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Analysis and Characterization of Sugar Mill Waste and its effect on growth and germination of seeds

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Abstract: *In this paper, waste water obtained from sugar industry in Delhi-NCR and other regions was characterized for basic parameters. The effluent was dark brown colored with decaying molasses smell and acidic in nature (pH 3.9-7.9). The effluent having high organic and inorganic load showing high electrical as conductivity 3180 - 4750 µS/cm in untreated waste and 1910- 2134 µS/cm in treated waste water. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total hardness, Phenol, Cr(VI), total Cr , heavy metals like Zn, Cu Ni and others were determined . The physico-chemical parameters were calculated as per the standards approved by Bureau of Indian Standards (BIS). Biological activity, seed germination and root shoot length were also determined.*

Keywords: *Sugar Industry, BOD, COD, Electrical Conductivity, TDS, Seed Germination.*

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I. Introduction

Sugar mill plays important role and regulates the socio-economic growth of rural and urban populations in India [1]. Our sugar-industry is the 2nd largest manufacturer of sugar after Brazil in worldwide sugar market [2]. Sugar mill runs from winter to pre-rainy season and produces large amount of effluent as solid wastes in the type of pulp and sugarcane press mud [3]. Effluent of sugar-mill contains maximum pollution which pollutes surface and ground water and other soil resources [4]. The concentrate amount should be select to eliminate TSS and TDS. But elevated TSS and TDS could not be eliminated by normal concentration and flocculation procedure [5]. To fulfill with ecological norms for the discharge of waste, normally predictable processes were carried in practices for the economical purpose [6]. Because of its complicated properties, handling of sugar-waste has become a growing dare [7]. SME are usually treated by implementing diverse physical, chemical and biological processes [8]. Some studies indicate simultaneous use of both anaerobic and aerobic procedure for the management of sugar industrial wastes [9]. Sugar manufacturing is an extremely significant agro-supported industry in our country and it releases large quantity of waste matter into water to create high pollution in water corpses which influences all animals, plants and other living organisms [10]. The waste matter harm full influences the plant increase and soil fertility when utilized for watering [11]. Such soil was extremely infected when untreated effluent was utilized for soil irrigation which contained high heavy materials and carbon compounds [12].

This polluted water is operated by human for domestic, drinking, agriculture and industrial purposes Sugar mills produce effluent which creates environmental troubles related to land and water pollution [13]. Water to majority of Rabi crop established unsuitable water through the sugar manufacturing period in November-April around sugar mill areas [14]. Human life is also affected by the unpleasant effects of untreated sugar industrial waste [15]. Liquid waste from mill domicile is normally mixed with different chemicals used during processing [16]. Sugarcane contains about seventy to eighty % water, so, large extent of waste-water is generated during its crushing and giving out in industry. The linked environmental concerns are disposal of molasses, waste matter and impressive pollution [17,18]. It's a common practice to use sugar waste for irrigation, therefore, with regards to public wellbeing and crop production, it is essential to identify how crops in field respond when they are irrigated or exposed to industrial wastewater [19].

II. Materials & Methods

This work was completed one of the well known sugar industry Kisan Sahkari Chini Mills (02501), Anoopshahr, Uttar Pradesh in India.

Waste water sampling: The wastewaters of sugar mill from various places of Delhi-NCR, India were collected over different and alternate time. All samples of untreated wastewater and treated wastewater will be taken from outlet of sugar mill. Wastewater was collected in sterilized glass bottles labeled with sample code and transported to the laboratory in an ice box. All samples were analyzed for different physical and chemical parameters. Characterization of Sugar Mill Waste and its effect on germination and growth of seeds were also studied.

Soil Sampling: Soil samples were composed from fields where sugar mill effluent was used as irrigation water. Four dissimilar sites were chosen of radius 500m for soil-samples collection where waste was used to water for vegetables.

