

## Impact of sugar industrial effluent on the growth factor of black gram

<sup>1</sup> Durgadevi R, <sup>\*2</sup> Sumathi S

<sup>1</sup> Department of Biochemistry, Dharmapuram Gnanambigai Govt. Arts College For Women's, Mayiladuthurai, Tamil Nadu, India

<sup>2</sup> Assistant Professor, Department of Biochemistry, Dharmapuram Gnanambigai Govt Arts College For Women's, Mayiladuthurai, Tamil Nadu, India

### Abstract

Sugar industry is the backbone of rural economy of India. Sugar mill industry releases huge amount of effluent. In this study we have tried to evaluate the impact of sugar mill effluent on physical parameters and biochemical studies of black gram. Shoot length, root length, plant height, number of leaves, leaf length, carbohydrates, proteins, amino acids, chlorophyll, moisture, ash, iron and reducing sugar were also calculated. Results showed that the physical parameter and biochemical studies of black gram decreased in sugar mill effluent plant compared with normal water plant. Thus the present study can be concluded that the effluent cannot be utilized for irrigation.

**Keywords:** sugar mill effluent, physical parameter, biochemical studies

### 1. Introduction

Sugar industry is one of the most important agro based industries in India and is highly responsible for creating significant impact on rural economy in particular and countries economy in general. Sugar industries rank second among the agro based industries in India. Sugar industry is seasonal in nature and operates only for 120 to 200 days in a year. A significant large amount of waste is generated during the manufacture of sugar and contains a high amount of production load particularly in items of suspended solids, organic matters, effluent, sludge, press mud and bagasse (Muthusamy *et al.*, 2012) <sup>[1]</sup>.

Among the various industries, sugar mill is one of the largest and most important agro based industries in India. It plays a major role in creating rural economy of the country as a whole. The sugar mill operates for 3 to 6 months per year. A considerable amount of waste water is released during crushing of sugar cane. These wastewaters are disposed into nearby water bodies and they are being used for irrigation. The discharge of this effluent into water bodies or on soil is causing a serious problem of water pollution resulting in severe damage to the flora and fauna and environmental degradation. Besides, the heavy metals are non-biodegradable and persist for longer periods in aquatic as well as terrestrial environments thus they can exert detrimental effect on human health and environment due to the toxicity of heavy metals (Maliwal *et al.*, 2004) <sup>[2]</sup>.

### 2. Materials and methods

#### 2.1. Collection of sugar mill effluent

The sugar mill effluent was collected from the Co-operative sugar mill at Thalainayiru, Nagapattinam District, Tamil Nadu. The fresh samples were collected in a sterile plastic cane for this study. The sample was brought to the laboratory to keep for the further analysis.

#### 2.2. Collection of seeds

Healthy certified seeds of black gram were procured from seed seller in Nagapattinam.

#### 2.3. Growth parameters

The growth parameters such as plant height, root length, shoot length, leaf length and number of leaves were measured at the end of 10<sup>th</sup> day, 20<sup>th</sup> day and 30<sup>th</sup> day.

#### 2.4. Biochemical studies

Estimation of carbohydrate (Thomas *et al.*, 1956) <sup>[3]</sup>, Estimation of protein (Lowery *et al.*, 1951) <sup>[4]</sup>, Estimation of amino acids (Moore *et al.*, 1948) <sup>[5]</sup>, Estimation of reducing sugars (Miller, 1972), Estimation of chlorophyll (Arnon *et al.*, 1949) <sup>[7]</sup>, Determination of ash content (Ghulam dastagir, 2013) <sup>[8]</sup>, Determination of moisture content (Shumaila and Mahpara, 2009) <sup>[9]</sup>, Estimation of iron (Abolfazl and Ebrahim, 2013) <sup>[10]</sup>.

### 3. Results and Discussion

The wastewater from industries has various negative impacts on the surrounding ecosystem due to lack of effluent treatment plants, improper disposal and management practices for wastewater, and presence of toxic substances in wastewater in deleterious amount. The problem due to wastewater is much more serious, nearby the disposal site of industrial wastewater, where its disposal was performed without any treatment. This practice of disposal may cause various harmful effects on agro-ecological situations depending on characteristics of wastewater (Gautam and Bishnoi, 1992) <sup>[11]</sup>.

