WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.074
Volume 7, Issue 7, 57-70. Conference Article ISSN 2277– 7105

STUDY ON THE PROPERTIES OF TANNERY EFFLUENT AND ITS EFFECT ON SEED GERMINATION AND SEEDLING GROWTH OF GROUND NUT (*ARACHIS HYPOGAEA L.)*

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Article Received on
13 Feb. 2018,

Revised on 05 March 2018,
Accepted on 26 March 2018,

DOI: 10.20959/wjpr20187-11591

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ABSTRACT

Groundnut is referred as king of oil seeds. It is a low annual herb. This is a legumes crop which is mainly cultivated for its edible seeds. Tannery industries are one of the oldest and the major industries in our country. A tannery effluents characteristics in India indicates that the pollutant are of high BOD, COD, sulfide, chromium, suspended particulate matter and salt concentration. Varietal screening experiment was conducted on five varieties of groundnut (JL24, TAG24, TMV7, TMV24, TG37A and TMV-13) treated with different concentration of tannery effluent taking cognizance of the parameter such as germination percentage, root length and shoot length. All these parameters were found to be at an increasing trends on 20% concentration of the effluent contrasting sharply with the situation in higher concentration and this work helps in conversation of tannery waste to a fertilizer which can helps in reduction of environmental pollution.

KEYWORD: BOD, COD, sulfide, chromium.

INTRODUCTION

Industrialization is an important tool for the development of any nation. Consequently, the industrial activity has expanded so much all over the world. With the rapid growth of industries (sugar, paper, tannery, textile, sago, dye industries) in the country, pollution of natural water by industrial waste water has increased tremendously. They contain higher amounts of total hardness, total dissolved solids, biological oxygen demand, chemical oxygen

demand, calcium, magnesium, sodium, iron and sulphate. The effluents not only affect the plant growth hut also deteriorate the soil properties when used for irrigation.

Tannery industry is one of the oldest and the major industries in our country. Nearly 80% of tanneries in India are engaged in the chrome - tanning process. Extensive use of chromium in leather industries have resulted in chromium — contaminated soil and ground water which cause a serious threat to environment and human health. In leather industry there are three major operational stages viz. pre — tanning, tanning and post tanning process are generated. Most of our water resources are gradually becoming polluted by addition of huge amounts of sewage and industrial effluents.

lt is found that one third of the total water pollution comes in the form of effluent have increased the level of toxins like cyanide and chromium up to 20 times the safe level in 22 critically polluted areas of the country. The surface water is the main source of industries for waste disposal. It is found that almost all rivers are polluted in most of the stretches by some industry.[1]

MATERIALS AND METHODS

Seed Material

The seeds of 5 varieties of groundnut JL24, TAG24, TMV7, TMV24, TG37A and TMV 13 were obtained from Tamil Nadu Corporation Oil Research Station, Tindivanum, Tamil Nadu, India. The seeds with uniform size, colour and weight were selected for expeimenta1 purpose. The experiments were conducted at the Department of Plant biology and plant biotechnology, Quaid -E -Millath Government College for Women, Chennai, Tamil Nadu, India.

Effluent Samples

The effluent samples from CLRI, Guindy campus, Chennai were collected in plastic containers from the point of disposal. The effluent sample was brought to the laboratory for the physic- chemical analysis.

The effluent samples were analyzed for its various physic chemical properties. The different concentrations of the effluent (20,40,60,80 and 100%) were prepared and they were used for the germination experiment. Groundnut seeds were surface sterilized with 0. 1% mercuric chloride and washed with distilled water. Ten seeds for each treatment were placed

equispacially in sterilized Petridishes, lined with filter l0 paper and soaked with different concentration of effluent. The seedlings raised in distilled water were designated as control.

Treatment Details

The treatment details are as follows:

T1 - Control (Untreated)

T2 - 20% effluent

T3 - 40% effluent

T4 - 60% effluent

T5 - 80% effluent

T6 - 100% raw effluent

Methods

Physico chemical analysis of tannery effluent

Colour

The colour of the effluent was observed visually.

Odour

It was categorized as objectionable or non - objectionable by direct smelling of the samples.

pH

The pH of the effluent sample was measured by pH meter in the field itself.

Electrical conductivity

Electrical conductivity of the effluent sample was measured by using a self contained conductivity meter at 25°C.

