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Physico-Chemical Characteristics Of Doon Distillery, Doiwala Effluent And Its In-Vitro Effect On Seed Germination Of Four Agricultural Crops

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Abstract
The present paper deals with the physico-chemical characteristics of Doon Distillery, Doiwala effluent and its in-vitro effect on seed germination of four agricultural crops i.e. *Solanum melongena* (Brinjal), *Cicer arientinum* (Black gram), *Glycine max* (Soyabean) and *Lycopersicon esculentum* (Tomato). The physico-chemical characteristics showed high degree of pollution load in the effuent as it is evident by high degree of BOD (35375mg/l), COD (81000 mg/l), MPN/100 ml ($30.56x10^5$) and SPC ($72.33x10^6$). The effect of effluent treatment on seed germination in-vitro showed a significant negative co-relation between different concentration of the effluent (5 to 100%) and in percentage of seed gemination of *S.melongena*, *C. arietinum*, *G.max* & *L. esculentum*. In all these four crops maximum percentage of seed germination was observed at 5% concentration of effluent. Germination of seeds treated with different doses was only recorded up to 25% concentration. Effluent showed deleterious effect at 50% and above that no seed germination was found.

Introduction
In the colonial period, it was not a governmental policy to industrialize the country. We have to depend almost entirely on other countries, especially on U.K. It is only after independence of the country in 1947 and after that large funds were made available for the industrialization of the country, but the planning commission that indeed started industrialization in India.

Albeit the role of industries in environmental pollution is well established but some of them are contributing high degree of pollution load especially in different aquatic system. Some of them may be considered as major polluting industries such as tanneries, chemical and fertilizer manufacturing units, refineries, paper & pulp mills, sugar and distilleries etc. Indiscriminate discharge of effluent from these industries in aquatic system or on land has altered the quality of both systems. Distilleries are primarily engaged in the production of alcoholic beverages *viz* ethyl alcohol by fermentation of molasses and subsequent distillation of the fermented wash. There are over 200 large distilleries in India and the spent wash of these are the largest effluent stream from distilleries. The spent wash is hot, highly acidic, coloured and contains high percentage of dissolved organic and inorganic matter. The effect of pollution caused, by the distillery spent wash on water & land are as lowering of pH value of the stream, increase in cropping period and increase in electrical conductivity of soil (Kaul *et al.*, 1995). The adverse effects of distillery waste are due to high BOD, COD, total solids, low values of dissolved oxygen and capability to impart colour. Stagnation of the effluent on land results in obnoxious condition in the region. If the soil is porous the effluent may also affect ground water quality. Distilleries wastes in the form of spent wash are among the worst water pollutants produced by industries both in magnitude & strength.

Since the land surface water is major source of water supply for civic purposes in most of the cities, therefore this surface water (aquatic reservoirs, rivers etc.) should be prevented / minimized from pollutant in order to protect human health hazard. Infact a large no. of human diseases are water born and if civic water supply is

contaminated it may cause severe outbreak of epidemic.Therefore, liquid waste treatment is very essential but the treatment plant is very costly affair in all the industries, which they cannot afford. Therefore, alternative method which can be useful and may minimize the harmful effect should be investigated and evaluated. Since our country is in underdeveloping stage, electricity supply is highly interrupted and labour problem is regular feature. Therefore, it is imperative to utilize these effluents in irrigation under liquid waste disposal programme. As a specific concentration of effluent will not be a general role for all agricultural crops and different parameter will not remain same for all the time in specific effluent. Therefore, it is highly needed that a regular monitoring of the effluent and concentration should be analyzed for each crop before taking the irrigation process in specific area. Disposal of liquid waste in irrigation helps as a solution of water for irrigation and as manure required for the crop. Keeping in view of the above facts efforts have been made to find out pollution load of Doon distillery effluent and its effect in different concentrations in seed germination of four agriculture crops. viz *Lycopersicon esculentum*, *Solanum melongena*, *Cicer arietinum* and *Glycine max*.

Materials and Methods

Composite samples of the effluent were collected from inlet of Doon distillery in plastic container and brought to laboratory for the analysis of certain physico-chemical and microbiological parameter as per APHA (1985). The effluent was further used for the treatment of seeds of test crops. Various concentrations of the effluent i.e.5%, 10%, 25%, 50%, 75% and 100% were prepared using tap water. Tap water was used as such for control. Seeds of four crops *Lycopersicon esculentum*, *Solanum melongena*, *Cicer arietinum* and *Glycine max* were used as test plants.

