Analytical metrics of effluent discharged from a North Indian sugar mill and its impact on rice cultivar (HR-26)

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ABSTRACT

Emphasis in our country in recent time is been laid on staple nutrition for masses in their diet. In lieu of chemical fertilizers used customarily, efforts to raise various crops employing effluent in different dilutions discharged by sugar mills in vicinal areas is an important boosting step for national economy. In the present study, analysis of effluent from exit point near Dhampur Sugar mill in Meerganj town district Bareilly (UP North India) was done for various (a) physical parameters - colour, odour, temperature, transparency, pH, electrical conductivity (b) chemical parameters- Total dissolved solids, total alkalinity, total hardness, sodium, potassium, nitrate, nitrite, calcium, phosphate, sulphate, total nitrogen, magnesium, ammonium -N and oil & grease, (c) demand parameters such as dissolved oxygen, COD, BOD and the (d) heavy metals - cadmium, chromium, copper, lead, nickel, zinc, iron, cobalt and manganese. Various dilutions (0%, 25%, 50%, 75%, and 100%) of the effluent were prepared and fed to raise a recent and much popular rice cultivar (HR -26). Assessment of nutrient profile for various biochemical metabolites in the said cultivar was done. Inhibiting effect was observed beyond 50% concentration of the effluent on crude protein, total nitrogen, albuminoid-N, total lipid content, total carbohydrates and total ash except for total free amino acids where irregular trend and an insignificant status was noticed. The outcomes of the experiment may lead to suggest the agriculturists to use equally diluted effluents of sugar mill as a substitute of fertilizer for healthy growth of plants, yielding nutritive rice grains.

Keywords: Sugar mill effluent, rice, biochemical metabolites, physico-chemical parameters

INTRODUCTION

On account of day by day improving industrialisation followed by subsequent urbanization across the whole globe in developed as well as new developing countries, a great problem of environmental pollution has been seen behind these (Sail et al., 2006). Observation of disposals of waste water from various industries, whether treated or untreated, in various water bodies spreading across a large area is well seen all across (Chaurasia and Tiwari, 2011). This polluted water consequently effected various living beings nearby the water resources (Nath et al., 2005). High levels of nutrients as well as presence of hazardous heavy metals are frequently observed which directly or indirectly effect the physiological growth and chemical metabolites in the plants grown through agricultural practices (Avasan and Rao, 2000; Srivastava et al., 2015).

The huge amount of effluents are discharged in the nearby water bodies or are drained in the adjacent agriculture fields (Kolhe et al., 2008; Agarwal and Singh, 2017; Baskaran et al., 2009).

Alternatives to chemical fertilizers are being searched to achieve good quality cultivation of the crops especially usage of either bio fertilizers or the sugar mill industrial effluents (Kumar and Chopra, 2014; Vaithiyanathan and Sundaramoorthy, 2017) as because India holds a key position as a largest producer of sugarcane and also sugar producer in the world. This inturn can fetch optimum yield and maximum nutrition in the agri-diet available to the citizens, besides this, it could lead to utilisation of less capital in order to save national monetary resources (Ezhilvannan et al., 2011; Kumar and Chopra, 2013a). With stand point of nation betterment, diluted sugar mill effluents could be used as a substitute for chemical fertilizers as it could be absorbed by the roots easily and can even alter the metabolic mechanism (Kumar and Srikantaswamy, 2015; Rath et al., 2010).

A triggered positive escalation of the nutrients profile in grains of graminaceous and leguminous crop families is expected (Srivastava et al., 2015). Rice is a staple diet among all cereal crops grown in North India region as well as many East and South East tropical and subtropical provinces of the world for the residing people there (Chandrasekar et al., 1998). A study was undertaken, employing a recent rice cultivar (HR-26) as an experimental crop cultivated in 'Tarai' farm lands of North India and the effect of sugar mill effluent procured from nearby industry, in various dilutions were observed, so that some fruitful results could be obtained with the marked objective all across.

