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Assessment of treated effluent from dyeing industry using Pungan leaves as adsorbent

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Abstract
Kanchipuram is named as silk city due to more number of dying and printing industries located in and around this place and it is also a traditional industry in Kanchipuram. These dyeing industries present in Kanchipuram area and the villages surrounding are under the great danger of subsurface water pollution with the chemicals of dyes, even though it is treated. So it is a necessity to retreat the effluent disposed by dyeing industry for preventing the contamination of ground water. The aim of the project work is to understand and analyze the adsorbent ability, the adsorbent being palletized Pongamia Glabra leaves, for the treatment of the effluent from the dyeing industry. This setup also includes a trickling bed that is prepared with cut Pungan leaves sieved to a specific size and is introduced as a secondary treatment by providing a natural green leaf surface. The treated effluent sample of known quantity is trickled into the bed by means of a perforated pipe. Then the filtered effluent is collected, analyzed and compared with the Bureau of Indian Standards (BIS).

Keywords: Pungan leaves, dye effluent, physical and chemical analysis, CPCB standards, filtered sample

1. Introduction
One of the major industries under the very important radar of the environmental agencies is the dyeing units and the dyestuff industries as a whole. Out of three basic needs such as food, cloth & pure air and water, the second basic need of man 'cloth' is given by processing of various synthetic and natural fibers in the textile industry. Even though many types of clothes are there, the main attraction for any fibers is given by their colors only. Hence, the dyeing industry has gained its momentum in a fast paced way over the past few decades. Textile industry contributes nearly 14 % of the total industrial production in India. In India 10000 garments manufacturers and 2100 numbers of bleaching and dyeing industries are in operation. The textile industry in India operates in more number with roughly 70 textile clusters producing 80% of the country. The majority are concentrated in the states of Tamil Nadu, Punjab and Gujarat. The processes followed in the textile manufacturing industry are spinning of fibre to yarn, sizing to improve stiffness, scouring, to remove impurities, the decision to remove the excess sizes of materials during the weaving process, bleaching is used to remove natural colouring from cotton and wax from the yarn and fabric and colouring and printing to provide desired colour and design to the cloth. Dyeing is the aqueous application of colour to the textile substrates, mainly using synthetic organic dyes and frequently at elevated temperatures and pressures in some of the steps. There are around 40 dyeing industries in and around Ayyampettai and Muthailpet villages of Kanchipuram. The dyeing industry effluent has various biodegradable natures of the dyes, including strong toxic metals and minerals in trace amounts, acids, alkalis and carcinogenic aromatic amines.
Arasu tree (Ficus Relegosia) leaves powder was used as an absorbent for the removal Grey BL dye [8, 13]. Gherkin (Cucumis Sativus) leaves were treated with sulphuric acid and formaldehyde were used for the removal of acid blue, acid red and malachite green from the aqueous solution [1, 15]. Neem leaves were used in a batch adsorption technique for the removal of toxicity of Congo red (CR) and methyl orange (MO) dyes from a wastewater [6, 7]. Guava tree leaves and activated carbon is used for the removal of auramine dye from waste solutions by using it has cheap bi-sorbent [10, 12]. Teak leaf (TLC), maize corn (MCC) and babool tree barks were processed and converted into activated carbon for the absorption of red industrial dye with various experimental conditions and the effects of various

parameters such as pH, particle size, contact time, dosage of absorbent and initial concentration were analysed [4, 11].

Jackfruit leaf powder was used for the removal of Methylene Blue by batch sorption experiments. Sumac leaves (*Rhus Coriario* L.) were used as an adsorbent for the removal of Metrhylene Blue was an inexpensive and effective method of adsorption. Various investigations were carried on the adsorption of Methylene Blue on Sumac leaves with the effects of many parameters such as initial dye concentration, p^H value, contact time and dosage of adsorbent [9]. The objective of this present work was analysed the physical, chemical and biological characteristics of the raw effluent and treated effluent from dying industries using Pungan leaves as an adsorbent.

The Pungan leaves are employed for secondary treatment. The leaves are so chosen because of their high tolerance capacity and can accumulate heavy concentrations of toxic metals like chromium and lead to name a few [2, 5, 14]. Also, they are employed in jewellery cleaning. The Pungan leaves have a variety of applications in various fields due to their unique nature and property.

1.1 Properties of Pungan leaves

Economic uses

- Used as cattle fodder.
- Used in stored grains to repel insects.
- Used as manure for rice and sugarcane fields.