Physico-chemical analysis: Temperature is a measure of heat in terms of a standardized unit, with a thermometer. Alkalinity was examined with titrimetric method. Hardness was analyzed by titrimetric method using EDTA. Electrical conductivity is capacity of water to take an electrical current and was measured by a digital multi-range conductivity meter. Color is an illustration sense attribute [20] and the principal parameter that is determined with a measure of odour is acc. to concentration [21]. It was analyzed by visual observation, Total dissolved solids (TDS), Total suspended solid (TSS) and total solids (TS) refers to quantity of minerals, metals, organic matter and salts that are soluble in certain water volume that is expressed in mg/l. It is directly connected with quality and purity of water [22]. These were analyzed by Gravimetric Method. The decay of organic substance in water is measured as BOD [23]. It was analyzed by Microbiological titration method. COD indicator covers a great amount of refractory organic material that is not a pollutant and could be a potential carbon sink. COD test method is depends on coulomb titration of constant current; its principle follows Coulomb's law [24]. It was analyzed by Titrimetric Method. Oil content was resolute by measurement of absorbance. Various trace elements and major mineral elements in industrial wastewater prior to and at last treatment were analyzed by spectrophotometer by AAS practice.

Germination of seed and physiological parameters: The plants growth was investigated on weekly basis [25]. The morphological parameters like germination %, length of seedling and fresh % dry weights of the plants were observed. Shoot and root length were also absorbed [26-28]. The okra and tomato plants seeds were chosen for test and were with uniform size, color and weight.

Various concentrations of waste: Control (Distilled water), 10%, 25%, 50%, 75% and 100% waste water was used for different experiments [29].

Bacterial analysis of mud samples: The mud samples were composed from the place of discharge of effluents. Two samples were collected from discharge site of sugar mill and stored at 4°C. Mud sample and autoclaved distilled water were mixed in 1:9 (m/V) than stirred properly. 1ml of each sample was pipette out into one sterile test-tube containing 9 ml of peptone water, making 1:10 dilution, second test-tube making 1:100 dilution and third test-tube making 1:1000 dilution respectively. 10 gm of Nutrient Agar was poured in 500 ml flask and the volume was made equal to spot by mixing DDW. pH of medium was changed with the help of conc. NaOH or conc. HCl. The medium was sterilized at 121°C and 15 psi for 15 min and cooled it about 37°C. One ml of the dilution (10-2 and 10-3) was stretch consistently on agar-medium petri dishes to conclude number of populations per gram soil incubation of the petri dishes was completed in a room set at 32±2ºC [30].

III. Results and Discussion

The parameters analyzed for sugar mill effluents are higher than BIS values for pH, BOD, COD, TDS, TSS, and others shows table no 1.

EC: The EC of observed samples was array from 3180 μS/m to 4750 μS/m. All samples have EC value more than safe limit 1000 μS/m. EC increases as total dissolved content of effluent increases. These effluents if used for watering purposes will affect soil productiveness and plants growth. The utmost value was 4750 μS/cm found in untreated SME trials indicating that waste limited high magnitude of ions.

pH: pH of waste, outside water and ground-water in study region was changed from 4.0 to 8.0. pH was acidic in behavior because of use of phosphoricacid and sulphuric acid during the clarification of sugarcane juice.

Table no1: Range of values of different physico-chemical parameters in waste of sugar industries and its BIS Standard value

Parameters	BIS Value	Observed Value	
		Untreated effluents	Treated effluents
Colour	-	Dark brown	Light brown
odour	-	decaying molasses smell	-
Turbidity	-	Highly turbid	-
pH	6.0 - 9.0	3.9 – 7.9	5.4 - 6.8
Temperature (0C)	Not exceed 30	42-70	33-45