**Table 1:** Physico-chemical parameters of the sugar mill effluent

S.No	Name of the parameter	Sample
1	Colour	Deep brown
2	Odour	Dis. Agre
3	Turbidity	Highly turbid
4	pH	6.80
5	Temperature	26 <sup>o</sup> C

The physico-chemical properties of the sugar mill effluent is shown in table 1. It is brown in colour and

decaying molasses smell and acidic in nature.

**Table 2:** Effect of sugar mill effluent on the physical parameters of black gram.

S.No	Parameters	The growth of Plant in Normal Water (control)			The growth of Plant in Sugar mill effluent		
		10 <sup>th</sup> day	20 <sup>th</sup> day	30 <sup>th</sup> day	10 <sup>th</sup> day	20 <sup>th</sup> day	30 <sup>th</sup> day
1	Plant length	23.5 cm	31.5 cm	35 cm	14.3 cm	17 cm	20 cm
2	Root length	7.5 cm	9.0 cm	10 cm	6 cm	5.5 cm	5 cm
3	Shoot length	16 cm	22.5 cm	26.5 cm	8.3 cm	11.5 cm	15 cm
4	Leaf length	2 cm	4 cm	5 cm	3.5 cm	4 cm	4.5 cm
5	Number of leaves	2	4	8	2	2	3

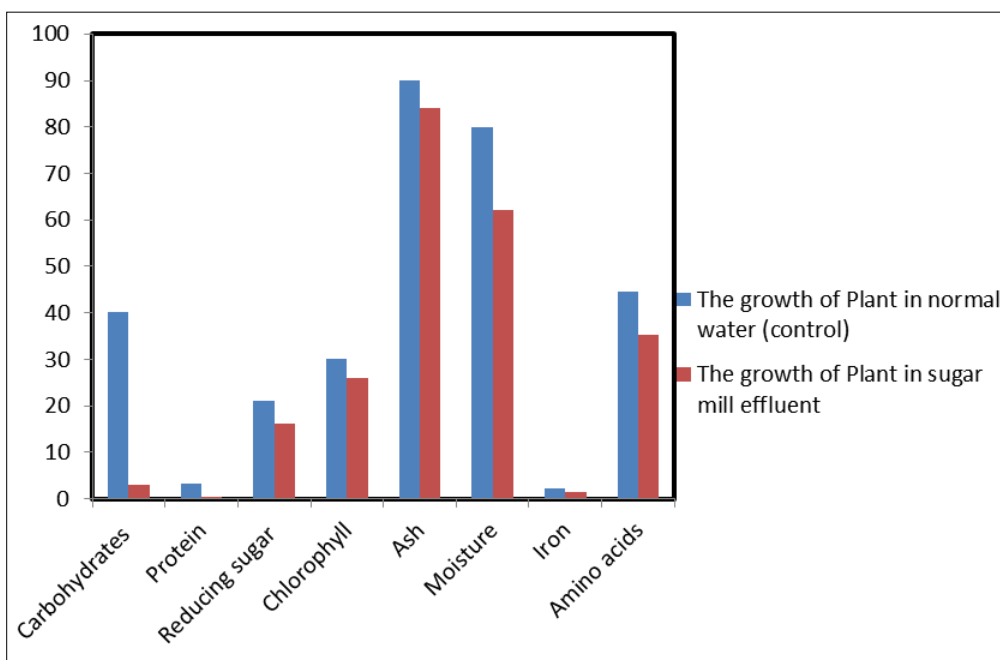
Scoccianti *et al.*, (2006) [12] and stated that the negative effect of wastewater on root and shoot fresh weight may probably due to that these metals decrease the root water uptake and relative water content, damage plant roots and inhibited uptake of nutrient, thus inhibiting normal plant growth. According to Sandalio *et al.*, (2001) [13] the reduction of plant growth by Cd toxicity could be the direct consequence of the decreased uptake of nutrient elements, inhibition of various enzyme activities and induction of oxidative stress including alterations in enzymes of the antioxidant defense system.