Medicinal Uses

- Juice of leaves is used for cold, cough, diarrhoea, dyspepsia, flatulence, gonorrhoea, leprosy.
- Leaves are antihelminthitic, digestive and laxative used for inflammations, piles and wounds.
- As an infusion to relieve rheumatism.
- As an extract to treat itches and herpes.

2. Materials and Methodology

The silk city of Kanchipuram is located at a distance of 76Km from the capital of Tamilnadu, Chennai on the northern bank of the river Vegavathi River. This town of Kanchipuram is located with many villages out of which Iyyampettai is one of the important village in Walajabad taluk as shown in the Figure 1. It is located 8 Km towards East from Kanchipuram and 68 Km from Chennai. It is located with 40 numbers of small scale dyeing industries.

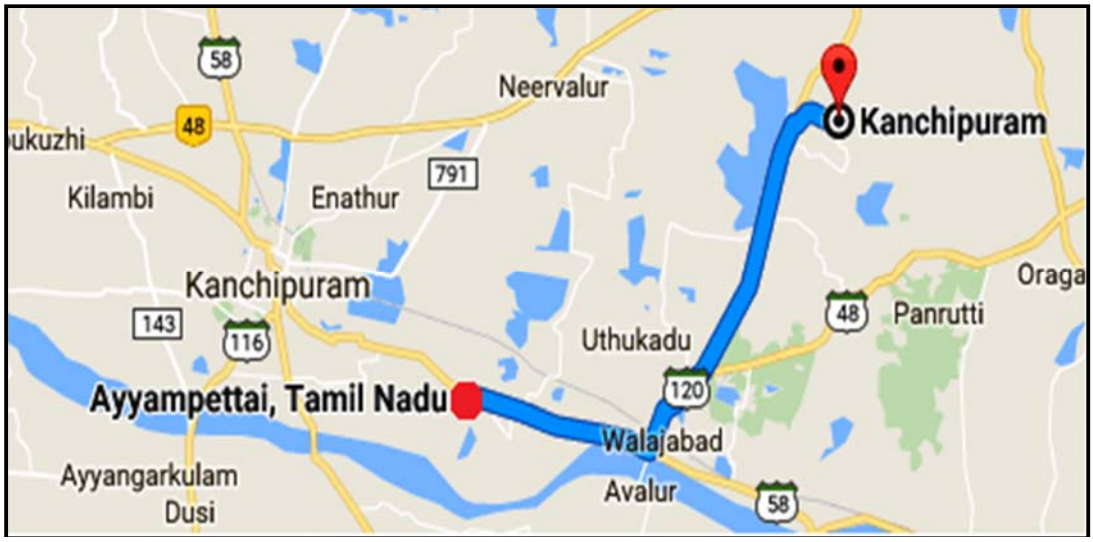

Fig 1: Location of the dying industries

The samples that are collected are of dyeing industry effluent from the Common Effluent Treatment Plant (CETP) at Iyyampettai in Kanchipuram. The raw sample is collected before the effluent was treated by CETP and the treated effluent was taken from CETP after it reached all the treatment process as per sequence. Then the sample was passed through the Pellatelized Pungan leaves as an adsorbent in gravity filters as shown in Figure 2 and it has taken as the filtered sample.

2.1 Instrumental Setup

A gravity filter is designed. The details are:

- The setup consists of three trays which are perforated from the underside.
- A fourth tray is kept as a collecting tray devoid of any perforations.
- Material Used: GI Sheets.
- Dimensions: 2'X2' tray.
- Depth of trays: 6cm and 3cm for collecting tray.
- Clear spacing between trays : 30cm.
- Supporting media used : Gravels of 20 cm size to a depth of 3cm
- Leaves used: Pongamia Glabra leaves, cut and sieved to a size minimum of 4.75mm and filled to a depth of 1cm

The leaves are washed and dried up at room temperature and then spread over the gravel media.

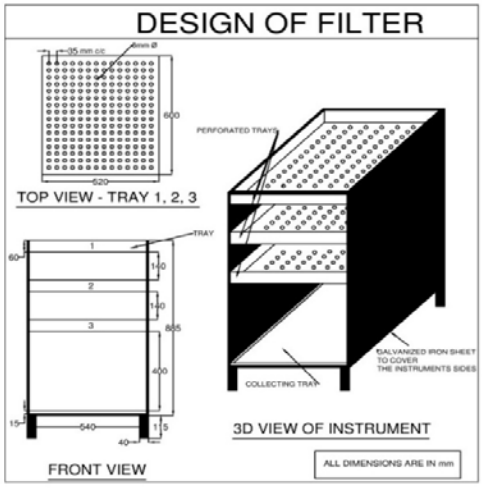

Fig 2: Arrangement of gravity filter

A motor is used for pumping the sample at a constant rate. A hose pipe is also connected to the sample to be spread over the tray. The sample is only made to trickle over the leaf on the tray and does not flow over it. The motor is made sure of this and then checked periodically for if there is an increase in the pumping rate or decrease for that matter.