MATERIALS AND METHODS

Effluent samples were collected in the first week of April 2018 from the exit point of effluent drain lines from the premises of Dhampur sugar mills in Meerganj district Bareilly (U.P., India). Various physical, chemical and demand parameters as well as heavy metals were analyzed as per standard methods adopted by APHA (2005). A recent rice cultivar (HR– 26) was chosen as the experimental crop for its cultivation through pot trials procedures, following all customary and traditional agricultural practices. Unglazed earthen pots (30 cm in diameter) were filled with uniform bulk density of garden loam soil and farmyard manure (FYM), thoroughly mixed together. The representative soil samples were analyzed for its characterisation which showed the following data.

Available nitrogen	=	105 kg/ha
Available phosphorus	=	40 kg /ha
Available potassium	=	54 kg/ha
pH	=	7.38
Organic matter	=	10.0 3%
Moisture holding capacity	=	42.1 3%

Soil texture	=	sandy loam
Sand	=	50%
Clay	=	30%
Silt	=	14%

The effluent obtained was diluted with water to prepare five different concentrations i.e. 0(T_1), 25(T_2), 50(T_3), 75(T_4) and 100% (T_5), all as v/v. The crops were sown in Kharif season of November 2018 and was harvested in April 2019. All the experimental variables were replicated thrice. The rice grains obtained were thrashed, cleaned and stored by numbering properly for further lab analysis of metabolic components like crude protein (CP), total nitrogen (TN), albuminoid nitrogen (AlN), total lipids (TL), total ash (TA) and total carbohydrates (TC) along with total free amino acid (TFAA) content. The data fetched by analysis was then subjected to statistical analysis employing two way ANOVA technique.

RESULT AND DISCUSSION

The data compiled in tables 1a to 1d showed the analysis of the discharged effluent fetched from sugar mill premises regarding physical, chemical, demand parameters as well as heavy metal concentrations. The colour and odour of effluent obtained was brownish and pungent smelling respectively on observation. The other physical parameters like temperature, transparency, electrical conductivity and pH showed the mean values of 28^0C, 9.8 units, 372 µS/cm and 6.8 respectively (table 1a). The brownish colour may be due to the presence of iron content in the effluent and pungent smell may be due to the presence of sulphurous compounds. Among chemical parameters TDS, TA, TH, sodium, potassium, nitrate, nitrite, calcium, phosphate, sulphate, total nitrogen, magnesium, Ammonia-N and even oil and grease showed the average values to be 1453.4, 262.2, 402.4, 65.1, 48.3, 42.01, 10.49, 630, 11.8, 248, 68.08, 124.0, 112.01, 62.4 mg/L respectively presented in table 1b. Besides this the concerned demand parameters DO, COD and BOD reflected the mean values of 7.29, 850 and 197 mg/L respectively given in table 1c. Data of heavy metal concentration assessed, in the effluent, for copper, nickel, iron, zinc, cobalt and manganese showed mean values 0.08, 0.014, 2.45, 4.20, 0.03 and 0.07 mg/L respectively, whereas chromium, cadmium and lead were not observed and were found to be missing in the detectable range as shown in table 1d.

Rice cultivar HR- 26 was raised by subjecting it with various dilution of effluent i.e. 0, 25, 50, 75 and 100% in the riped grains of this graminaceous crop was analysed for assessing various biochemical metabolites i.e. crude protein, total nitrogen, albuminoid nitrogen, total free amino acids, total carbohydrate, total ash and total lipids. Kumar and Chopra (2014) also observed the

effect of effluent dilution on crude fibre and total carbohydrates metabolites in *V. radiata*. In their experiment, an optimal uptake of these metals, at 25% concentration by crop plants is well supported to observed alterations in various biochemical reactions and physiochemical processes. Baskaran et. al.(2009) have reported that higher concentration of sugar mill effluent (SME) showed an inhibitive growth of green gram (*V. radiata*).He further observed a decline in crude protein (CP), crude fibre (CF) and total carbohydrate (TC) content in *V. radiata* from 50 to 100% concentration. However in the present experiment the crude protein and total nitrogen content was found to be in a treatment of 50% effluent dilution and on higher dilution there was marked decrease in the concentration. This maybe attributed that higher concentration of effluent negatively affected the metabolic physiological changes, thus resulting in a decrease of proteinous matter whereas in case of lower concentration of 25% and 50%. It showed positive metabolic response resulting in higher value of protein content. Babu and Mohan (1998) showed in their experiment that the dilutions of the effluent provided different mineral nutrients in an appropriate proportion which further induced the improvement in growth as well as dry matter production. Albuminoid -N content showed similar response as that of total nitrogen and crude protein. However, another significant metabolic moiety i.e. total carbohydrate showed a significant decrease in the values with the increase effluent concentration that is the maximum value was found at zero concentration (90.28) and minimum value was found at 100% concentration (86.33) on dry matter basis. The total lipid and total ash content was also found to be peaked at 50% effluent dilution treatment in the grains of the experimental cultivar, however, an irregular trend was found to be noticed in case of total free amino acid content in the rice grain along with reflecting an insignificant statistical output.

