



Amelioration of sugar mill effluent on morphological and biochemical constituents of Moth bean – *Vigna aconitifolia* (JACQ.) Marechal

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Abstract

Sugar industry effluent is a very important agro-based industry in India and discharges large amount of into water bodies which affects the plants and other living organism. In the present investigation, the physio-chemical analysis of sugar industry effluent was determined and the impact of different concentrations of [control 0, 25, 50, 75, 100 %] sugar mill effluent on seed germination behaviour of Moth bean (*Vigna aconitifolia*) was studied. In addition, we also analysed the morphological parameters such as shoot length, root length, fresh and dry weight, photosynthetic pigments and biochemical compounds were calculated. The results recorded for the analysis of sugar mill effluent indicated some parameters such as pH, EC, sulphate, copper, potassium, sodium, chlorine exceeded the permissible limit compared to TNPCB (Tamil Nadu Pollution Control Board). The morphological parameters, photosynthetic pigments and biochemical compounds increased in lower concentration of sugar mill effluent. Thus lower concentration of effluent may be used as a liquid fertilizer for agricultural purpose.

Keywords: moth bean, effluent, sugar industry, total sugar, biochemical

Introduction

Environmental pollution is one of the primary issues of the globe. Industrialization is the main cause for environmental pollution. It is very essential for developing country on the other side it discharge hazardous materials into environment. Water is mainly affected by industries due to huge amount of effluent released into water bodies. It changes the physico-chemical properties of water and harmfully affected plants and other living organisms. In fact, industrial waste and other different human activity waste have emerged as one of the main reasons of pollution of water bodies. Human-induced activities can alter the natural source of contaminants and also initiate pollution load in the receiving water bodies [1]. The corrosion of groundwater quality affects its usage for domestic, agriculture and industrial activities [2, 3]. Approximately, one-third of death and 80% of diseases in the developing nations are caused by the drinking of contaminated water [4]. Industries are categorized into three types such as Red (high polluting industry), Orange (polluting industry) and Green (moderately or non-polluting industry) based on produced hazardous wastes into environment by Ministry of Environment and Forests, India. Industries are huge amount of waste water release into nearby water bodies and it affects the nature of water [5]. Sugar mill is coming under red category and is one of the vital agro-based industries in India and is notably answerable for creating substantial impact on rural economic system but it released large amount of effluents at some stages in sugar manufacturing. The sugar factory effluent has obnoxious odour and unpleasant colour, when it is released into the environment without proper treatment. Farmers have been using these effluents for irrigation and found that the growth, yield and soil health were reduced. The

contaminants like chloride, sulphate, phosphate, magnesium and nitrate are discharged with the effluent by various industries, which create nuisance by the way of physical appearance, odour and taste. Such harmful water is injurious to plants, animals and human beings. *V. aconitifolia* (Moth bean) is a draught resistant legume, belonging to the family Fabaceae, stem herbaceous, cylindrical, hairy with dense-packed branches. Leaves trifoliate, vary in shape, deeply lobed, oblong, acute hairy. Flowers yellow. They are commonly grown in arid and semiarid regions of India. It is exceptionally hardy legume and known by various other names including mat bean, matki, Turkish gram, or dew bean. India's driest state, Rajasthan is the major moth bean growing state contributing almost 86% area of the country. The present study is focused on impact of sugar mill effluent on morphological and biochemical changes of *V. aconitifolia*.

2. Material and methods

2.1 Collection of seeds and culture conditions

Seeds of *V. aconitifolia* were collected from seed store of Tamil Nadu Agricultural University, Coimbatore. The seeds were as showed and seedlings grown individually in polythene bags (7"× 5") filled with homogenous mixture of garden soil containing red soil, sand and farm yard manure (1:2:1). The seeds were irrigated with tap water and maintained in the Botanical Garden, PSG College of Arts & Science, Coimbatore.

2.2 Effluent treatment and experimental design

30 days old, mature and healthy seedlings were selected for sugar effluent treatment. The preliminary experiments were carried out in *V. aconitifolia* at different concentrations of

sugar effluent (0, 25, 50, 75, 100 %) in order to determine the viable range of sugar. Above 75% the seedlings did not survived. The experimental plants treated with sugar effluent by soil drenching method up to 100% were alone maintained in the experimental plot. The experimental yard was roofed with transparent polythene sheet at a height of 3m from the ground in order to protect the plants from rain. The morphological, photosynthetic pigments and biochemical content were estimated.

