PHYSICO-CHEMICAL ANALYSIS OF SUGAR INDUSTRY EFFLUENT AND ITS EFFECT ON SEED GERMINATION OF *VIGNA ANGULARIS*, *VIGNA CYLINDRICAL* AND *SORGHUM CERNUM*

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ABSTRACT

We assessed physico-chemical parameters of treated waste water effluents from a sugar industry and determined the effect of various concentrations (0%, 20%, 40%, 60%, 80 % and 100%) of effluent on seed germination, germination speed, peak value and the germination value of Mung (*Vigna angularis*), Chavali (*Vigna cylind*rical) and Jowar (*Sorghum cernum*) seeds. The low effluent pH (4.35), total dissolved solids, (TDS, 720 mg/L) and chemical oxygen demand, (COD, 1330 mg/L) indicate the high inorganic and organic content with an acidic load. Germination percentages and germination values decrease with increasing concentration of effluent in all the seeds tested.

Keywords: Mung, Chavali, Jowar, effluent, physico-chemical analysis, seed germination.

1. INTRODUCTION

Diverse sugar industry effluents disposed of in soil and water cause major pollution problems. The sugar industry plays an important role in the economic development of India, but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystems [1]. The effluents also alter the physico-chemical characteristics, and flora and fauna of receiving aquatic bodies. In addition, sugar factory effluent discharged in the environment poses a serious health hazard to the rural and semi-urban populations that use stream and river water for agriculture and domestic purposes. Fish mortality and damage to paddy crops due to sugar industry waste-waters entering agricultural land have been reported [2]. Sugar factory effluent that has not been treated properly has an unpleasant odor when released into the environment. Farmers using these effluents for irrigation to reduce water demand have found that plant growth and crop yield were reduced and soil health was compromised. Because sugar industry effluents are commonly used for irrigation, it is essential to determine how crops respond when exposed to industrial effluents. In this regard, efforts have been made to determine the effect of industrial effluents on seed germination of various crops such as maize [3], rice [4, 5], wheat [6], pine [7], Green gram [8] and catechu [9]. Seed germination is a critical stage that ensures reproduction and controls the dynamics of plant populations, so it is a critical test of probable crop productivity [10]. A laboratory experiment was designed to determine the effect of different concentrations (0-100%) of sugar industry effluent on seed germination in Mung (*Vigna angularis*), Chavali (*Vigna cylindrical*) and Jowar (*Sorghum cernum*).

2. MATERIALS AND METHODS

The effluent from a sugar industry located at Bhavninagar, Indapur, Pune (M.S.) India was collected in pre-cleaned, acid washed, 5 L carboys and stored in a refrigerator below 5°C until used. Temperature, pH, electrical conductivity (EC) and dissolved oxygen (DO) were measured immediately at the polluted site with help of a soil -water analysis kit. Physico-chemical properties such as total dissolved solids (TDS), chemical oxygen demand (COD), chloride, calcium, magnesium, sulfate, sodium and potassium were measured using APHA standard methods [11]. For bioassays, the effluent was diluted to 0%, 20%, 40%, 60%, 80% and 100% with distilled water. Seeds of Mung (*Vigna angularis*), Chavali (*Vigna cylindrical*) and Jowar (*Sorghum cernum*) were sterilized with 0.1% w/v mercuric chloride solution for 5 minutes to remove microbes and then washed three times with sterile distilled water. Plant seeds were spread on each sterilized Petri dish lined with blotting paper and then irrigated with 5 mL of the different concentrations of sugar industry effluent. Each treatment consisted of three replicate plates with forty seeds per plate. Observations were recorded at 24 hr intervals, the germinated seeds were counted

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and the number of germinated seeds was expressed as a percentage. The methods followed for data recording, calculation and analysis of seed germination speed are as follows: Peak value and germination value were determined by the formulae [7],

Peak Value = Cumulative percentage germination on each day/No. of days elapsed since initial imbibitions (1)

Germination value = Peak value × Germination percentage (2)

3. RESULTS AND DISCUSSION

The physico-chemical analysis data of the sugar industry effluent are given in Table 1. Some of physico-chemical parameters of the effluent were found to exceed those permissible by the Bureau of Indian Standards (BIS). The pH was relatively low due to the use of phosphoric acid and sulfur dioxide during clarification of sugar cane juice [12, 13]. The pH is an essential factor in the formation of algal blooms that makes the water unfit for irrigation; if the same water is used for irrigation over a large area, the soil becomes acidic resulting in poor crop growth and yield. Similarly, the effluent had a very high TDS, which was in agreement with the previous report of sugar factory effluent [14]. The COD value of the effluent was 1330 mg/L, while the recommended level set by BIS is 250 mg/L; the measured COD indicates the high organic load. The remaining measured parameters are within the permissible limits.