Suspended solids

100 ml of volume of the sample filtered through the filter paper. The filtrate was washed with distilled water to remove the soluble salts. The crucible was kept in an oven at 103 - 105°C and the final weight was taken. The amount of' suspended solids can be calculated by using the formula.

Total suspended solids = Total solids - Total dissolved solids

Dissolved solids

The dissolved solids were estimated by filtering a known volume of 100ml of well mixed sample through a standard glass fiber filter. The filtrate was evaporated to dryness.

$$\text{Total dissolved solids (mg/L)} = \frac{\text{Weight of sat in dish} \quad X\ 10^6}{\text{Volume of sample}}$$

Biological oxygen demand (BOD)

$$\text{BOD (mg/L} = \left[\begin{array}{l}\text{Dissolved oxygen}\\ \text{before incubation}\end{array}\right] - \left[\begin{array}{l}\text{dissolved oxygen} \quad X \text{ dilution factor}\\ \text{after incubation}\end{array}\right]$$

Chemical oxygen demand (COD)

$$\text{COD(mg/L)} = \frac{(a-b) \text{ x Normality of FAS}}{\text{Volume of sample}} \quad X\ 8000$$

a = mL FAS used for blank

b = mL use for sample

Preparation of effluent Concentration

The collected effluent sample from the outlet of tannery effluent was considered as 100% raw effluent. Different concentrations (20%, 40%, 60%, 80% and 100%) for tannery effluent were prepared freshly by using tap water when ever necessary. They were used for all experiments.

For 100mL

Control	:	Tap water
20%	:	20mL effluent + 80mL of water
40%	:	40mL effluent + 60mL of water
60%	:	60mL effluent + 40mL of water
80%	:	80mL effluent + 20mL of water
100%	:	Raw effluent (undiluted)

Germination Study: Varietal Screening Experiment

The healthy seeds of groundnut varieties (JL24, TAG24, TMV7, TMV24, TG-37A and TMV- 13) were surface sterilized with 0.1 % mercuric chloride for 2 mm and washed thoroughly with tap water and then with distilled water. Ten seeds of Five varieties of groundnut seeds were arranged equispacially in plastic trays lined with filter paper, They were irrigated uniformly with equal volumes (l0mL) of different concentrations (20, 40, 60, 80 and 100%) of tannery effluent. The seeds irrigated with tap water were treated as control.

They were allowed to grow for a week. Three replicates were maintained for this varietal screening experiment. The seedlings raised in distilled water were designated as control.

Germination percentage

The number of seeds germinated in each treatment was counted on each and every day up to 7^{th} day after sowing. The total germination percentage was calculated by using the following formula:

$$\text{Germination percentage} = \frac{\text{Total number of seeds germinated}}{\text{No.of seeds sown}} \text{ X } 100$$

Seedling length (cm / seedling)

Ten seedlings were randomly selected on 7^{th} day from each treatment to record the seedling growth. The growth of the five varieties of groundnut seedlings was measured by using a centimetre scale and the values were recorded.

Experiment with tolerant variety

Germination study was conducted with the tolerant variety. The seeds were equispacially arranged in petriplates with different concentrations (23, 40, 60, 80 and 100%) of tannery effluent. The germination studies parameters such as germination percentage, root length. shoot length were taken by the following methods described in varietal screening experiment. From these data, the following values of vigour index and tolerance index and phytotoxicity were calculated. Three replicates were maintained for this experiment.

Vigour index

Vigour index of the seedlings were calculated by using the formula proposed by Abdul - Baki and Anderson (1973).

Vigour index = Germination percentage X seedling length.

Tolerance index

Tolerance index of the seedlings were calculated by using the formula proposed by Turner and Marshal (1972).

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}}$$

Morphological parameters

Plant samples were collected randomly at various stages (10, 20 and *30* DAS) of its growth and used for recording morphometrical observations like shoot length, and root length, total leaf area. Five plants were selected from each concentration including control for recording the various morphological parameters.

Biochemical Analysis

Besides morphological parameters, some biochemical constituents such as chlorophyll 'a', chlorophyll 'b', and carotenoid were analyzed and recorded at 10, 20 and 30 DAS.

RESULTS AND DISCUSSION

The present work deals with the effect of tannery effluent on seed germination, seedling growth and biochemical content of five varieties of groundnut *Arachis hypogaea* L.).