BOD (mg/l)	100 - 160	331-750	270 - 350
COD (mg/l)	250 - 300	1400-4047	1217-1480
TDS (mg/l)	2000	3745 - 4268	2578 - 3094
TSS (mg/l)	150-500	1500 - 2100	600-960
Hardness (mg/l)	500	353 – 750	426 – 580
EC (µS/cm)	1200	3180 – 4750	1910 – 2134
Oil and grease	10	19	15-16
Cr(VI) (mg/l)	0.5 – 1.0	3.2-7.9	2-6
Zn (mg/l)	5.0	1.4-2.5	2.8 – 5.0
Cu (mg/l)	3.0	7.0	1- 5
Ni (mg/l)	3.0	6.0	3 -5
Fe (mg/l)	2.0	0.8-1.20	6 -7
Cd (mg/l)	0.10	0.09 - 0.46	0.28
Chloride	600	435-785	920
DO (mg/l)	4.5-8	1.18-3.23	4.09
HCO_3 (mg/l)	400	290-420	550
Na (mg/l)	200	150-165	179.33
Ca (mg/l)	200	138.33-151	140.56
Mg (mg/l)	100	52-70	65
P (mg/l)	N/A	8.29	5.30

Maximum pH value was 7.9 and minimum pH was recorded 3.9 for untreated SME and it was 5.4 to 6.8 for treated SME. It may source of negative effects on nearby soil and ground water utilized for crop's irrigation [31,32].

Temperature: In agriculture irrigation has agreeable limits of temperature are 40ºC. Untreated SME collected from site has suitable temperature (33 - 45ºC) for irrigation [33].

BOD and COD: COD was considered by using closed reflux method. During COD calculation, O_2 demand value is helpful in identifying toxic situation and existence of biologically resistant matter. It is significant, quickly measured parameter for waste water studies and control of waste water treatments. COD analysis is utilized to calculate the load of organic toxin in the industrial waste. COD in untreated SME and exterior water was changed between 1400-4047mg/l. The COD is a chief pointer of worsening of water excellence from discharging untreated and treated industrial effluent. BOD of waste matter was examined by incubating sample at 20^0 C for 4-5 days prior and later the waste treatment. Prominent data of BOD demonstrate quantity of bio-degradable subject exists in waste. Higher decomposable material, larger BOD results because extra O_2 is required. Fewer value of BOD is an indicator of high-quality water, while high amount of BOD point to polluted water. Higher BOD (331-750 mg/l) values indicated presence of elevated quantity of organic substance load in untreated effluents, which reason for poisonous effects on marine biota and sustains present result. Higher conc. of COD and BOD in all trials designated severe contamination of region caused by discharged waste threatened to our environment [34].

Total Dissolved Solids: TDS shows total salts in waste-water. Total dissolved solids, is quantity of total inorganic substances and other salts which are soluble in water. Many salts are generally present in natural waters; like bicarbonates, carbonates, sulphates, chlorides, nitrates and phosphates of Ca, Mg, Na, K, Fe and Mn. Water is classified on basis of concentration of TDS as- fit for drinking (500 mg/l), acceptable for drinking (1,000 mg/l), valuable for irrigation (2,000 mg/l), not useful for drinking & irrigation (more than 3,000 mg/l). In present work average value of TDS was noticed in range of 3745-4268 mg/l in untreated waste and 2578-3094 mg/l in treated waste.

Total Suspended Solids: In this work, the total suspended solids were found in range of 280-430 mg/l in textile industry waste and 120 mg/l in tannery industry waste. This is high compare to the BIS value (100 mg/l).

Hardness: It was studied by titrimetric method by EDTA. It assessment ranged from 353-750 mg/l in untreated waste and 426-580 mg/l in treated waste. Specified limit of this parameter by BIS is 500 mg/l.

Chloride and Bicarbonates: Cl^{-1} values in all trial varied from the safe limit (600 mg/l). The minimum value was 435 mg/l while the maximum was 785 mg/l for untreated waste. In case of treated waste it was measured 920 mg/l. Cl^{-1} ion must be at least level like it causes salinity and hardness. Cl^{-1} ion mostly survives in normal water and help in dissolving other deposits coming from industries, sewage etc. Maximum value for bicarbonate was 420 mg/l, while the minimum was 290 mg/l in untreated sample. No limit has been set for HCO_3 by WHO for SME effluents but according to other standard it may be 400 mg/l [35].