- The rate of Pumping of the motor: 300ltrs/HR.
- Pumping height: Max 0.6m.
- Rate of Filtration: 2 litres/hour.

The sample filtered through the leaves and collected in the collecting tray.

3. Results and Discussion

The samples collected as raw, treated and filtered were compared with the permissible limits prescribed by CPCB as shown in Table 1 [3].

Table 1: Physical, chemical and biological parameters of raw, treated and filtered samples with their permissible limits

S. No	Parameter	Permissible limit as per CPCB standard	Unit	Raw sample	Treated Sample	Filtered sample
1	Colour	5	NA	6.0	2.0	2.0
2	Odour	100-500	-	Agreeable	Agreeable	Agreeable
3	pH	6-9	mg/l	7.08	10.26	8.01
4	TDS	1000	˚C	950.0	5780.0	8190.0
5	Temperature	45	mg/l	29.0	29.0	29.0
6	TRC as Cl_2	250	mg/l	BDL (DL 0.1)	3385.47	1471.17
7	Ammoniacal Nitrogen as N	50	mg/l	0.65	BDL(DL 0.02)	BDL(DL 0.02)
8	Free ammonia as NH_3	500	mg/l	BDL (DL 0.02)	BDL(DL 0.02)	BDL(DL 0.02)
9	BOD, 3 days 27˚C as O_2	20	mg/l	16.0	32.0	74.0
10	COD as O_2	60	mg/l	96.0	192.0	440.0
11	Lead as Pb	0.1	mg/l	BDL (DL 0.01)	BDL(DL 0.01)	BDL(DL 0.01)
12	Total Chromium as Cr	0.05	mg/l	BDL (DL 0.01)	BDL(DL 0.01)	BDL(DL 0.01)
13	Copper as Cu	0.1	mg/l	0.12	0.03	0.04
14	Zinc as Zn	0.5	mg/l	0.02	0.03	0.07
15	Nickel as Ni	0.1	mg/l	0.06	0.14	0.18
16	Chloride as Cl^-	400	mg/l	284.15	3066.89	5888.83
17	Fluoride as F^-	200	mg/l	0.18	BDL(DL 0.02)	BDL(DL 0.2)
18	Sulphate as So_4	200	mg/l	288.71	148.41	205.65
19	Sulphide as S_2^-	0.2	mg/l	BDL (DL 0.04)	BDL(DL 0.04)	BDL(DL 0.04)
20	Arsenic as As	0.05	mg/l	BDL(DL 0.005)	BDL(DL 0.005)	BDL(DL 0.005)
21	Mercury as Hg	0.001	mg/l	BDL(DL 0.001)	BDL(DL 0.001)	BDL(DL 0.001)
22	Cadmium as Cd	0.003	mg/l	BDL (DL 0.01)	0.05	BDL(DL 0.01)
23	Selenium as Se	0.01	mg/l	BDL (DL 0.005)	BDL(DL 0.005)	BDL(DL 0.005)
24	Phenolphthalein Alkalinity as $CaCo_3$	100	mg/l	BDL (DL 1)	1000.0	BDL(DL 1)
25	Total Alkalinity as $CaCo_3$	100	NTU	220.0	3000.0	2000.0
26	Turbidity	100-1000	mg/l	1.0	20.0	15.0
27	Total Hardness as $CaCo_3$	50-100	mg/l	490.0	8000.0	11000.0
28	Calcium as Ca	150	mg/l	144.0	2800.0	4000.0
29	Magnesium as Mg	150	mg/l	31.20	240.0	240.0
30	Total iron as Fe	1	mg/l	0.42	0.35	0.39
31	Manganese	0.5	mg/l	BDL (DL 0.01)	BDL(DL 0.01)	BDL(DL 0.01)
32	Sodium as Na	100-1000	mg/l	136.0	1470.0	2800.0
33	Potassium as K	100-1000	mg/l	10.0	105.0	210.0
34	Nitrate	20	mg/l	47.64	75.68	80.38
35	Phosphate	2	/100ml	11.26	BDL(DL 0.01)	BDL(DL 0.01)
36	Total Coliform Bacteria	Nil	NA	22	Absent	Absent

3.1 Discussion

Due to the pharmaceutical properties of the Pungan leaves, there was an increase in the parameters that are observed, namely, Total dissolved solids, BOD, COD, Chlorides, Sulphates, total hardness, copper, sodium, potassium, nitrate, zinc and nickel. It may be due to the increase in the concentration of the dissolved solids concentration and thereby influentially increasing certain characteristic values. The following parameters were found to have been increased from their permissible limits as given in Table 2 and Figure 3.

