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Comparative study of untreated and bioremediated sugar industry effluent for Irrigation with reference to biochemical attributes of *Triticum astevium*

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ABSTRACT

In the present investigation, in situ was conducted to determine the comparative phytotoxic effects of untreated and bioremediated sugar industry effluent with immobilized Spirogyra sp. The present research work includes the effects of different concentrations viz., 25%, 50%, 75% and 100% of sugar industry wastewater and bioremediated wastewater on percentage of seed germination, shoot length, root length, and some biochemical parameters viz., chlorophyll, protein, total carbohydrates, starch and free amino acids of Triticum astevium (Wheat).The results of this research work revealed that, using undiluted effluent no seed germination was observed even after 7 days while in 75% diluted effluent 90% seeds were germinated after 7 days. By using bioremediated waste water, 100% seed germination was observed only after 3 days. The shoot length, root length and biochemical parameters showed inhibitory effects with increasing concentration of effluent. In case of bioremediated wastewater, strikingly most of the parameters showed stimulatory effects as compared to control.

Keywords: Sugar industry, Wastewater, Bioremediation, *Spirogyra sp.*, *Triticum astevium*, Stimulatory effects, Inhibitory effects.

INTRODUCTION

Increasing urbanization and industrialization in the developing countries like India pose severe problems in collection, treatment and disposal of effluents. However sugar mill have a great environmental impact upon the surrounding environment. Sugar industries rank second among the agro based industries in India. Sugar industry is seasonal in nature and operates for 120 to 200 days in a year. India is the largest producer of sugar in the world. There are more than 550 installed sugar industries in the country [16]. Sugar industries generate about 1000 liters of wastewater for every tonne of sugar cane crushed. Because of high BOD content, sugar industry wastewater depletes dissolved oxygen content of water bodies rendering them unfit for both aquatic life and human uses.

Water is essential to human health, economic growth, and environmentally sustainable development. Population growth combined with rapid agricultural and industrial development has not only increased the total demand of fresh water, but also resulted in increased waste into the watercourses causing deleterious effects on the environment. This has made natural water scarcity problem even worse. It is because water resources have been exploited to their maximum capacity [4, 8], and more and more water will be needed to satisfy water demand for human use in the coming decades [3].

In order to conserve the limited water resources and protect the environment, wastewater reuse is becoming more attractive. It has now become an option to relieve the demand of fresh water and environmental pressure and which will play an important role in future for water utilization patterns [5, 6]. Wastewater reuse has several benefits. After proper treatment, wastewater can be used for different purposes, such as agricultural irrigation etc. This will act as an additional source of water instead of traditional water sources to reduce the demand on fresh water supplies [1, 13].

Damage to crops due to sugar industry effluent leaching in agricultural land have been reported by various researchers. Farmers using the sugar industry effluent for irrigation purpose so as to reduce the burden on water demand have found that plant growth and crop yield were reduced and soil health was compromised. Sugar industry effluents are commonly used for irrigation, thus it becomes essential to determine how crops respond when they are exposed to industrial effluents. In this regards, efforts have been made to determine the effects of untreated and bioremediated sugar industry effluent on various parameters *viz*., seed germination, shoot length, root length and biochemical parameters of *Triticum astevium*.

MATERIALS AND METHODS

Bioremediation studies

A Bioremediation study was performed in 250 ml conical flask containing 100 ml of effluent sample and 10 ml of immobilized beads of algal cells. The flask was incubated for 10 days at room temperature. The samples were collected after 10 days of treatment.

Experimental design for germination test

For germination tests, 10 seeds of *Triticum astevium* (wheat)crop were placed in sterilized glass Petri dishes of uniform size lined with two filter paper discs. These filter paper discs were then moistened with 5 ml of tap water for control, and with the same quantity of various concentrations of the sugar industry effluent like 25, 50, 75 and 100%with distilled water and bioremediated samples. The Petri dishes were incubated at 30±1^{o}C in an incubator. Germination was recorded daily at a fixed hour, and the emergence of the radical was taken as a criterion of germination.