Physico- Chemical Properties of Tannery Effluent

The physico — chemical characteristics of raw effluent with its tolerance limit values for agricultural irrigation are given in Table 1. The tannery effluent was brown colour with acidic (pH 6.13) in nature contained higher amount of total dissolved solids (20520 mg/L). The electrical conductivity of the effluent was 29207 rnMhos/cm with higher biological oxygen demand (240 mg/L) and chemical oxygen demand (806 mg/L). The tolerance limit of the wastewater for agricultural irrigation as prescribed by Tamil Nadu Pollution Control Board was also given in the same table for comparison. Most of the parameters are found to be exceeded beyond the tolerance limits.

Germination Study: Varietal Screening

The effect of different concentrations of tannery effluent on seed germination percentage of five varieties of groundnut seedlings are presented in Table 2 and Figure 1.

The variety TMV- 13 showed the highest seed germination percentage (90.00%) treated with 20% concentration of' tannery effluent whereas the lowest seed germination percentage (20.00%) was recorded in the variety of JL24 at 100% concentration of tannery effluent.

Shoot and Root Length

The effect of different concentrations of tannery effluent on shoot and root length of groundnut (*Arachis hypogaea* L.) var. TMV – 13 is presented in Table 3 and 4 Table 4.

The highest shoot and root length (20.0 ± 0.60, 9.6 ± 0.288) were recorded in TMV – 13 treated with 20% concentration of tannery effluent. Whereas the lowest values were (1.0 ± 0.03, 2.5 ± 0.075) observed in 100% concentration of tannery effluent.

Biochemical Analysis

Groundnut seedlings were separated into root, stem, and leaves were used for biochemical aspects like chlorophyll 'a', chlorophyll 'b' and carotenoid. In the chlorophyll estimation chlorophyll 'a', chlorophyll 'b' and carotenoid content of the plant significantly affected under tannery effluent irrigation. The tables 5& 6 shows the seedlings grown in 20% effluent concentration (1.268 ± 0.038, 0.718 ± 0.021) shows an increase in the chlorophyll content compared with control. The carotenoid content was, high at 20% effluent concentration (0.83 ± 0.024), whereas it gets gradually reduced as the concentration of the effluent increases (Table - 7).

Table 1: Physico - chemical analysis of tannery effluent with its tolerance limits for agricultural irrigation.

Sl.No.	Parameters	Raw effluent	Tolerance limits for agricultural irrigation prescribed by TNPCB
1	Colour	Brownish	Colourless
2	Odour	Offensive	Odourless
3	pH	6.13	5.5—9.0
4	Electrical conductivity (mMhos/cm)		-
5	Chloride		20
6	Total hardness (as $CaCO_3$) mg/L	3200	-
7	Total dissolved solids (mg/L)	20520	29207
8	Biological oxygen demand (mg/L)	240	9157
9	Chemical oxygen demand (mg/L)	806	250
10	Calcium as $CaCO_3$ (mg/L)	460	-
11	Magnesium as Mg (mg/L)	312	-
12	Sodium (as Na) mg/L	4900	-
13	Sulphate (as SO_4) mg/L	1426	20
14	Total chromium		-

All parameters except colour, odour, pH, EC are expressed in mg/L. TNPCB - Tamil Nadu Pollution Control Board.

Table 2: Effect of different concentrations of tannery effluent on seed germination percentage of five varieties of groundnut *(Arachis hypogaea* L.).

Treatment	JL24	TAG24	TMV – 7	TG – 37A	TMV – 13
Control	67.00 ± 2.01	53.00 ± 1.59	63.00 ± 1.89	53.00 ± 1.59	80.00 ± 2.40
20% effluent	70.00 ± 2.10	60.00 ± 1.89	67.00 ± 2.01	70.00 ± 2.10	90.00 ± 2.70
40% effluent	63.00 ±1.89	50.00 ± 1.50	60.00 ± 1.80	63.00 ± 1.89	73.00 ± 2.19
60% effluent	43.00 ±1.29	40.00 ± 1.20	50.00 ± 1.50	47.00 ± 1.41	57.00 ± 1.71
80% effluent	37.00 ± 1.11	47.00 ± 1.41	57.00 ± 1.71	40.00 ± 1.20	50.00 ± 1.50
100% effluent	20.00 ± 0.6	33.00 ± 0.99	27.00 ± 0.81	27.00 ± 0.81	47.00 ± 1.41

± Standard deviation

Table 3: Effect of different concentrations of tannery effluent on shoot length (cm/plants) of ground nut (*Arachis hypogaea* L.) var.TMV-13.