Heavy Metal in SME:

Iron and Zinc Concentration: Maximum value of Fe found in untreated SME sample was 1.2 mg/l and minimum was 0.8 mg/l. This advanced conc. of iron may be cause pathogenic microbial growth in the SME and other water system as in soil [36]. In analyzed sample of untreated SME, max. and min. values of Zn were 2.5

mg/l and 1.4 mg/l respectively but in case of treated SME samples it was 6-7 mg/l. Zn value in all untreated SME samples were within standard permissible levels (5.0 mg/l). Absorption of higher quantity of Zn causes necrosis, chlorosis etc. or also affects plants growth [37].

Cadmium and Cupper Concentration: Minimum demonstrable limit of Cd was 0.09 mg/l and maximum was 0.46 mg/l. According to the standard valves, maximum toxin level for Cd is 5 mg/L. Previous research results illustrated that percentage of seed-germination, shoot or root length decreased as concentrations of solution increased. No germination was noticed at 1000 ppm of cadmium level. [38]. Results demonstrated that only one samples contained Cu values higher (7.0 mg/l) than allowed limits (3.0 mg/L), for untreated SME samples. Cu is a micronutrient and critical for living organism but higher amount of Copper, making water unpleasant to drink and may damage the liver [39].

Chromium and Lead Concentration: Maximum assessment of Cr was 7.9 mg/l and minimum was 3.2 mg/l in analyzed untreated SME samples and was more than allowed limit (1.0 mg/l). Conc. of Pb in few untreated SME samples was within standard limit (0.5 mg/L). Lead may collect in human body during food sequence and causes damaging effects on different human organs [40]. As human eat poisonous metal ions, they can collect in bones and other body parts. So it causes sickness like diarrhea, renal disorder, carcinogenic, and kidneys diseases, artillery and nervous system problems [41].

Heavy Metals Analysis of Soil Sample: As different journalism studies demonstrated that sugar mill effluent is used for watering. Different kind of crops and vegetables were watered by those effluents which affect soil characteristics. Zn is significant trace essential that play very important role in outer appearance and metabolic procedures of several organisms. Soil was also investigated for some metal contents and results [42,43] are given in Table no 2.

Table no 2: Concentration (mg/kg) of metals in SME irrigated soil

Parameters	S3	Standards
Fe	19.53	N/A
Zn	10.03	600- 1100
Cd	0.085	0.43
Cu	4.61	200- 270
Cr	0.542	11
Pb	2.69	200
K	2454	N/A
P	79.54	N/A

Microbial Study: Different Industrial effluents result indicates decrease in bacterial mud micro-flora as contrast to control (Table no 3). From information's it is apparent that effluent released from sugar mill pollute the mud and it may due to higher BOD and COD values of effluents [44].

From information it is apparent that maximum bacterial reduction was in case of tannery industry waste and minimum was perceived in textile industry waste liquid. The brightness of color change is also noticed when dilutions of mud samples are compared. The results explain that the bacterial counts have reduced because of contamination of mud samples by effluent waste from unusual industries.

Table no 3: Bacterial CFU x 10^3 in mud samples

Samples	**Bacterial CFU × 10^3 Dil. (10^{-2})**	**Colour of Agar**	**Bacterial CFU × 10^3 Dil. (10^{-3})**	**Colour of Agar**
Control	360	Yellow	360	Yellow
T3	175 - 210	Dark brown	124 - 155	Brown

The brightness of colour change is noticed when dilutions of mud samples are compared. The results explain that the bacterial counts have reduced because of the contamination of the mud samples by effluent waste from sugar manufacturing unit.

Germination percentage: Number of sprouted seeds in all concentration was calculated on 15th day and germination proportion for all three industrial effluents (table no 4) was considered by using given formula [45].

Germination % = No. of germinated seeds /Total numbers of spreaded seeds X 100

Following calculation shows the collected and observed germination percentages of okra and tomato.

Table no 4: Effect of SME on seed germination percentage of okra and tomato plants

Effluent Conc. (%)	**Seed germination %**		**Time of germination (Hrs)**	
Vegetable	Okra	Tomato	Okra	Tomato
Control	95	90	24	24
5	98	88	24	24
10	96	91	24	24
25	89	74	24	24
50	54	41	48	48
75	21	13	48	48
100	00	00	48	48

Values in given table explained that when effluent conc. goes upward, seeds germination proportion goes down ward. The maximum seeds germination was with control effluents (okra 95 % and tomato 90%) and minimum germination was for 100 % in all effluent concentrations.