The seeds of these test crops were surface sterilized with 0.1% $HgCl_2$ solution for 20 second and were repeatedly washed with distilled water. These seeds were treated in six different concentrations. Seeds as such (without treatment) were used for control. The seeds were irrigated with equal quantity of the effluent. Four replicates were maintained for each concentration including control. Germination of seeds of two crops i.e. *Cicer arietinum* (black gram) and *Glycine max* (soyabean) were recorded on 7th day while that of *Lycopersicon esculentum* (tomato) and *Solanum melongena* (brinjal) on 15th day. The data was statistically analysed.

Results & Discussion

The physico-chemical and microbiological characteristics of Doon distillery, Doiwala effluent and its effect on the percentage of seed germination of four agricultural crops are presented in table 1 & 2.

The study revealed that the colour of Doon distillery effluent was deep brownish and yielded odour of molasses. Electrical conductivity was recorded 9 at 20 μ mhos. Conductivity of water and wastewater is the property caused by the presence of various ionic species. Conductivity of water and wastewater is due to the presence of total dissolved solids. Higher value of total solids i.e. 65,040 mg/l was recorded in the effluent. Total solids have profound effect on several parameter related with pollution load. Dissolved solids in the mill were recorded to be 64,221.6 mg/l. The mill contains considerable amount of dissolved solids because of the escape of viscose fibres and wood being used as raw materials in the factory. High values of these parameters signify the presence of both organic and inorganic compound in the effluent which increase the total pollution load of the effluent.

Alkalinity of the effluent was recorded to be 1666.66 mg/l. Alkaline value are important in calculating the dose of alum and biocides in water. Values of phosphate and sulphate were found to be 1200 mg/l and 3886.83 mg/l respectively. Phosphate is an important component which is being utilized as nutrient by majority of micro organism especially algal species utilize the phosphate for their growth.

Hardness in the effluent was recorded to be 10,750 mg/l. Hardness decreases after biological treatment due to the use of alum, lime etc. as coagulants which remove the salts of Ca & Mg, dissolved phosphates thereby reducing the hardness. Chloride in the effluent is recorded to be 2153.66 mg/l. High chloride content harm the metallic pipes & structure of these factories.

Albeit the dissolved oxygen is essential for aquatic living biota but DO was recorded nil in the distillery effluent (Table-1). Absence of dissolve oxygen in the effluent is directly linked with degradation of biodegradable organic components present in the effluent. Total oxygen of effluent was utilized by aerobic bacteria and other aerobic microorganism during the degradation process of biodegradable organic component and resulted in absence of oxygen. Manivaskam (1994) reported that decomposition of dissolved oxygen in receiving water give rise to odoriferous products of anaerobic decomposition. BOD content of the effluent was (35375 mg/l). High values of BOD are found before biological treatment, due to the presence of oxidizable organic matter, which by the addition of the alum and lime as coagulants and by continuous aeration gets considerably reduced. Bhargava (1977) has stated that the set of BOD and DO values taken together would not only show the pollution status, but sequential reaching of such sets would indicate the self purifying ability of the river. COD in the effluent was reported to be 81,000mg/l. The COD test gives a measure of the total oxidizable material present in the effluent.

The results of the effect of different concentrations of distillery waste showed varied percentage of seed germination of the crops like *S. melongena*, *C. arietinum*, *G. max* and *L.esculentum*. In case of *S. melongena* maximum percentage of seed germination (+5.42%) was recorded at 5% concentration of effluent in comparison to control. As the concentration of the effluent increased there was a decline in the percentage of seed germination. The declined trend was noted from 10 to 25% (-8.26 to-43.89). At 50%, 75% and 100% there was no germination. The gradual fall in percentage of germination at higher concentration might be due to increase in concentration of inhibitory compounds in the effluent. Since the effluent has acidic property, the effluent is treated with $Ca(OH)_2$ to enhance pH level before discharging out of the mill. The value of 'r' was -0.95 which represents highly negative correlation between the concentration of the effluent & seed germination.