Phytotoxicity study

The phytotoxicity studies were carried out at room temperature using *Triticum astevium* seeds followed by watering separately with 5 ml effluent sample of various concentrations and 5 ml of treated effluent per day. A control set was also kept by using tap water.

Biochemical estimation

Chlorophyll content was estimated by Arnon's method [2]. Total chlorophyll was calculated for each sample using the Arnon's formula. Protein contents were estimated by the Lowry *et* al. method [10]. The total carbohydrate and starch contents were estimated by the Anthrone reagent method [7]. The total free amino acids were estimated by the Ninhydrin method [12].

RESULTS AND DISCUSSION

In the diluted and bioremediated effluent, pollution load of the effluent was decreased. The effluent at lower concentration can serve as a liquid fertilizer for the cultivation of agricultural crops. The biochemical parameters like chlorophyll, protein, carbohydrate, starch and amino acids showed stimulatory effects when diluted and treated wastewater was used. All the results of this experiment exhibited in figure 1 to 7, revealed that as the concentration of sugar industry effluent increases the damage to crop plants also increases.

Some researchers worked out the laboratory scale experiments to observe the effects of different concentrations (0, 6.25, 12.5, 25, 50, 75, and 100%) of both textile effluents untreated and treated on seed germination(%), delay index, plant shoot length and root length, plant biomass, chlorophyll content and carotenoid of three different species of wheat. The textile effluent hasn't shown any inhibitory effect on seed germination at low concentration (6.25%). Seeds show germination in 100% effluent but did not survive for longer period [9].

Some workers studied the biochemical profile of water hyacinth prior to and after its growth in the aqueous solution containing selenium showed adverse effect on chlorophyll a, chlorophyll b, total chlorophyll, protein, carbohydrate, starch and free amino acids. Selenium showed stimulatory effects at 5 mg/L and 10 mg/L for all the observed parameters. However selenium showed adverse effects at 20 and 50 mg/L concentrations for all the observed parameters [14].

Several researchers showed the effects of metal on chlorophyll, protein, carbohydrate, starch, and amino acid. Such study revealed the inhibitory as well as stimulatory effects of the used metals depending on concentration of the metals. Different organisms, however, have different sensitivities to the same metal, and the same organism may be more or less damaged by different metals [11, 15].

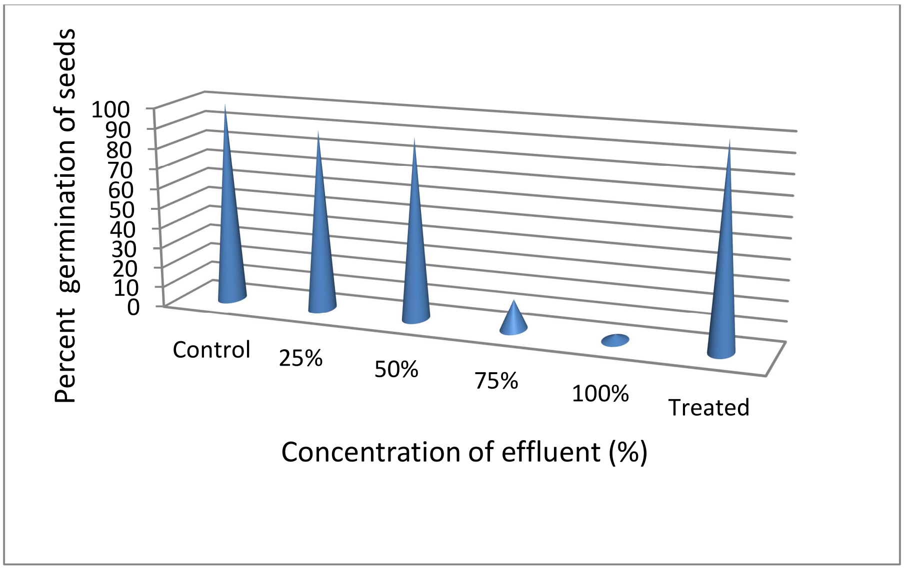

Figure 1. Effects of various concentrations and treated effluent of sugar industry on percent seed germination of *Triticum astevium*