Physiological Parameters of Plants: The shoot and root lengths of plants was measured at 40th day of germination. Garden fresh okra and tomato vegetation were taken and weighed and then dried into oven at 80°C for 24 hours. The following table indicates the measured value of the selected plants physiological parameter. Results showed that maximum plants growth was recorded for control and lower concentration from 5% to 25% SME concentrations (table 4.11). Higher conc. of effluent used for watering decreased enlargement of plants with increased waste concentration [46].

Table no 5: Shoot and Root length of tomato and okra grown in various conc. of sugar industrial effluents

Effluent conc. (%)	**Okra**		**Tomato**	
	Root length (cm)	Shoot length (cm)	Root length (cm)	Shoot length (cm)
Control	32.5±1.60	32.8±1.4	32±1.42	32±2.50
5	34±1.10	37±1.55	33±1.28	34±2.80
10	29±1.25	30±1.75	27±1.75	38±3.18
25	31.9±2.48	32±1.57	29.8±2.12	31±2.78
50	29±2.14	39±2.22	28±2.15	33±2.11
75	28.5±2.6	28±2.51	26±3.12	31±2.30
100	00±00	00±00	00±00	00±00

III. Conclusion

Untreated waste of Sugar industry from local area highly contains pH, EC, TDS, TSS, BOD, COD and lower limits of DO, which are causes of degrading of water bodies. Hence, these are unfit and must not be discharged into irrigation and drainage systems. Analyzed values of collected samples of these Sugar Industries demonstrate clearly that untreated effluents discharging from Sugar industry not only degrade ground water body, fertile soil except pollute groundwater. It is mentioned that without management of waste-water may be not released into irrigation and drainage network, which will toxic water quality for aquatic life and ecological habitat. During field visits, it was established that livestock including buffalos, cows and goats suffered due to various diseases. Even some out of these were died due to utilization of sugar mills wastes discharged into drains, which in neighborhood of villages. The fish catching birds and aquatic fauna are dependent on the drain system. All wetlands attract local and migratory wildlife, particularly in winter. The contaminated water always threat for wildlife. It was created those dead birds in drains due to local sugar industry wastes.

The lower conc. (10%) of sugar industry waste promoted the seed-germination and seedling expansion of plant then other concentrations and control as germination and expansion of plants gradually decreased with increased effluent concentrations. As human intake poisonous metal ions during foodstuff, they can collect in bones and further organs. Hence, it creates disease like carcinogenic, diarrhea, kidney diseases, renal disorder, nervous system and artillery. Consequently, it is compulsory that effluents of all industry must be treated properly, as per national environmental excellence standards, and be disposed thereafter so that it may not jeopardize the nearby soil, as a natural resource.

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References

[1]. Harush D P and Hampannavar U S, Total water management, operation and maintenance, troubleshooting of ETP in sugar industry, International Journal of Environmental Sciences, 2014;5(3): 580-586

[2]. Solomon S, The Indian Sugar Industry: An Overview, Sugar Tech, 2011;13(4): 255-265

[3]. Kolhe A S, Ingale S R and Sarode A G, Physico Chemical Analysis of Sugar mill effluents, Sodh Samiksha aur Mulyankan (International Research Journal), ISSN-0974-2832, 2008;307-311