Treatment	Days after sowing (DAS)		
	10	20	30
Control	2.5 ± 0.07	6.7 ± 0.20	10.5 ± 0.31
20% effluent	3.0 ± 0.09	12.5 ± 0.37	20.0 ± 0.60
40% effluent	2.0 ± 0.06	4.5 ± 0.13	9.0 ± 0.27
60% effluent	1.0 ± 0.03	4.4 ± 0.13	7.0 ± 0.21
80% effluent	1.0 ± 0.03	3.2 ± 0.09	4.5 ± 0.13
100% effluent	1.0 ± 0.03	2.5 ± 0.09	4.5 ± 0.13

± Standard deviation

Table 4: Effect of different concentrations of tannery effluent on root length (cm/ plant) of groundnut (*Arachis hypogaea* L.) var. TMV – 13.

Treatment	Days after sowing (DAS)		
	10	20	30
Control	1.5 ± 0.045	5.4 ± 0.162	8.7 ± 0.261
20% effluent	3.5 ± 0.105	8.5 ± 0.255	9.6 ± 0.288
40% effluent	3.0 ± 0.090	7.4 ± 0.222	8.4 ± 0.252
60% effluent	2.8 ± 0.084	6.3 ± 0.189	7.5 ± 0.225
80% effluent	2.9 ± 0.087	6.8 ± 0.204	7.2 ± 0.216
100% effluent	2.5 ± 0.075	6.2 ± 0.186	7.0 ± 0.21

± Standard deviation

Table *5:* Effect of different concentration of tannery effluent on chlorophyll 'a' Content (mg/g fr. wt.) of groundnut *(Arachis hypogaea* L.) var. TMV-13.

Treatment	Days after sowing (DAS)		
	10	20	30
Control	0.567 ± 0.017	0.768 ± 0.023	0.892 ± 0.026
20% effluent	0.679 ± 0.020	0.894 ± 0.026	1.268 ± 0.038
40% effluent	0.528 ± 0.015	0.648 ± 0.019	0.734 ± 0.022
60% effluent	0.452 ± 0.013	0.511 ± 0.015	0.645 ± 0.019
100% effluent	0.218 ± 0.006	0.338 ± 0.010	0.505 ± 0.015

± Standard deviation

Table 6: Effect of different concentrations of tannery effluent on chlorophyll 'b' Content (mg/g fr. wt.) of groundnut *(Arachis hypogaea* L.) var. TMV-13.

Treatment	Days after sowing (DAS)		
	10	20	30
Control	0.470 ± 0.014	0.514 ± 0.015	0.685 ± 0.020
20% effluent	0.558 ± 0.016	0.610 ± 0.018	0.718 ± 0.021
40% effluent	0.340 ± 0.010	0.497 ± 0.014	0.555 ± 0.016
60% effluent	0.289 ± 0.008	0.369 ± 0.011	0.447 ± 0.013
100% effluent	0.190 ± 0.005	0.234 ± 0.007	0.301 ± 0.009

± Standard deviation

Table *7:* Effect of different concentrations of tannery effluent on carotenoid content (mg/g fr. wt.) of groundnut *(Arachis hypogaea* L.) var. TMV-13.

Treatment	Days after sowing (DAS)		
	10	20	30
Control	0.34 ± 0.010	0.53 ± 0.015	0.62 ± 0.018
20% effluent	0.56 ± 0.016	0.74 ± 0.022	0.83 ± 0.024
40% effluent	0.44 ± 0.013	0.62 ± 0.018	0.69 ± 0.020
60% effluent	0.32 ± 0.009	0.41 ± 0.012	0.50 ± 0.015
100% effluent	0.20 ± 0.006	0.35 ± 0.010	0.42 ± 0.012