Table 2: Increased parameters after adsorption

S. No.	Parameters	Permissible Limits	Units	Raw sample	Treated sample	Filtered sample
1	Total Dissolved Solids	1000	mg/l	950	5780	8190
2	BOD	20	mg/l	16	32	74
3	COD	60	mg/l	96	192	440
4	Chloride (Cl^-)	400	mg/l	284.15	3066.89	5888.83
5	Sulphate(So_4)	200	mg/l	288.71	148.41	205.65
6	Total Hardness	50-100	mg/l	490	8000	11000
7	Copper (Cu)	0.1	mg/l	0.12	0.03	0.04
8	Sodium (Na)	100-1000	mg/l	136	1470	2800
9	Potassium (K)	100-1000	mg/l	105	105	210
10	Nitrate (No_3)	20	mg/l	47.64	75.68	80.38
11	Zinc (Zn)	0.5	mg/l	0.02	0.03	0.07
12	Nickel (Ni)	0.1	mg/l	0.06	0.14	0.18

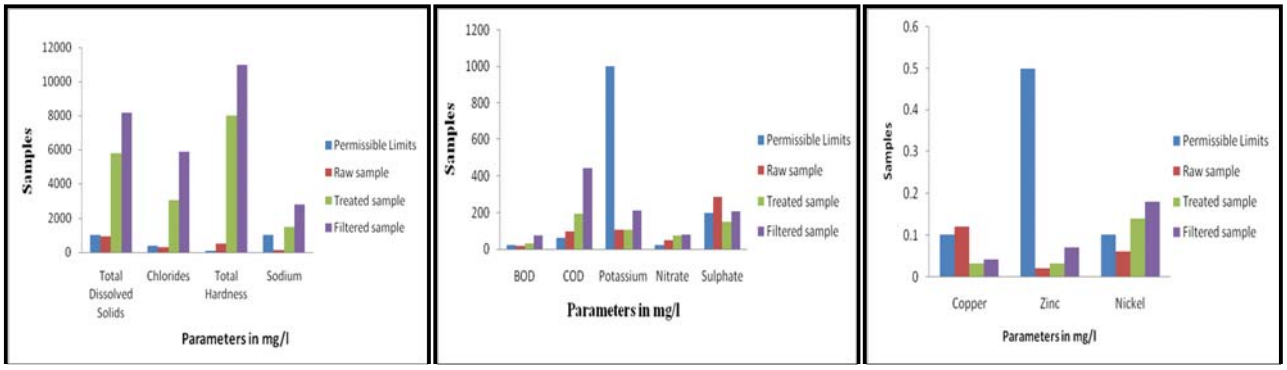

Fig 3: Increased parameters versus samples with their permissible limits

Even if there is a significant increase in the parameters there have been certain noticeable, if not drastically, decrease in certain other parameters too, namely, pH, Total residual Chlorine, Cadmium, Phenolphthalein alkalinity, Total alkalinity and turbidity as given in Table 3 and Figure 4.

Table 3: Decreased parameters after adsorption

S. No.	Parameter	Permissible limit	Units	Raw sample	Treated sample	Filtered sample
1	pH	6-9	-	7.08	10.26	8.01
2	Total Residual Chlorine	250	mg/l	0	3385.47	1471.17
3	Cadmium (Cd)	0.003	mg/l	0	0.5	BDL
4	Phenolphthalein Alkalinity	100	mg/l	0	1000	BDL
5	Total Alkalinity	100	mg/l	220	3000	2000
6	Turbidity	100	NTU	1	20	15

