reduction of electrical conductivity, pH, chloride, sulfate along with dissolved oxygen. The significant reduction of these pollution indicating parameters of the tannery effluent indicated its high applicability to treat the tannery wastes along with other waste water treatment in near future. This is the first report of decontamination of tannery waste water by *Azadirachta indica* leaf extract.

***Key words*:** Phytochemical constituents, Tannery waste water, Waste water treatment, Chloride

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Introduction

Water is the most essential and valuable resource to sustain the life on earth. In the last few decades, rapid industrialization and urbanization has caused a serious problem in pollution because of the disposal of industrial and sewage effluents to natural water bodies (Paul and Sinha, 2013; Sinha and Paul, 2015). The enormous use of water in tannery industries has caused a serious problem of drainage of waste water from industries. Industrial effluents are deteriorating the surface and underground water quality through seepage, because of chemi-

cal components of undesirable concentration and thus creating water pollution (Imran *et al.*, 2012). The pollutants of tannery industrial wastes are of organic, inorganic and toxic in nature. These effluents change the physical and chemical property of the soil that finally affects the productivity and microbial community (Shanthi *et al*., 2012).

The use of plant materials to purify turbid water is not a new idea. Sanskrit writing in India dating from several centuries BC mentioned the use of seeds of *Strychnos potatorum* as a clarifier. Peruvian in 16th and 17th centuries used the powdered roasted grains of *Zea mays* for settling impurities (Firth *et al.,* 2010; Sasikala and Muthuraman, 2015). Recently, in the 19th century Chileans used 'tuna' cactus (*Opuntia Ficus-indica*) for clarification of water (Sutherland *et al.,* 1990).

Moringa oleifera and *Azadirachta indica* are common tropical plants belonging to the family Moringaceae and Meliaceae respectively. *Moringa oleifera* and *Azadirachta indica* are the two plants of which almost all parts of plants (leaves, flower, seeds-bark) can be used as food or with medicinal and therapeutic purposes (Anwar *et al*., 2007). *Moringa oleifera* leaves, seeds and flowers shows efficacy in waste water treatment. It has been found that *Moringa oleifera* is the ideal natural coagulant discovered yet, that can replace synthetic coagulants which is used widely all around the world (Ali *et al*., 2009). Coelho *et al.* (2009) assert that the protein found in *Moringa oleifera* is the lectin, responsible for coagulation/flocculation of the waste water. Further, the presence of a high molecular weight, cationic dimeric protein is reported in *Moringa oleifera*, that destabilizes the particles contained in the water and flocculates the colloids through a process of adsorption and neutralization followed by sedimentation (Ndabigengesere *et al*., 1995). *Azadirachta indica* sawdust proved to be potential biosorbent for removal of heavy metals from effluents (Febriana *et al*., 2010). *Azadirachta indica* has certain powerful chemical ingredients; they are salannin, azadirachtin, meliantriol, nimbidin and nimbin. These chemical compounds were found to have a great metal binding capacity (Ang *et al*., 2013).

Several inorganic and synthetic coagulants can be used for the treatment of tannery waste water but these coagulants are not cost-effective and create other level of pollution. Drawbacks of synthetic, inorganic coagulants are that they causes Alzheimer's disease and similar health related problems, reduction of pH, production of large sludge volume and low efficiency in coagulation of cold water (Ndabigengesere and Narasiah, 1998; Vieira *et al*., 2010; Baptista *et al*., 2015). Hence biological treatment by natural coagulants is found to be important. Natural coagulants have low cost, produce lesser volume of biodegradable sludge, and do not affect the pH of the water. A large number of plants are there which possess the ability to treat the waste water such as *Cassia angustifolia* (Sanghi *et al*., 2002), *Ipomoea dasysperma* (Sanghi *et al*., 2006), *Schinopsis balansae* (Sánchez-Martín *et al*., 2010), *Dolichos lablab, Cicer arietinum* (Asrafuzzaman *et al*., 2011), *Calotropis procera* (Danlami *et al*., 2014), *Strychnos potatorum* (Pandian *et al*., 2014), *Opuntia ficus-indica* (Belbahloul *et al*., 2015), *Ocimum basilicum* (Shamsnejati *et al*., 2015) etc. In the present investigation the tannery effluents collected were treated with the leaf extract of *Moringa oleifera*

and *Azadirachta indica* to remove or minimize the various parameters of waste water indicative of pollution.

Materials and methods

Collection of tannery waste water

Tannery waste water was collected in glass sampler (capacity 500 ml) aseptically from Bantala Tannery Factory, Kolkata, West Bengal, India.