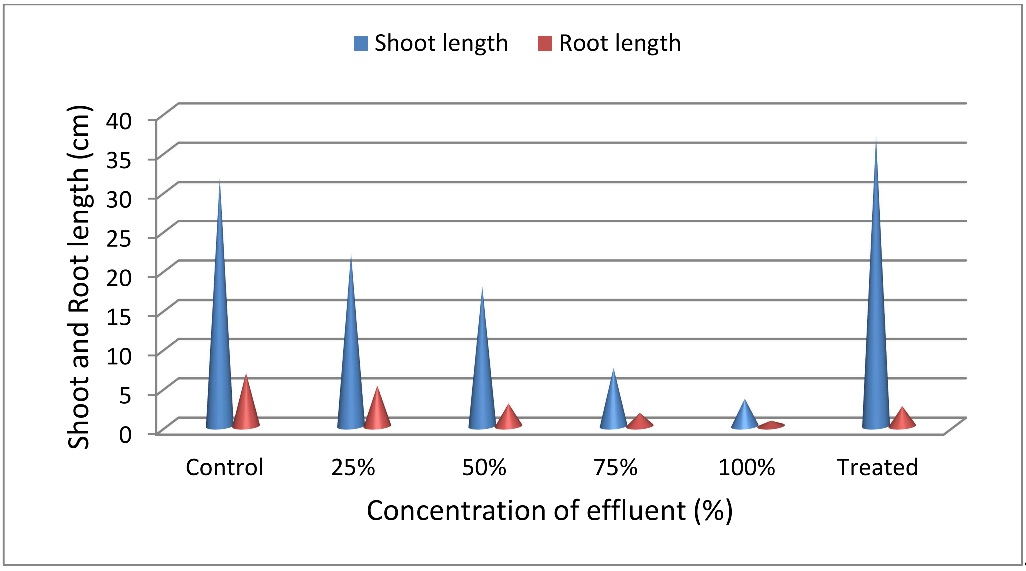

Figure 2. Effects of various concentrations and treated effluent of sugar industry on shoot and root length of *Triticum astevium*

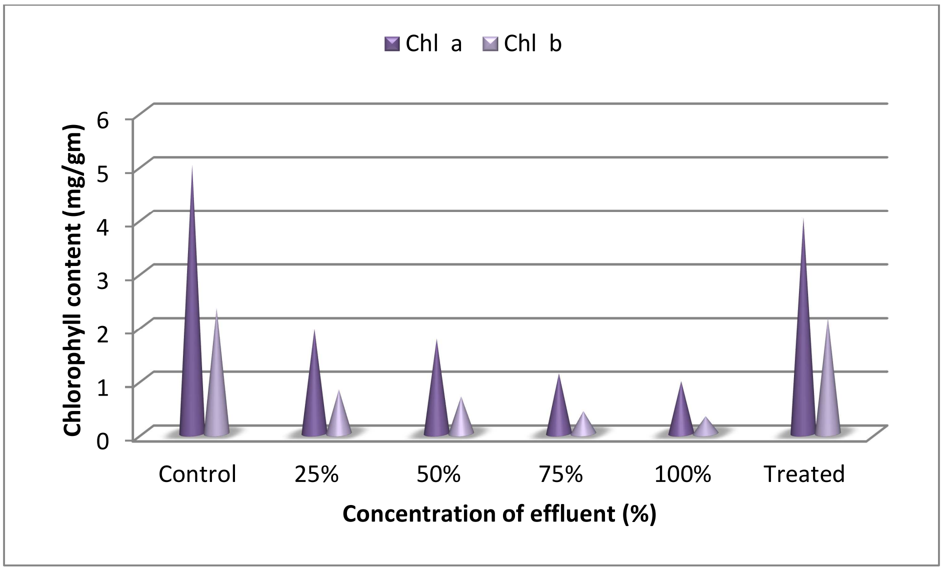

Figure 3. Effects of various concentrations and treated effluent of sugar industry on chlorophyll content of *Triticum astevium*