[4]. Mohan N and Bajpai, New technique for effluent treatment in sulphitation sugar factories, A Proc S Afr Sug Technol Ass, 2018;91: 341-349
[5]. Benatti C T, Tavares C R G and Lenzi E, Sulfate removal from waste chemicals by precipitation, Journal of Environmental Management, 2009;90:504- 511
[6]. Saxena C, Madan S, Evaluation of adsorbents efficacy for the removal of pollutants from sugar mill effluent, ARPN J. Agric. Biol. Sci. 2012;7(5): 325-329
[7]. Kushwaha J P, A review on sugar industry wastewater: sources, treatment technologies, and reuse, Desalination and water treatment 2015;53(2): 309-318
[8]. Gupta V K, Jain C K, Ali I, Chandra S, Agarwal S, Removal of lindane and malathion from wastewater using bagasse fly ash—a sugar industry waste. Water Res, 2002;36(10): 2483-2490
[9]. Nähle C, Purification of waste water in sugar factories-anaerobic and aerobic treatment, N-elimination, Zuckerindustrie, 1990;115(1): 27-32
[10]. Ezhilvannan D, Sharavanann PS, Vijayaragavan M., Effect of sugar mill effluent on changes of growth and amino acid and protein contents of maize (Zea mays L.) plants, J Ecobiotechnol, 2011;3(7): 26-29
[11]. Kumar V, Chopra AK., Fertigation effect of distillery effluent on agronomical practices of Trigonella foenum-graecum L, (Fenugreek). Environ Monit Assess 2012;184(3): 1207-1219
[12]. Jagannathan R, Venkatraman K, Vasuki R., Bioremediation of sugar mill effluent by immobilized bacterial consortium. Int. J. Pharm. Technol, 2014;6(3):7107-7114
[13]. Agale M C, Patel N G and Patil A G, "Impact of sugar industry effluents on the quality of groundwater from Dahiwad village, District Dhule (M.S.)," Archives of Applied Science Research, 2013;5(2):58-60
[14]. Rahim M A and Mostafa M G, Impact of sugar mills effluent on environment around mills area, AIMS Environmental Science, 2021;8(1):86–99
[15]. Hossain and Kabir, Exploring the Nutrition and Health Benefits of Functional Foods, 2010.
[16]. Verma A, Singh A. Physico-Chemical Analysis of Dairy Industrial Effluent. Int. J. Curr. Microbiol. App. Sci, 2017;6(7):1769-1775
[17]. Güven G, Perendeci A, Tanyolaç A, Electrochemical treatment of simulated beet sugar factory wastewater, Chemical Engineering Journal, 2009;151(1): 149-59
[18]. Mancera A, Fierro V, Pizzi A, Dumarçay S, Gérardin P, Velásquez J, Quintana G, Celzard A, Physicochemical characterisation of sugar cane bagasse lignin oxidized by hydrogen peroxide, Polymer Degradation and Stability, 2010;30: 95(4), 470-476
[19]. Thorpe A, Van Anrooy R, Inland fisheries livelihoods in Central Asia: policy interventions and opportunities, Food and Agriculture Organization of the United Nations, 2009.
[20]. Muhamad Haziq Hasnul Hadi et al. The Amber-Colored Liquid: A Review on the Color Standards, Methods of Detection, Issues and Recommendations, Sensors, 2021;21: 6866
[21]. Naddeo V, et al., Odour measurement in wastewater treatment plant using both European and Japanese standardized methods: correlation and comparison study, Global NEST Journal, 2016;18 (4): 728-733
[22]. Rodger B B, Andrew D E, and Eugene W R, Standard Methods for the Examination of Water and Wastewater. APHA, Washington, DC, 23nd Edition. 2017.
[23]. Al-Sulaiman, A M and Khudair B H, "Correlation between Bod5 and cod for Al-diwaniyah wastewater treatment plants to obtain the biodigrability indices," Journal of Biotechnology, 2018;15(2)
[24]. Zhang B, Ning D, Yang Y, Van Nostrand J D, Zhou J, Wen X.. Biodegradability of wastewater determines microbial assembly mechanisms in full-scale wastewater treatment plants, Water Res, 2020;169: 115276
[25]. Jibril and Omprakash, Effect of Distillery Industry Effluent on Fertility of Soil and Crops, International Journal of Soil and Crop Sciences, 2014;8, 2(3):039-045