Physicochemical analysis of tannery waste water

The pH, dissolved oxygen (DO), electrical conductivity (EC), chloride, sulfate, total hardness and total dissolved solids (TDS) were determined by the standard methods (APHA, 2005).

Collection of plant materials

Moringa oleifera leaf and *Azadirachta indica* leaf samples were collected from Berhampore, West Bengal, India in the month of February, 2014. Both the plants were authenticated and identified by a renowned plant taxonomist Prof. Sobhan Kumar Mukherjee, Taxonomy laboratory, Department of Botany, University of Kalyani, West Bengal. The plant specimens (Voucher No. SNSM1 and SNSA1) were preserved in the herbarium in the Department of Botany, University of Kalyani, West Bengal.

Preparation of plant extracts

Before extraction, the plant materials viz. *Moringa oleifera* and *Azadirachta indica* leaves were washed in running tap water and then blotted and dried at room temperature (30^{o}C). The dried materials were powdered in grinder to prepare stock solution. 20 gm of dried plant materials were soaked in 100 ml ethanol solvent and incubated for 48 hours and then filtered using Whatman filter paper No. 1 to obtain ethanolic plant extract. The final filtered crude extract was utilized for further experiment.

Phytochemical screening

Phytochemical screening of the plant extracts was carried out qualitatively for the presence of various phytochemicals such as alkaloids, carbohydrates, reducing sugars, coumarin, cardiac glycosides, phlobatannin, quinone, flavonoids, amino acid, tannins, phenol and saponins (Harborne, 1973).

Treatment of tannery effluent by plant extract

Tannery effluents were treated with 10 ml of each part of plant extract of ethanol for 5 days. After 5 days all the above mentioned physicochemical parameters were determined again to record any change in the parameters of the effluents.

Results and discussion

Phytochemical analysis of Moringa oleifera and Azadirachta indica

The phytochemical analysis of ethanolic extract showed the presence of alkaloid, carbohydrate, tannin, phenol, saponin and reducing sugar in all the plant extract studied. However, *Azadirachta* leaf extract contain coumarin, phlobotannin, quinine, flavonoids and amino acid in addition to the above (Tab. 1).

Treatment of tannery waste with plant leaf extracts

pH (hydrogen ion concentration)

pH indicates the acidic or alkaline status of any water body. Treatment of tannery waste water with *Moringa oleifera* leaf extract as well as *Azadirachta indica* leaf extract reduced sufficiently to acid level. Plant extract contain cellulose, hemicellulose, lig-

nin, and crude fiber. Its matrix network consists of fibre carbonaceous, carboxylic and amino functional groups. These functional groups may be dissociated at various pH values and accordingly take part in the adsorption process. Therefore, pH may affect the adsorption of components onto *Moringa oleifera* (Akhtar *et al*., 2007).

Table 1. Phytochemical screening of plant extracts (20 gm plant part powder/100ml ethanol extract)

Phytoconstituents	***Azadirachta indica* leaf**	***Moringa oleifera* leaf**
Alkaloids	+	+
Coumarins	+	-
Cardiac glycosides	-	+
Phlabotannins	+	-
Quinones	+	-
Flavonoids	+	-
Amino acids	+	+
Carbohydrates	+	+
Tannins	+	+
Phenol	+	+
Saponins	+	+
Reducing sugars	+	+

(+ indicated present or negative reaction, - indicated absent or negative reaction)

Dissolved oxygen (DO)

Dissolved oxygen (DO) is one of the most key parameter in determining the quality of water and reflects the different physical and biological processes existing in water. Good water should have the solubility of water (Kudesia, 1995). It is an important parameter to reveal pollutional level of any water body. Treatment with leaf extract of *Moringa oleifera* elevates the oxygen level in the tannery water. Similar results were obtained in case of tannery water treated with *Azadirachta indica* leaves (Tabs. 2-3).

Electrical conductivity (EC)

Electrical conductivity (EC) is a numerical expression of the capacity of an aqueous solution to conduct electric current which depends on total concentration of ions present in solution, their mobility, valence and relative concentrations and on the temperature of measurement. All the extracts of plants remarkably reduced the EC value of the tannery waste water (Tabs. 2-3).