Similar observations were obtained by Sahai *et al.*, (1979) [16], Singh and Mishra (1987) [15], Verma and Verma (1995) [14], Lakshmi and Sundaramoorthy (2000)

[19] and Rajesh *et al.*, (2013) [17] while studying the effect of various industrial effluents on germination studies of some agricultural crops. The increase in germination study parameters at lower concentration may be due to presence of growth promoting nature of nutrients in the diluted effluent. The reduction in germination and seedling growth at higher concentrations of effluent are due to the presence of excess amount of minerals present in the effluent. These excess amount of minerals inhibit the germination and growth by interfering the metabolic activities during germination and growth (Biradar *et al.*, 1989 [20]; Srivastava *et al.*, 1988 [22]; Verma and Verma, 1995 [14]; Kaushik *et al.*, 2004 [21]; Siva Santhi and Suja Pandian, 2012) [18].

**Table 3:** Effect of sugar mill effluent on the biochemical parameters of black gram.

S.No	Parameters	The growth of Plant in Normal water (control)	The growth of Plant in Sugar mill effluent
1.1.	Carbohydrates	40.2 ± 0.95	3.06 ± 0.043
2.	Protein	3.2 ± 0.95	0.43 ± 1.77
3.	Reducing sugar	21.1 ± 1.63	16.6 ± 1.56
4.	Chlorophyll	30 ± 1.36	26.6 ± 1.35
5.	Ash	90 ± 1.55	84 ± 1.32
6.	Moisture	80 ± 1.46	62 ± 1.27
7.	Iron	20.3 ± 8.14	8.3 ± 1.13
8.	Amino acids	44.6 ± 2.05	35.3 ± 1.24



**Fig 1:** Effect of sugar mill effluent on the biochemical parameters of black gram.



Fig 2: The growth of Plant in normal water at 10 th day



Fig 6: The growth of Plant in Normal water at 30 th day



Fig 3: The growth of Plant in sugar mill effluent at 10 th day



Fig 7: The growth of Plant in Sugar milleffluent at 30 th day



Fig 4: The growth of Plan in Normal water at 20th day



Fig 5: The growth of Plant in sugarmill effluent at 20<sup>th</sup> day

### 3.1. Carbohydrate

The results for carbohydrate content for black gram are depicted in Table 3 figure 1. The carbohydrate content was more in control and compared with sugar mill effluent. Amount of carbohydrate was  $40.2 \pm 0.95$  in plants with control and  $3.06 \pm 0.04$  in plants with sugar mill effluent respectively (Table 3). The decrease in sugar content may be due to the increase in the concentration of various cations and anions present in the effluent.

These results are in conformity with the results of Chandrasekar *et al.*, (1998) [23] and Swaminathan and Vaidheeswaran (1991) [24]. The increase in the amount of sugar might be either due to inhibition in starch synthesis from hexose or stimulation of starch hydrolysis was recorded by Murata *et al.*, (1969) [25].

### 3.2. Protein

Results presented in table 3 revealed that increasing concentration of protein content  $3.2 \pm 0.95$  in control compared with sugar mill effluent  $0.43 \pm 1.77$ . The increase in protein concentration (in control) may be due to enhanced activity of nitrite reductase and increased nitrogen utilizing efficiency. Increase in protein content in the biodegraded effluent treated seeds is observed. The bacterial strains release free nitrites which are utilized by the plants in making of the protein needed for their growth.

The protein content decreased with high concentration of cadmium chloride. Protein content under  $CdCl_2$  influence may be affected due to enhanced protein hydrolysis resulting

in decreased the protein content and protein synthesis becoming reduced under metals stress condition (Melnichuk Yu *et al.*, 1982) [26].

### 3.3. Reducing sugar

A pronounced reduction was observed in the reducing sugar  $16.6 \pm 1.56$  of black gram after being treated with sugar mill effluent.

The increase in sugar content in the black gram seedlings under different treatment of CdCl<sub>2</sub> solutions might be to overcome the Cd stress on plants by increasing carbohydrate synthesis (Krishnan *et al.*, 2014) [27].