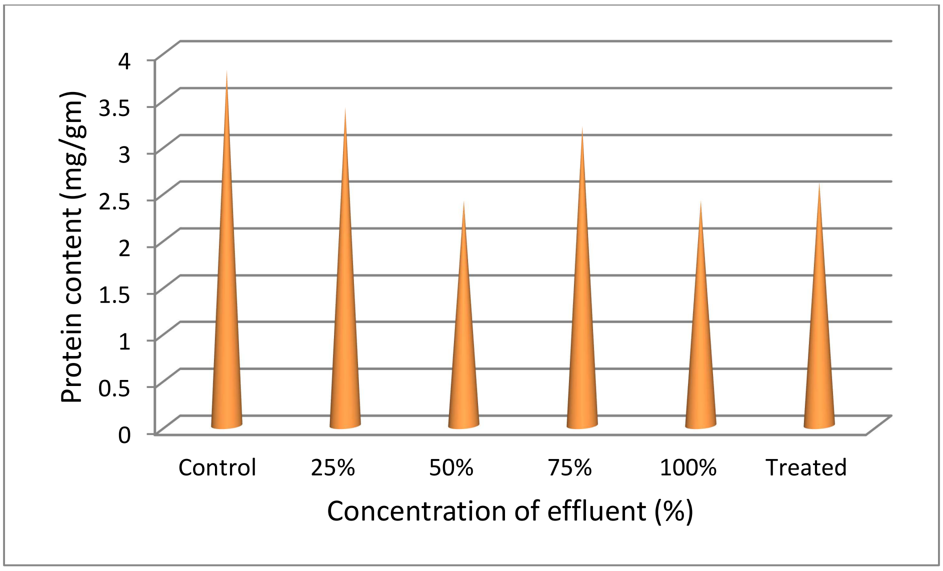

Figure 4. Effects of various concentrations and treated effluent of sugar industry on protein content of *Triticum astevium*

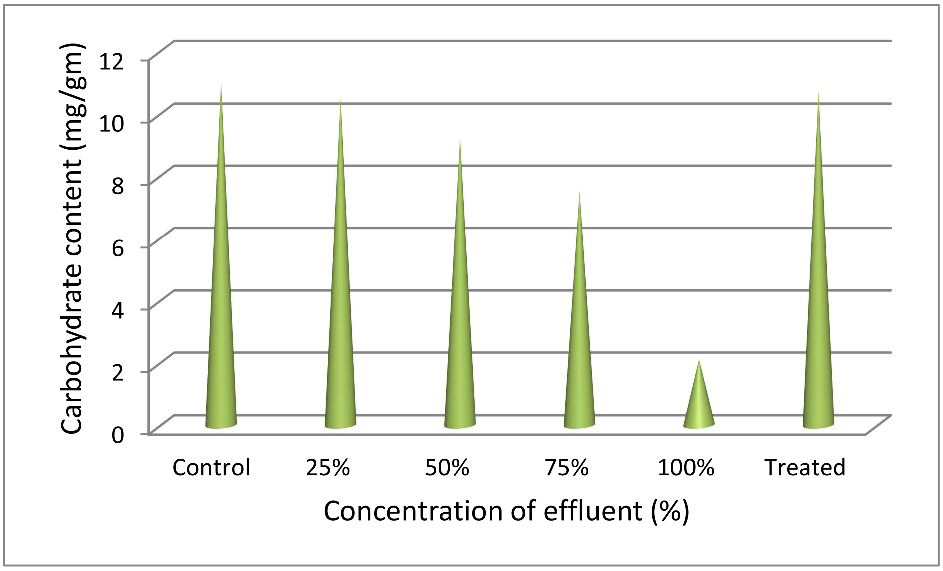

Figure 5. Effects of various concentrations and treated effluent of sugar industry on carbohydrate content of *Triticum astevium*