The percentage germination of crop plant seeds varied with respect to different concentrations of effluent (Table 2). The percentage of seeds germinating decreases as the effluent concentration increases. Chavali (*Vigna cylindrical*) seeds showed the most drastic reduction in seed germination percentage as the effluent concentration increased from 20% to 100% (Fig. 1).

The germination percentage value also decreased for the seeds of Jowar (*Sorghum cernum*) (Fig. 2), and Mung (*Vigna angularis)* (Fig. 3). Thus the germination value and percentage germination of each seed decreased with increase in effluent concentration. The percentage germination and germination value was maximum at the lower effluent concentrations of 20% and 40%. At lower concentrations (20% – 40%) of sugar factory effluent; 88-98% of the seeds of Mung and Jowar had germinated whereas in undiluted effluent the percentage germinations were 25.1% to 72.8% (Table 2). Lower concentration of effluent (25%) was shown to support 100% seed germination in kidney bean, and millet, but osmotic pressure associated with higher concentration of sugar factory effluent were found to reduce the germination in kidney bean and millet [15].

Table 1 The Physico-chemical characteristics of sugar industry effluent.

Sr. No.	Parameter	Value	BIS, Indian Standards
1	Temperature (^{0}C)	26.2	40
2	pH	4.35	6.5-8.5
3	Electrical Conductivity (μmhos/cm)	3400	300
4	Total dissolved solid (mg/L)	720	500
5	Ca (mg/L)	8.0	75
6	Mg(mg/L)	1.2	-
7	Dissolved oxygen (DO) (mg/L)	4.9	4 to 6
8	COD(mg/L)	1330	250
9	Chlorides(mg/L)	174	250
10	Sulphate(mg/L)	182	200
11	Sodium(mg/L)	125	200
12	Potassium(mg/L)	70	-

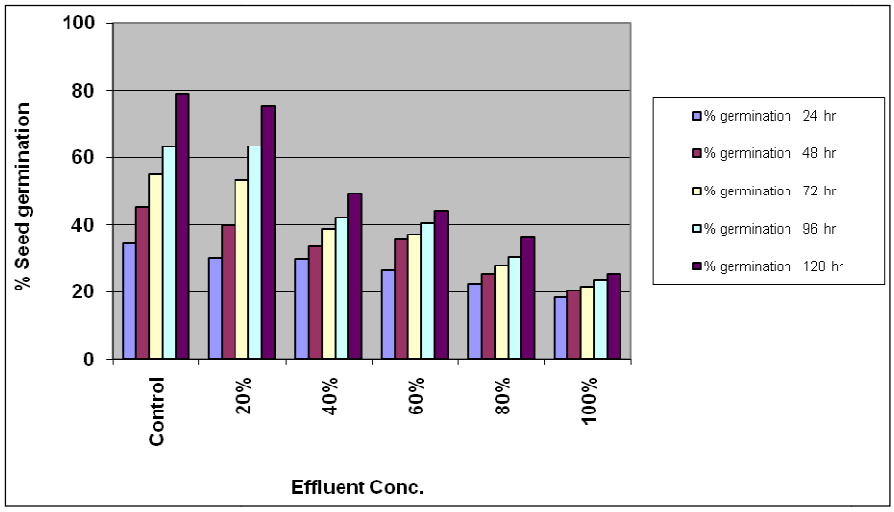

Figure 1 Percentage seed germination of Chavali at different effluent concentrations.