Table 2. Parameters of tannery waste water treated with ethanol extract of *Moringa oleifera* leaf

Physicochemical parameters	**Untreated sample**	**Treated sample (after 5 days)**
pH	7.30	4.85
Dissolved oxygen (mg/L)	2.40	4.40
Electrical conductivity	2.340	0.897
Chloride (mg/L)	65.32	62.48
Sulfate (mg/L)	70.00	10.40
Total hardness (mg/L)	2380	2040
Total dissolved solids (TDS) (mg/L)	382.80	192.00

Table 3. Parameters of tannery waste water treated with ethanol extract of *Azadirachta indica* leaf

Physicochemical parameters	**Untreated sample**	**Treated sample (after 5 days)**
pH	7.30	5.14
Dissolved oxygen (mg/L)	2.40	5.60
Electrical conductivity	2.340	0.896
Chloride (mg/L)	65.32	29.82
Sulfate (mg/L)	70.00	11.60
Total hardness (mg/L)	2380	1760
Total dissolved solids (TDS) (mg/L)	382.80	184.20

Chloride

The amount of chloride in aquatic ecosystem determines the water salinity. The leaf extracts decreased the concentration of chloride in waste water to some extents. *Azadirachta indica* leaf extract remarkably decreased the concentration of chloride (Tab. 3), because cations from the leaf extract attract negatively charged chloride ions present in tannery waste water and neutralize the chlorides (Mangale *et al*., 2012).

Sulfate

Water with high level of sulfate concentration can leads to dehydration and diarrhoea.

Kids are often more sensitive to sulfate than adults. Animals also show sensitivity to high levels of sulfate. Severe chronic diarrhoea may occur in young animals due to high levels of sulfates and in some cases death occurs. A considerable reduction in sulfate concentration was obtained by employing ethanolic extract of leaves of *Moringa oleifera* and leaf extract of *Azadirachta indica* (Tabs. 2-3).

Total hardness

Hardness of water occurs due to presence of different divalent metal ions such as magnesium, calcium, zinc, iron etc. The U.S. Environmental Protection Agency (EPA) has classified hardness into 4 categories viz., soft (0-50 mg/ml), moderately hard (50-150 mg/L), hard (150-300 mg/L) and very hard (>300mg/L). In most of the water it consists mainly of magnesium and calcium salts with minor amount of other metals. If the hardness is more than 300 it will become very hard which will not lather with detergent. Hardness of water has an impact on fish health because it influences osmoregulation (Parmar and Singh, 2011). Sample treated with 10 ml of ethanol extract of *Azadirachta indica* leaf reduced more salts (620mg/L) on 5th day than *Moringa oleifera* leaf extract (340 mg/L) (Tabs. 2-3). According to Muyibi and Evison (1995) as a polyelectrolyte it may therefore be suggested that *Moringa oleifera* decreased hardness in water through adsorption and inter-particle bridging.

Total dissolved solids (TDS)

High concentration of dissolved solids indicates that a river is polluted. If total dissolved solid (TDS) content is excessive, various forms of aquatic life will be affected. The salts dehydrate the animal's skin. Elevated dissolved solid concentrations can add a laxative effect to water or impart an unpleasant mineral taste to the water. Hence removal of TDS is a primary factor. In the present study about 50% reduction of TDS occurred by the treatment of plant extracts. *Moringa oleifera* is known to be a natural flocculant and cationic polyelectrolyte with a chemical constitution of basic polypeptides with molecular weights ranging from 6000 to 16,000 daltons, containing up to six amino acids of mostly arginine, glutamic acid and methionine and (Jahn, 1986).

According to Ndabigengesere *et al.* (1995), *Moringa oleifera* contained a cationic dimeric protein of high molecular weight, which destabilizes the particles contained in the water. This is mediated by a method of neutralization and adsorption, the flocculate of colloid followed by sedimentation. Acording to Davino (1976) protein present in *Moringa* causes coagulation/flocculation of water which is very much similar to the mechanism caused by polyelectrolytes that are polymers originating from proteins and polysaccharides of natural or synthetic origin. The present work also corroborated the work of Okuda *et al.* (2001). Ghebremichael *et al.* (2005) found that the *Moringa oleifera* plant extract is nontoxic and good coagulant in treatment of water. It is suggested to be utilized as a coagulant in developing countries.

Conclusions

From the above experiment it is revealed that leaf extracts of both the plant were found to be potent to minimize the various parameters relating to pollution. These extracts raised the dissolved oxygen concentration to a level that alleviates the pollution

load. *Azadirachta indica* showed higher reduction of pH, EC, chloride, sulfate, TH and TDS than *Moringa oleifera*. This is the first report of decontamination of tannery waste by *Azadirachta indica* leaf extract. The significant reduction of these pollution indicating parameters of the tannery effluent indicated its high applicability to treat the tannery wastes along with other waste water treatment in near future. Further work is needed in future for removal of heavy metals.

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