± Standard deviation

Water plays a vital role in tannery operations. Approximately 30-40 litres of water is used for processing of one kilogram of raw hide/ skin into finished leather. However volume of effluent and its physicochemical characteristics vary from tannery to tannery. The physic - chemical characteristics of tannery effluent are shown in Table 1. The raw effluent was acidic and brown in colour. It contained high amounts of suspended and dissolved solids it showed the deficit in dissolved oxygen, rich in total solids high amount of BOD and COD with considerable amounts of sodium, calcium and chloride. This is conformity with the earlier findings of.[2],[3] and [4]

In the present study Table 2 shows the higher germination percentage was observed at 20% effluent concentration. At higher concentrations, the germination percentage was gradually decreased from 40% to 100% raw effluent. It may also be due to the disturbance of the osmotic relations of the seed and water, thus reducing the amount of absorbed water and retarding seed germination by enhanced salinity and conductivity of the solutes. Further more, the germinated seeds will not get any oxygen due to organic and inorganic chemicals present in the effluent. Similar findings were also noted by.[5],[2],[6] and[7] The increase percentage might be due to the reduction in level of toxic metabolite by dilution and better utilization of nutrients present in the effluent.[8]

The reduction in germination percentage at higher concentrations may also be due to the excess amount of minerals and nutrients present in the effluent.[9] Reduction in seed germination percentage at higher concentration maybe due to the higher amount of solids present in the effluent, which causes changes in the osmotic relationship of the seed and water. The reduction in the amount of water absorption take place with results in to reduction of seed germination due to enhanced effluent salinity.[10]

Root and shoot length of groundnut plants differed with different concentrations of effluent in the soil. For the lower concentrations of irrigated effluent (20%) the root and shoot length of plants were higher than that of control plants. This may be taken as an indication of beneficial range, while for higher concentrations of effluents (40%, 60%, 80% and 100%) a decreasing trend was observed. It may be the presence of toxic pollutants in the effluent. That kind of pollutants mainly affects the respiration of the root. Respiration of root and soil organism tends to reduce the oxygen and increase the CO_2 concentration. The soil becomes harder and closed the pores of the soil are closed causing less aeration and retarding the growth of plant.[10]

Maximum photosynthetic pigments such as chlorophyll ‘a’ chlorophyll ‘b’ and carotenoid at 20% concentration of the effluent. The increased chlorophyll content was obviously due to effluent at low concentrations which act as structural and catalytic components of proteins, enzymes and as cofactors for normal development of chlorophyll biosynthesis. The increase in the chlorophyll a, chlorophyll b and carotenoid content of plants at lower concentration of the effluent might be due to the favorable effect of nitrogen and other inorganic elements which are present in their optimum quantities. It may be due to the decrease in the chemical concentrations to an optimum level on the dilution of the effluent. The increase in carotenoid

content might be due to enhanced influence of nitrogen and other inorganic elements present in the effluent.[11]

It is generally known that continuous use of industrial waste water may deteriorate the quality of the soil and make it unfit for crop production. The use of waste water from other industrial sources inhibited adverse effect on physico - chemical characteristics and fertility of the soil. This might be due to the differences in the types and the quantity of certain toxic elements in the waste water released by the industry for irrigation purpose.[12]

CONCLUSION

The present investigation is centered on the detection of the response of groundnut when subjected to tannery effluent irrigation, under the backdrop of an ecological experiment in controlled vicinity. Systematic experiments including varietal screening, germination study were conducted and inferences were recorded.

Varietal screening experiment (germination study) was conducted on five varieties of groundnut (JL24, TAG24, TMV7, TMV24, TG-37A and TMV - 13) treated with different concentrations of tannery effluent, taking cognizance of the parameters such as germination percentage, root length and shoot length. All these parameters were found to be at an increasing trend at 20% concentration of the effluent contrasting sharply with the situation in higher concentrations. Among five varieties treated the variety TMV- 13 is established as tolerant on the basis of the appreciating trend observed with reference to the morphological parameters. Hence this variety was ‘singled out’ and subjected to further experiments.

In the experiments viz., the varietal screening and tolerant variety experiment, the morphological parameters and biochemical analysis showed an increase at 20% concentration decreased in the case of higher concentrations.

The present study reveals that (*Arachis hypogaea L.*) var. TMV- 13 is a oil yielding crop that is sensitive to effluent polluted soils and great care has to be taken when considering the cultivation of this plant on such soils and proper treatment of effluents has to be done before these could be used of the irrigation of this plant.

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