CONCLUSION

The results clearly depicted that the dilution of 25% to 50% may be recommended for farming practices regarding rice cultivation in field surrounding Dhampur sugar mill in district Bareilly (UP North India). 25% to 50% dilution of the sugar mill effluent can found to be much safer on account of reduced toxicity which can alter the soil quality and its composition. This in turn may enhance the nutrient status of the experimental farm soil thereby optimizing the nutrition profile in the matured grains of the graminaceous crops. The experimental results could solve the problem of nutritional imbalance in rice cultivars by using a diluted effluent as per above said range of dilution, that may prevent the problem of malnutrition among the masses of the area. This could be achieved even better by liasoning between local government bodies, agricultural practioners and the concerned corporate entities, directly or indirectly.

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Conflict of Interest : The authors declare their no conflict of interest.

Table 1: Physico-chemical characteristics and tolerance limits for effluent

Table 1(a) : Physical Parameters

S.No.	Parameters	Effluent mean value	Tolerance limits for irrigational water mg/L (ISI)
1	Colour	Brownish	-
2	Odour	Pungent smell	-
3	Temperature	28^0C	40^0C
4	Transparency	9.8	10
5	Electrical Conductivity	372	300
6	pH	6.8	5.5-9.0

Table 1(b) : Physical Parameters

S.No.	Parameters	Effluent mean value	Tolerance limits for irrigational water mg/L (ISI)
1	TDS	1453.40	2100.00
2.	TA	262.20	200.00
3.	TH	402.40	500.00
4.	Na	65.10	200.00
5.	K	48.30	200.00
6.	NO3	42.01	45.00
7.	NO2	10.49	3.00
8.	Ca	630.00	75.00
9.	PO4	11.80	0.10
10.	SO4	248.00	1000.00
11	Total Nitrogen	68.08	-
12	Mg	124.00	50.00
13.	NH4-N	112.01	50.00
14.	Oil & Greese	62.40	100.00

Table 1(c) : Demand Parameters

S.No.	Parameters	Effluent mean value	Tolerance limits for irrigational water mg/L (ISI)
1	DO	7.29	3.00
2	COD	850.00	250.00
3	BOD	197.00	500.00

Table 1(d) : Heavy Metal Ion Concentration (mg/L)

S.No.	Parameters	Effluent mean value	Tolerance limits for irrigational water mg/L (ISI)
1	Cd	ND	0.01
2	Cr	ND	0.05
3	Cu	0.08	0.50
4	Pb	ND	1.00
5	Ni	0.01	2.00
6.	Fe	2.45	1.00
7.	Zn	4.2	2.00
8.	Co	0.03	0.50
9	Mn	0.07	0.50

ND = Not Detected

Table 2: Biochemical metabolites in grains of rice cv. (HR-26) (g% on dry matter basis).

Treatment		CP	TN	Al N	TFAA*	TC	TL	TA
No.	% Effluent							
T_1	0	8.32	1.24	1.07	0.48	90.28	1.02	1.00
T_2	25	9.08	1.33	1.14	0.60	89.44	1.22	1.02
T_3	50	10.31	1.45	1.22	0.63	88.60	1.36	1.06
T_4	75	9.69	1.25	1.17	0.67	87.02	1.21	1.04
T_5	100	7.77	1.11	1.06	0.57	86.33	1.15	1.03

*mg % on dry matter (DM) basis.

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