The concentration of total soluble sugars and reducing sugars was maximum at higher concentrations of spray and drench treatments. This may be considered indicative of the fact that seaweed extracts stimulate various biological processes that increase the carbohydrate levels in tomato plants. Similar observations were recorded for *Vigna catajung* using 10% *Caulerpa racemosa* extracts (Anantharaj and Venkatesalu 2001) [28].

### 3.4. Chlorophyll

The chlorophyll content from table 3 showed a declining trend with the sugar mill effluent. The chlorophyll is one of the important biochemical content which is used as an index of production capacity of the plant. It may be due to the decrease in the chemical concentrations to an optimum level on the dilution of the textile mill effluent the increase in carotenoid content might be due to enhanced influence of nitrogen and other organic elements present in the effluent.

Reduction in chlorophyll content induced by effluent may be associated with mineral ions. Some of the possible reasons for the decrease in chlorophyll content may be the formation of enzyme such as chlorophyllase which is responsible for chlorophyll degradation (Rodriquez *et al.*, 1987; Krishna and Leelavathi, 2002.) [29, 30]. Iron, magnesium, potassium, zinc and copper are essential for the synthesis of chlorophyll (Rao and Kumar, 1983.) [31].

### 3.5. Moisture and Ash

The seeds of Black gram plants grown in some industrial effluents were analyzed for the moisture content. The lowest moisture was in sugar mill effluents ( $62 \pm 1.27$ ). The highest value of moisture content ( $80 \pm 1.46$ ) was recorded in seeds of plants grown in sugar mill effluents (Table 3). This may be attributed due to presence of an alkaline pH 7.9. The seeds collected from the plants grown in the industrial effluent were analyzed for ash. The result showed that ash content decreased with altering the water nature. The highest percent of ash was recorded in control ( $90 \pm 1.55$ ), while the lowest amount was in the marble effluents ( $84 \pm 1.32$ ).

### 3.6. Iron

Data shown in table 3 indicates that decreased Iron content in black gram ( $20.3 \pm 8.14$ ) as compared to sugar mill effluent ( $8.3 \pm 1.13$ ). Enhancement in chlorophyll content may be due to high nutrient uptake, synthesis and translocation probably facilitated by optimum availability of iron and magnesium and also due to reduction in phenol content in the treated effluent. Similar results are obtained by using distillery waste water (Srivastava, 1987) [32].

Fe is required for the functioning of a range of enzymes especially those involved in oxidation and reduction processes for synthesis of the porphyrin ring (chlorophyll and heme biosynthesis), reduction of nitrite, sulphate and N<sub>2</sub>-fixation (as part of leghemoglobin) (Zuo *et al.*, 2004) [33].

### 3.7. Amino acids

From the result shown, it is evident that the control plant ( $44.6 \pm 2.05$ ) shows higher amino acids content compared to that of sugar mill effluent plant ( $35.3 \pm 1.24$ ).

Amino acids play a central role in plant primary metabolism. Previous studies indicated that decrease in the mitochondrial electron transport activity accompanies increase in proline accumulation under heavy metal stress (Saradhi *et al.*, 1995) [34]. The induction of proline accumulation in response to abiotic stress may be due to increase in its de novo synthesis or decreased degradation (Kasai *et al.*, 1998) [35], and the effect of proline on the permeability of membrane (Pesci and Reggiani, 1992) [36]. Therefore, the increase of proline can be considered as an indicator of tolerance of heavy metal stress.

### 4. Conclusion

It may be further concluded that the release of industrial effluent causes many types of inhibitory effects on the plant growth, plant height, shoot length, root length, leaf length and number of leaves. This inhibition may also due to the presence of excessive amount of trace elements, major elements as well as other pollutants reduce the seedlings growth and the subsequently the weight of the seedlings. The biochemical studies like carbohydrates, protein, amino acids, ash, moisture, iron, chlorophyll and reducing sugar were found to be more in control and the contents gradually decreased in sugar mill effluent. On the overall basis performance as exhibited by black gram when subjected to sugar mill effluent, it produces a higher amount of water pollution. Because it contains large quantities of chemical elements. The untreated sugar mill effluent could possibly lead to soil deterioration and low productivity.

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