3. Results

The various morphological and biochemical parameters analyzed exhibited significant variations in the plants grown under sugar mill effluent.

3.1 Morphological and Photosynthetic pigments

The maximum shoot and root length number of leaves and roots, leaf area, fresh weight and dry weight was observed in 25% concentration and minimum in 100% effluent. The photosynthetic pigments such as chlorophyll and carotenoid showed a significant decrease under increasing sugar mill effluent) Table 1, 2, 3, 4 & 5).

Table 1: Effect of sugar industry effluent on shoot and root length of *V. aconitifolia*

Treatment	<i>Vigna aconitifolia</i>	
	Shoot Length (cm)	Root Length (cm)
Control	17.4 ± 0.1	3.8 ± 0.1
25 %	18.1 ± 0.1	6.1 ± 0.1
50 %	14.8 ± 0.1	4.5 ± 0.1
75 %	16.4 ± 0.1	4.6 ± 0.1
100 %	13.1 ± 0.1	3.7 ± 0.1

Table 2: Effect of sugar industry effluent on number of leaves and roots of *V. aconitifolia*

Treatment	<i>V. aconitifolia</i>	
	Number of Leaves	Number of Roots
Control	13 ± 0.1	8 ± 0.1
25%	17 ± 0.1	5 ± 0.1
50%	18 ± 0.1	5 ± 0.1
75%	10 ± 0.1	6 ± 0.1
100%	9 ± 0.1	5 ± 0.1

Table 3: Effect of sugar industry effluent on leaf area of *V. aconitifolia*

Treatment	<i>V. aconitifolia</i>
	Leaf Area (cm ²)
Control	3.14 ± 0.01
25 %	4.62 ± 0.01
50 %	3.58 ± 0.01
75 %	4.38 ± 0.01
100 %	2.97 ± 0.01

Table 4: Effect of sugar industry effluent on total fresh and dry weight of *V. aconitifolia*

Treatment	<i>V. Aconitifolia</i>	
	Fresh weight (g)	Dry weight (g)
Control	0.482 ± 0.001	0.082 ± 0.001
25 %	0.974 ± 0.001	0.138 ± 0.001
50 %	0.774 ± 0.001	0.103 ± 0.001
75 %	0.742 ± 0.001	0.124 ± 0.001
100 %	0.282 ± 0.001	0.055 ± 0.001

Table 5: Effect of sugar industry effluent on chlorophyll and carotenoid content in leaves of *V. aconitifolia*

Treatment	<i>V. aconitifolia</i>	
	Chlorophyll (mg/g fr.wt)	Carotenoid (mg/g fr.wt)
Control	1.542 ± 0.001	1.054 ± 0.001
25 %	1.608 ± 0.001	0.673 ± 0.001
50 %	1.562 ± 0.001	0.907 ± 0.001
75 %	1.498 ± 0.001	1.018 ± 0.001
100 %	1.412 ± 0.001	1.307 ± 0.001

3.3 Biochemical constituents

There were prominent changes observed in the starch content of *V. aconitifolia* leaf, stem and root. Starch contents were decreased in the concentration 25% as 0.408 and gradually increased in 100% sugar effluent concentration. Total sugar content showed a decreasing trend with progressive increase in sugar mill effluent concentration. The increased value was noted in concentration 25% and decreased in concentration 100% as 1.211. Sucrose content decreasing trend with progressive increase in sugar mill effluent concentration. The increased value was noted in concentration 25% as 0.772 and decreased in concentration 100%. There were some changes observed in protein content of *V. aconitifolia* when treated with different concentration of sugar mill effluent. Protein content were increased in concentration 25% as 0.392 and decreased in the concentration 100%. There were some changes observed in amino acid content of *V. aconitifolia* when treated with different concentration of sugar mill effluent. Amino acid content were increased in concentration 75% as 1.497 and decreased in the concentration 100%. The higher concentration of sugar mill effluent contains high amount of proline content in concentration 100% as 1.975 and control contains low amount of proline (Fig 71, 2, 3, 4, 5 & 6).

