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Impact of pharmaceutical industry effluent on seed germination and seedling growth of some common crops of Bangladesh

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Abstract

This project was carried out to investigate the effect of pharmaceutical industry effluents on seed germination and seedling growth of some common cultivated crops of Bangladesh. Four varieties of crops such as Okra, Data shak, Ridge gourd, and Black mustard were selected to grow in this effluent. Concentrations used for the effluents in terms of seed germinations were 0%, 25%, 50%, 75% and 100% respectively. The optimum condition of seed germination obtained for Okra, Data shak and Ridge gourd were 25%, 100% and 50% respectively. However, in terms of Black mustard the germination percentage was same in all condition. At lower dilutions the crops exhibited favorable effect on seed germination, seedling growth, shoot length and root length. Among all 100% concentrations of the effluent caused inhibitory effect in terms of all crops except Black mustard. Based on the present investigations, it can be concluded that pharmaceutical effluent which is discharging as waste can be used for irrigation purpose, after proper dilution.

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Introduction

Bangladesh is an agrarian country. It's fertile land is suitable to grow different vegetables. Vegetables are not only an important part of human diet but also providing important functional food component by contributing iron, vitamins, calcium etc. which have significant health value (Arai *et al.,* 2002). Day by day, consumers demand for high quality vegetables are enhancing. But it is inhibiting by different industrial activities at an alarming rate. Now a days a large amount of effluents are discharging to the surface. While the developed countries discharge their industrial effluents with proper treatment but the developing countries such as India, Bangladesh and Pakistan are discharging different industrial effluents without further treatment. These effluents are either released to the water bodies or throwing to the agricultural land. Sometimes these effluents are used for agricultural purpose due to the scarcity of water (Ghafoor *et al.,* 1994). Treating waste effluents is very much significant for cultivation of crops and environment. Moreover, the economy of Bangladesh is predominantly based on agriculture but, in the race towards industrialization, industries are taking place in a gradual increasing phase. The important industries are paper, oil refinery, chemical, pharmaceutical, lather tanning, textiles, fertilizer, and sugar industry and so on. Effluents generated by industries are one of the major sources of pollution. Contaminated air, water and soil by effluents from the industries are associated with many diseases (WHO, 2002) and this could be part of the reasons for the current shorter life expectancy (WHO, 2003) when compared to the developed nation. Presently less than 10% of the effluent generated is treated and the rest of the untreated waste water is discharged into the nearby water bodies. The use of industrial effluents for irrigation has emerged in the recent past as an important way of utilizing waste water, taking the advantage of the presence of the considerable quantities of N, P, K and Ca along with other essential nutrients (Niroula *et al.,* 2003).

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But there might be beneficial and detrimental effects of waste water irrigation of crops including vegetables (Ramana *et al.,* 2002; Saravanmoorthy *et al.,* 2007). Recently, many researchers worked on the effect of different industrial effluents on seed germination and seedling growth of different varieties of crops (Iqbal *et al.,* 2021; Sankar *et al.,* 2014; Rena *et al.,* 2020; Amina *et al.,* 2020; Rupa *et al.,* 2018; Islam *et al.,* 2017). Therefore, it is necessary to study the impact of these effluents on crop system before they are recommended for irrigation (Thamizhiniyan *et al.,* 2009). The present investigation was carried out to study the impact of untreated effluents from pharmaceutical industry on seed germination and early growth of four common crops of Bangladesh. The effect of these effluents on root and shoot lengths were also investigated. Besides the physico-chemical parameters of this effluent were also studied.

Materials and methods

Collection of the effluents

The effluents used in this study were collected in a pre-cleaned plastic bottle from SILCO pharmaceutical company limited which is situated at Khadimnagar in Sylhet city. The effluents were stored at 4˚C temperature to avoid the changes of physic-chemical features. Different physico-chemical features were studied at the organic chemistry research laboratory of Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh.

Characterization of the effluent

According to previously reported procedure of American Public Health Association (APHA, 1989) the physico-chemical properties of the effluent samples were studied.

Collection of seed materials

The seed materials were collected from a local market. Four varieties of seeds such as Okra, Amaranthus, Ridge gourd and Black mustard were collected for germination purpose. Experiments were designed according to the reported literature (Nawaz *et al.,* 2006).