Table 2 Percentage seed germination and germination value with treated sugar industry effluent

Effluent concentration	Germination Percentage (120 hrs)			Germination value		
	Mung	Chavali	Jowar	Mung	Chavali	Jowar
Control (0%)	98.2	78.9	94.2	597.5	881.1	765.1
20%	98.3	75.2	90.0	408.8	848.2	806.4
40%	88.1	49.0	89.6	373.3	236.9	850.8
60%	83.3	44.1	63.0	346.0	196.8	349.8
80%	78.4	36.2	53.3	308.5	127.7	211.3
100%	72.8	25.1	40.0	294.4	42.5	117.0

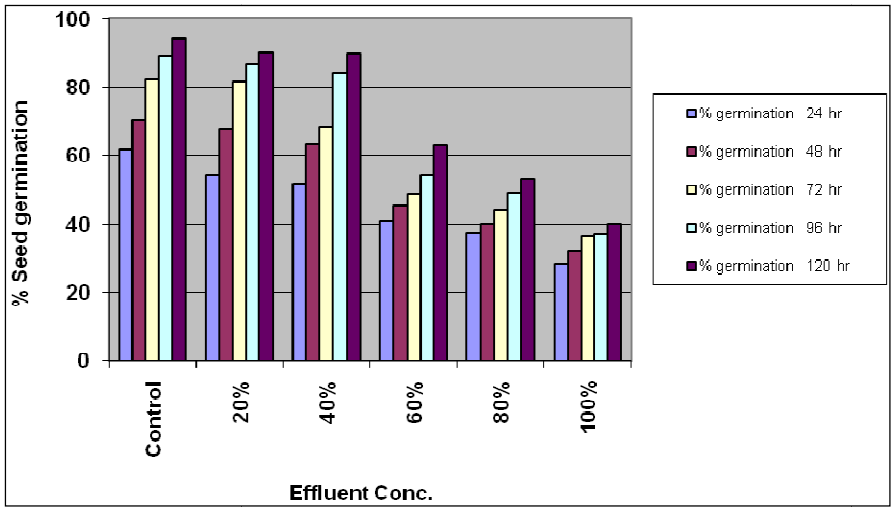

Figure 2 Percentage seed germination of Jowar at different effluent concentrations.

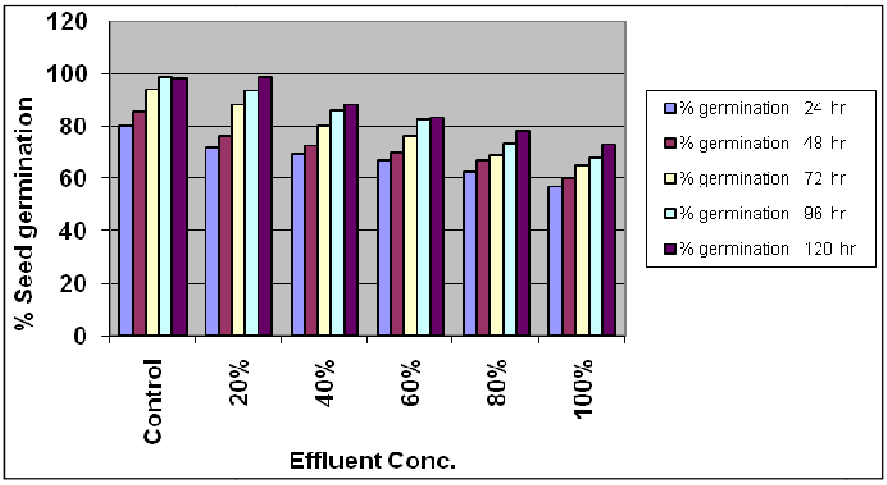

Figure 3 Percentage seed germination of Mung at different effluent concentrations.

4. CONCLUSIONS

This study concluded that physico-chemical parameters such as pH, electrical conductivity, COD, chloride, hardness, calcium, magnesium, sulfate and TDS were relatively high in the sugar factory effluent and severely affected seed germination. There was a gradual decrease in the percentage seed germination and germination value with sugar industry effluent concentration. The untreated sugar industry effluent could possibly lead to soil deterioration and low productivity. Terrestrial and aquatic environmental pollution could be averted by proper treatment of the effluents using suitable conventional methods. In conclusion, sugar industry effluent concentration governs seed germination. The effects vary from crop to crop because each plant species has its own tolerance of the different effluent concentrations.

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