Germination of seed of *C.arietinum* decreased from 4.5 to 53.6 in the range of 5 to 25% concentration of effluent. Seed germination was completely inhibited above 25% concentration. Negative relationship was established between effluent concentration and seed germination. This might be due to the seeds that take up water during germination to hydrolyze the stored food material in order to activate enzymatic action. As the absorption takes place by osmosis, the salt content outside the seed may act as a limiting factor which may be responsible for seed germination. Further high salt content may be another factor inhibiting seed germination. Our findings are in accordance to finding of Raja and Vijay Kumari (1982) who studied the impact of distillery effluent spent wash in seed germination. morphological characters yield and pigment concentration of *Trigonema foenum graceum* L. and observed that high concentrations of the effluent adversely affect plant growth and grain yield. Dilute distillery effluent treatment of 1% and 0.1% had a growth promoting effect and enhanced growth and yield of crop is more than control. Our results are also in agreement with findings of other workers (Ghosh & Kumar, 1998 and 2000) on the effect of distillery effluent on seed germination of *C. arietinum* and the effect of plywood industry effluent on seed germination and seedling growth of *C. arietinum* and observed that at higher concentration there was complete inhibition of seed germination and concentration of effluent.

In case of *G.max* maximum percentage of seed germination (+51.94) was observed at 5% concentrated effluent than control. Decline trend of seed germination was recorded from 10 to 25% concentration and above that no seed germination was observed. As the distillery effluent contains higher concentration of salts, their higher concentration inhibits germination process. Higher salt concentration and high BOD and COD in the effluent alter the hydrolytic enzyme activity, which are responsible for seed germination. Our results are in agreement with findings of other workers (Rajannan & Oblisami 1979, Mishra & Sahoo 1989, Khan & Srivastava 1996).

There was highly negative correlation ($p<0.05$, $r = -0.96$) between seed germination and concentration of effluent.

In case of *L. esculentum* maximum percentage of seed germination (+13.26%) was oberved at 5% concentrated effluent than control. Seed germination started decreasing from +2.04 to -16.6. Above 25% no germination was seen. This might be due to mitotic irregularities of less concentration in these effluents. The cytodeformity induction by these effluents at higher concentration was due to the presence of toxic chemicals that damage cellular machinery in the cells of tomato.

Albeit effluent has adverse effect on seed germination of the different test crops but since at lower concentration i.e. 5% effluent has shown a promotive tendency of seed germination therefore it can be utilized in irrigation at highly diluted condition. Irrigation at 5% concentration may be useful for *S. melongena*, *C.arietinum*, *G.max* & *L. esculentum*. However, before recommending this effluent for irrigation careful scientific investigation regarding deposition of chemical components in the product and also their effect on land and biota should be taken.

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Table 1 : Physico-chemical and microbiological characteristics of effluent of Doon distillery, Doiwala (Values are mean ± S.D. of six replicates)

Parameters	Characteristics
Colour	Deep Brownish
Odour	Smell of molasses
Turbidity (NTU)	11.53 ± 2.07
Conductivity (at 20 μhos)	9 ± 2
Total Solids (mg/l)	65040 ± 715.82
Dissolved solids (mg/l)	64221.66 ± 697.07
Suspended Soli (mg/l)	818.30 ± 31.75
Dissolved oxygen (mg/l)	Nil
Biological oxygen demand (mg/l)	35375 ± 305.98
Chemical oxygen demand (mg/l)	81000 ± 0.00
Chloride (mg/l)	2153.66 ± 106.89
pH	3.55 ± 0.03
Hardness (mg/l)	10750 ± 273.86
Alkalinity (mg/l)	1666.66 ± 258.19
Phosphate (mg/l)	1200 ± 200
Sulphate (mg/l)	3886.83 ± 6.79
Calcium (mg/l)	3660.64 ± 41.39
Magnesium (mg/l)	1729.86 ± 67.58
MPN/100 ml.	$30.56 \times 10^5 \pm 0.47 \times 10^5$
SPC	$72.33 \times 10^6 \pm 0.60 \times 10^6$

Table 2 : In vitro percentage of seed germination of four agricultural crops (Values are mean ± S.D. of 12 replicates

Conc of effluent (%)	*S. melongena* (Brinjal)	*C. arietinum* (Black gram)	*G.max* (Soyabean)	*L.esculentum* (Tomato)
Control	81.1	73.3	77.1	58.8
5	85.5 (+5.42)	70 (-4.50)	81.1 (+51.94)	66.6 (+13.26)
10	74.4 (-8.26)	41.1 (-43.92)	54.4 (-29.44)	60.0 (+2.04)
25	45.5 (-43.89)	34.4 (-53.06)	22.2 (-71.20)	42.2 (-16.6)
50	Nil	Nil	Nil	Nil
75	Nil	Nil	Nil	Nil
100	Nil	Nil	Nil	Nil
(r value)	-0.95	-0.88	-0.96	-0.85

% increase or decrease in composition to control given in parenthesis.
r value - Coefficient of correlation
Chi - Square calculated value in relation to percentage of effluent in the seed germination of all the crops=15.41