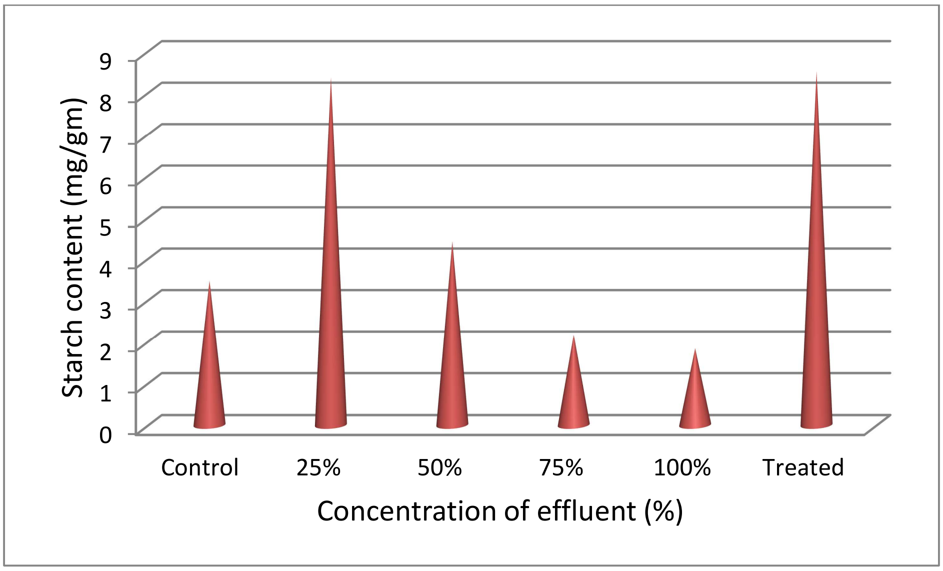

Figure 6. Effects of various concentrations and treated effluent of sugar industry on starch content of *Triticum astevium*

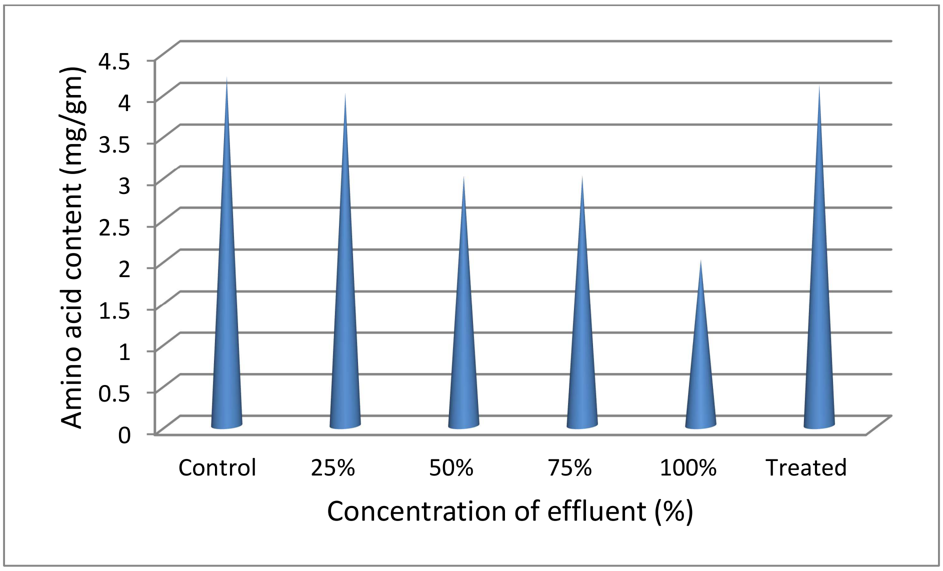

Figure 7. Effects of various concentrations and treated effluent of sugar industry on total amino acids content of *Triticum astevium*

CONCLUSION

The use of bioremediated sugar industry effluent for crop plant nourishment would be beneficial as alternative resource to fresh water. The overall performance exhibited by *Triticum astevium* subjected to bioremediated effluent, showed that, treated sugar industry wastewater is a prospective source of different plant nutrients. Thus, bioremediated sugar industry effluent can be used for irrigation purpose in agricultural practices.

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