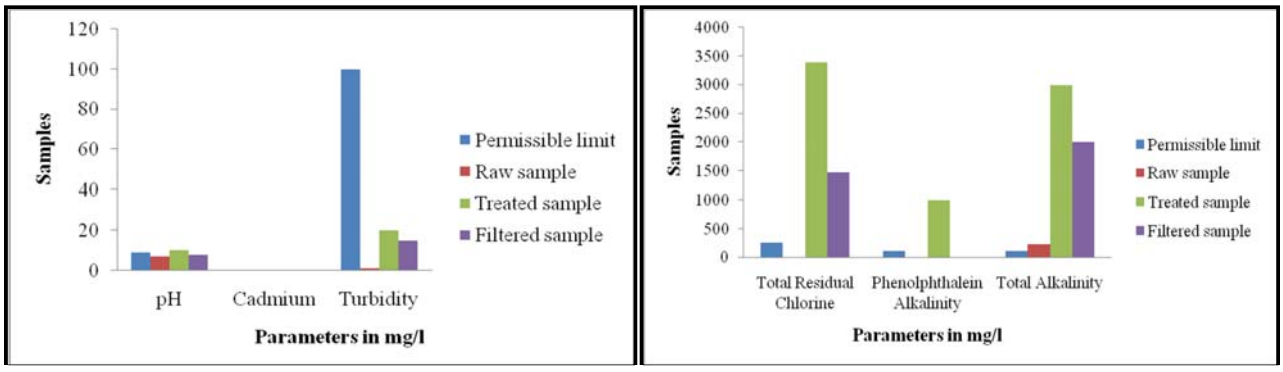

Fig 4: Decreased parameters versus samples with their permissible limits

The other parameters were found to have remained unchanged or have been below the deduction limit. Then, the Pongamia Glabra leaves are washed thoroughly with tap water and soak in distilled water for a period of around an hour. This water is then collected, then tested and analyzed for major parameters that have been found to be affected while the sample passed through the leaves. This helped in knowing about certain characteristics of the leaves and thus stands to justify the major increase or decrease of parameters that is observed in the testing that has been performed as given in Table 4.

Table 4: Results from leaf soaked in distilled water

S. No	Parameter	Unit	Leaf in Distilled Water
1	Colour	HU	-
2	Odour	NA	-
3	pH	-	6.82
4	TDS	mg/l	2850.0
5	Temperature	˚C	-
6	TRC as Cl_2	mg/l	-
7	Ammoniacal Nitrogen as N	mg/l	-
8	Free ammonia as NH_3	mg/l	-
9	BOD, 3 days 27˚C as O_2	mg/l	38.0
10	COD as O_2	mg/l	240.0
11	Lead as Pb	mg/l	-
12	Total Chromium as Cr	mg/l	-
13	Copper as Cu	mg/l	-
14	Zinc as Zn	mg/l	-
15	Nickel as Ni	mg/l	-
16	Chloride as Cl^-	mg/l	2694.5
17	Fluoride as F^-	mg/l	-
18	Sulphate as So_4	mg/l	52.0
19	Sulphide as S_2^-	mg/l	-
20	Arsenic as As	mg/l	-
21	Mercury as Hg	mg/l	-
22	Cadmium as Cd	mg/l	-
23	Selenium as Se	mg/l	-
24	Phenolphthalein Alkalinity as $CaCo_3$	mg/l	-
25	Total Alkalinity as $CaCo_3$	mg/l	-
26	Turbidity	NTU	-
27	Total Hardness as $CaCo_3$	mg/l	-
28	Calcium as Ca	mg/l	-
29	Magnesium as Mg	mg/l	
30	Total iron as Fe	mg/l	-
31	Manganese	mg/l l	-
32	Sodium as Na	mg/l	-
33	Potassium as K	mg/l	-
34	Nitrate	mg/l	-
35	Phosphate	mg/l	-
36	Total Coliform Bacteria	/100ml	-

Note: hyphen symbol referred as BDL

4. Conclusion

From the above discussion, it can be said that the discharged effluent when introduced to the Pungan leaves have undergone significant changes.

- Certain important characteristics have been found to increase beyond the permissible limit.
- The increased parameters include total hardness, BOD, COD, Sulphates, Total Dissolved Solids, and Chlorides etc.
- There has been a decrease in certain characteristics of the effluent both physically and chemically, turbidity, Cadmium, pH, Total residual chlorine etc., to name a few.

The leaves with appropriate treatment can be effectively used for secondary treatment. One such way is sterilized with 1% Bavistin for an hour and followed by treatment with savlon and few other solutions. Acid treatment is generally employed for lowering the pH levels to the desired limit. The bark of the *Pongamia Pinnata* is widely employed lately for the effluent treatment especially for dye removal. Hence a combination of leaves and barks in the pelletized form can be used for the secondary treatment and the results shall be analysed for any significant changes in the filtered sample. Hence, it can be concluded that this method is proven to be economical and eco-friendly for secondary treatment of the effluents provided the leaf properties are properly altered and the hindrances are taken care off through chemical treatment.

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