[26]. Gassama UM, Puteh AB, Abd-Halim MR, Kargbo B, Influence of municipal wastewater on rice seed germination, seedling performance, nutrient uptake, and chlorophyll content, J Crop Sci Biotech, 2015;1, 18, 9-19
[27]. Islam K N, Misbahuzzaman K, Majumder A K, Chakrabarty M, Efficiency of different coagulants combination for the treatment of tannery effluents: A case study of Bangladesh, African Journal of Environmental Science and Technology, 2011;5(6): 409-419
[28]. Keshavarzi B, Mokhtarzadeh Z, Moore F, Mehr MR, Lahijanzadeh A, Rostami S, Kaabi H, Heavy metals and polycyclic aromatic hydrocarbons in surface sediments of Karoon River, Khuzestan Province, Iran, Environmental Science and Pollution Research, 2015;1, 22 (23): 19077-92
[29]. Lakshmi S, Sundaramoorthy P, Effect of sugar mill effluent on germination, seedling growth and biochemical changes in ragi, Ind. J Environ Ecoplan, 2000;3(3): 501–506
[30]. Harley J P and Prescott L M, Basic laboratory and culture techniques, In: Laboratory exercises in Microbiology. 2nd Ed.; W.C. Brown Publishers, Dubuque, p. 14-46, 1993.
[31]. Bhattacharjee S, Datta S, Bhattacharjee C, Improvement of wastewater quality parameters by sedimentation followed by tertiary treatments, 2021;212: 92–102
[32]. Ayyasamy P M, Yasodha R, Raja K S, Lakshmanaperumalsamy P, Rahman PKSM, Lee S, Impact of sugar factory effluent on the growth and biochemical characteristics of terrestrial and aquatic plants, Bull Environ Contam Toxicol, 2008;81: 449–454
[33]. Shiva K D, Srikantaswamy S, Evaluation of effluent quality of a sugar industry by using physico-chemical parameters, Int J Adv Res Eng Appl Sci, 2015;4(1): 16-25
[34]. Saifi S, Mehmood T, Effects of socioeconomic status on students' achievement, Int J Social Sci Edu, 2011;1: 119-128
[35]. Kaloi G M and Memon M, Influence of Sugar Industry Wastewater on Sugarcane Juice Quality and Soil Health, 2021;34 (4): 766-773
[36]. Khan M M, Yi Yang and Islam, Impacts of Sugar mill's Effluent on soil and Plant's Seed Germination, Punjab, Pakistan, 2019;4 (3): 623-637
[37]. Bharti P K, Tyagi P K, Singh V, Assessment of heavy metals in the water of Sahastradhara hill stream at Dehradun, India, International Journal of Environment, 2014;13, 3(3):164-72
[38]. Moosavi S A, et al, Effects of Some Heavy Metals on Seed Germination, Journal of Agricultural Science, 2012;4(9)
[39]. Adriano D C, Trace elements in the terrestrial environments: Biogeochemistry, bioavailability, and risks of heavy metals. Springer-Verlag, New York, NY, 2001;2(3): 34-39
[40]. Saha M K, Ahmed S J, Sheikh M A H, et al., Occupational and environmental health hazards in brick kilns, J Air Poll Health 2020;5: 135-146
[41]. Islam M R, Mostafa M G, Textile Dyeing Effluents and Environment Concerns - A Review, J Env Sci & Nat Res, 2018;11:131-144
[42]. Sharma RK, Agrawal M, Marshall F. Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India, Ecotoxicology and environmental safety, 2007;28, 66 (2):258-66

[43]. Hasan Z, Anwar Z, Khattak K U, Islam M, Khan R U, Khattak J Z, Civic pollution and its effect on water quality of river Toi, NWFP, Research Journal of Environmental and Earth Sciences, 2012;1, 4(3): 334-339

[44]. Kaur A, et.al, Physico-chemical analysis of the industrial effluents and their impact on the soil microflora, Procedia Environmental Sciences 2010:2: 595-599

[45]. Vaithiyanathan T and Sundaramoorthy P, Analysis of sugar mill effluent and its influence on germination and growth of African marigold, Appl Water Sci, 2017;7: 4715-4723

[46]. Sajani S, Muthukkaruppan S M, Physico-chemical analysis of sugar mill effluent, contaminated soil and its effect on seed germination of paddy, Int J Pharm Biol Arch, 2011;2(5): 1469–1472

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