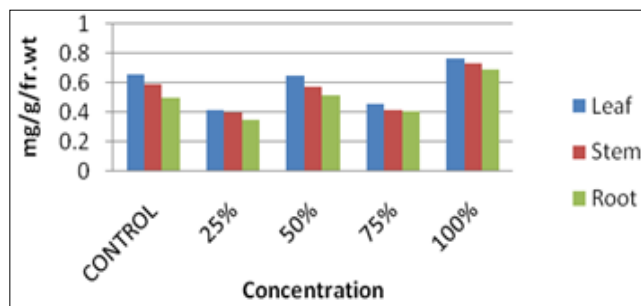


Fig 1: Effect of sugar industry effluent on free sugar content of *V. aconitifolia*

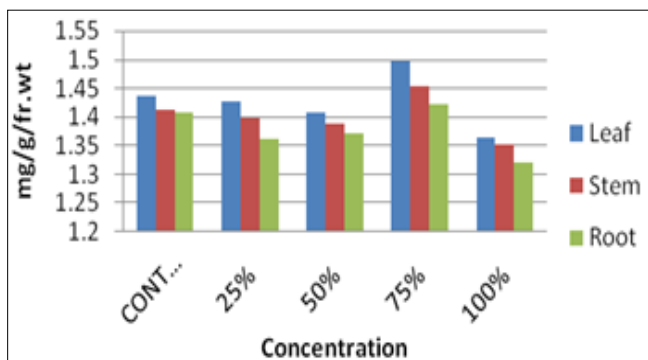


Fig 2: Effect of sugar industry effluent on amino acid content of *V. aconitifolia*

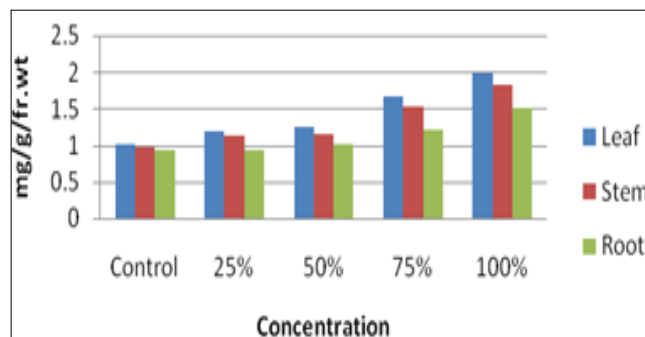


Fig 3: Effect of sugar industry effluent on proline content in *V. aconitifolia*

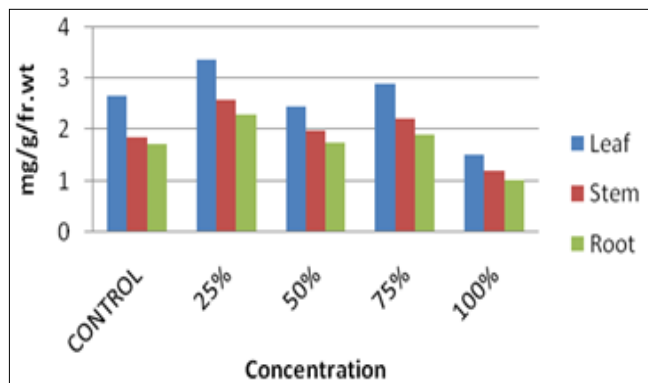


Fig 3: Effect of sugar industry effluent on starch content in *V. aconitifolia*

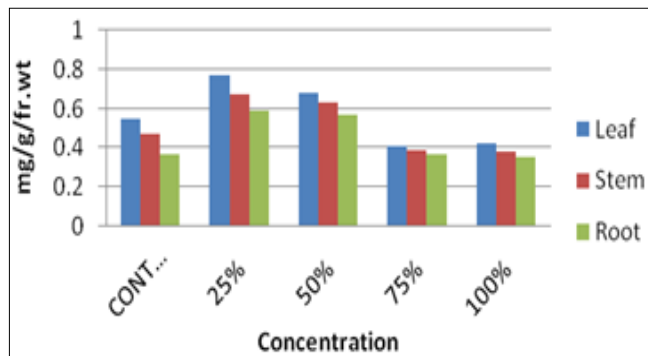


Fig 4: Effect of sugar industry effluent on sucrose content of *V. aconitifolia*

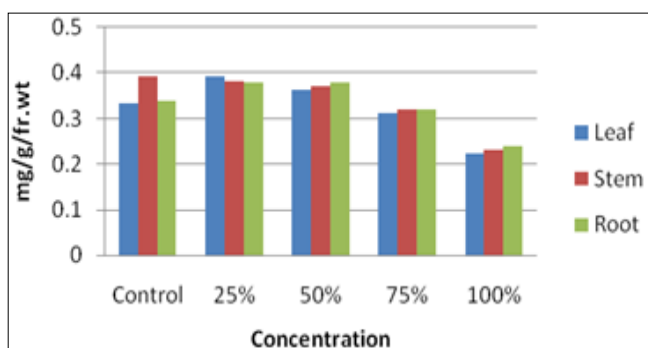


Fig 5: Effect of sugar industry effluent on protein content in *V. aconitifolia*

4. Discussion

Now a days treated waste water is considered as a potential water resource because it contains considerable amount of nutrients which may prove beneficial for plant growth [6, 7] and hence the use of waste water in agricultural is gaining importance rapidly. In present study agricultural crop *V. aconitifolia* was subjected to sugar mill effluent throughout the experiment to reveal the responses of morphology & biochemical contents, In general, sugar mill effluent enhance or had no effect on growth and biochemical parameters. Sugar mill effluent does not significantly affect the shoot and root length, fresh and dry weight of the plants rather they showed some changes in the biochemical properties in the present study when treated with low concentration of sugar mill effluent. The lower concentration of sugar mill effluent (25%) promoted the shoot and root length of the plants similar observations were obtained by [8]. [8] stated that high concentration of sugar industrial effluent inhibited the root and shoot length of seedling. The fresh and dry weight of the seedling increased at 10% of sugar mill effluent concentration while decreased at higher concentration of sugar mill effluent. The interference of heavy metals decreases the root and shoot length of the plant might be due to effect of physiological processes of plant and it also involved in inhibition of enzyme activities affected the nutrition, water imbalance and alteration of hormonal status changed the membrane permeability [9, 10] reported that higher concentration of effluent causes delayed shoot growth, seedling growth and chlorophyll content in sun flower (*Helianthus annus*) and it could be safely used for irrigation purpose at low concentration. [11]. reported the significant increase in the sapling height in the treatment irrigated with municipal raw sewage in the species of *Casuarina glauca*, *Eucalyptus camaldulensis* and *Tamarix aphylla*. The availability of water and nutrients probably had positive effects on shoot growth [12]. Vegetative growth of *Zea mays* was lowered at higher concentration of sugar mill effluent. A high EC indicates higher salt content in the higher sugar mill effluent concentrations, which lowered the plant height, root length, number of leaves, fresh weight, chlorophyll content, and leaf area index of the plant *Zea mays* [13]. The lower concentration of sugar mill effluent (25%) increased the photosynthetic pigments like chlorophyll and carotenoid the similar observations were obtained by [14]. [15] reported that treated effluent irrigation increases chlorophyll and protein contents in pearl millet plants (*P. glaucum*) at the

25% and 50% sugar mill effluent concentrations followed but a decrease in 75% and 100%.

Total sugar content showed a decreasing trend with progressive increase in the sugar mill effluent concentration in *V. aconitifolia*. However 25% effluent concentration produced positive effect on the sugar content. The same trend was recorded with treatment implies the derange starch metabolism and poor translocation of sugar to growing parts by [16, 17]. Amino acid and protein content of *V. aconitifolia* were higher at lower concentration 25% of sugar mill effluent. Further the values decreased with a gradual increase in effluent (50%, 75%, 100%). Similar results were observed by [14]. Decrease in free amino acid at high salinity concentrations can be attributed to the inhibitory effect of the effluent on protease activity [18, 19]. The significant increase in the protein content of plant might be due to the potassium and nitrate in their optimum quantity present in the lower concentration of the effluent as reported by [20].

The higher concentration of sugar mill effluent treated plant contained more amount of proline content when compared to lower concentration. Similar results were observed by [21]. Exposure of plants to sugar mill effluent promoted the accumulation of proline. The accumulation of the proline has been frequently used as a biochemical marker for stress tolerance in plants [22, 23]. Aside from acting as a metal chelator and osmolyte, proline has been reported to scavenge hydroxyl radicals and singlet oxygen, thus providing protection against ROS- induced cell damage [24, 25]. Thus the effluent after diluting up to 25% can be used for irrigation as soil fertilizers for the better growth, biochemical and yield of moth bean. In the beneficial effluent concentrations, 50% was also better.

5. Conclusion

Effluent at 25% and 50% concentration favoured the plant growth and increased the biochemical contents. This may be attributed to the optimum levels of inorganic nutrient and reduction in toxicity level due to dilution. Thus the effluent after diluting up to 25% can be used for irrigation as soil fertilizers for the better growth, biochemical and yield of moth bean. In the beneficial effluent concentrations, 50% was also better.

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