Germination study

The healthy and uniform seeds were selected and surface sterilized with 0.1% $HgCl_2$ and thoroughly washed with distilled water to avoid surface contamination. The germination test was carried out in a sterile petridishes of 9, 10, 11, 12 cm in size placing a double ring filter paper on each petridishes. Different concentration such as 0%, 25%, 50%, 75% and 100% of collected waste water were prepared with respect to the distilled water and stored for seed treatment. The waste water of each concentration was added to each petridish of respective treatment daily in such an amount just to allow the seeds to get favorable moisture for germination and growth. The control was treated with distilled water only. 20 seeds of each agricultural crop and in case of Ridge Gourd 15 seeds were placed in the petridishes. The petridishes were set at organic chemistry research laboratory at room temperature (30±2)˚C. The experiment extended over a period of nine days to allow the last seed germination and measurement of the root and shoot length. The results were determined by counting the number of germinated seeds, measuring the length of primary root and main shoot at the 9^{th} day of the experiment. The data were subjected to analysis of Duncan's Multiple Range Test (DMRT) (Duncun *et al.,* 1957). The ratio of germination and elongation were calculated as previously reported method (Hoque *et al.,* 2003; Rao *et al.,* 1983).

Germination percentage

Different parameters used for germinations are given here:

Here,

C_0 = Seeds of receptor plants grown in distilled water only (control)

C_1 = Seeds of receptor plants grown in waste water of 25% concentration

C_2 = Seeds of receptor plants grown in waste water of 50% concentration

C_3 = Seeds of receptor plants grown in waste water of 75% concentration

C_4 = Seeds of receptor plants grown in waste water of 100% concentration

A = Number of seeds in each petri dish, B = Number of seeds Germinated

C = percent of germination, D = Percent of inhibitory effect.

(-ve inhibitory effect and +ve indicates stimulatory effect).

Calculation of D

D can be calculated by using the following equation as,

$D=(C_2-C_1)/C_1 * 100$ [for the first value D] and $D=(C_3-C_1)/C_1 * 100$ [for the second value of D]

Where, C_1, C_2 and C_3 are the first, second and third value of C [e.g germination percentage]

Other values of D were calculated in the same way.

Results and discussion

The effluent was dark brown in color with an unpleasant smell. It was acidic in nature and consists of high amounts of total dissolved and suspended solids. The physico-chemical properties of the pharmaceutical effluent have been displayed in Table I.

After collecting the pharmaceutical industry effluents, its physico-chemical parameters were studied and its impact was investigated on seed germination, seedling growth, root length, shoot length etc. According to a previous report (Rodosevich *et al.,* 1997) seed germination control plants populations, ensure reproduction and crop productivity. From the experimental outcome we may bioassay that for okra and Ridge Gourd, the rates of germination is decreased with increasing the concentration of the effluent. It means that high concentration of the pharmaceutical effluent is not suitable for these two species. In case of Data Shak the rates of germination is increased with increasing the concentration of the effluent. It seems that there are some essential organic compounds in waste waters which may alleviate some part of negative impacts. According to the method described by Panasker *et al.* (2011), polluted water at low concentration does not inhibit the seedling growth but at higher concentration germination of seeds and seedlings growth will be affected. Other researcher also reported that waste water contained some essential organic compound which increase growth of crop (Pathak *et al.,* 2009; Lubello *et al.,* 2004). In terms of Black Mustard there is no inhibitory effect of effluent on seed germination, it might be because ofsome organic matter present in polluted water which can alleviate the negative effect of toxic materials and may improve their rate of

Table I. Physico-chemical parameters of pharmaceutical effluent

Sl. No.	Parameters	Values	Standards
1	Color	Dark brown	Colorless
2	Odor	Unpleasant	Odorless
3	Temperature (˚C)	27	40
4	pH	6.5	5.5-9
5	Electrical conductivity (S/m)	0.423	0.3
6	Total solids (mg/L)	2000	3500-4000
7	Total Suspended Solids (mg/L)	1000	< 50
8	Total Dissolved Solids (mg/L)	1000	< 3000
9	Dissolved oxygen (mg/L)	3.05	5-6
10	Biochemical Oxygen Demand (mg/L)	1.28	< 20
11	Chemical Oxygen Demand (mg/L)	22	< 150 ppm

Table II. Percent of seed germination for some cultivated crops

Treatment	Okra				Data shak				Ridge gourd				Black mustard			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
C_0	20	16	80	-	20	8	40	-	15	11	73	-	20	20	100	-
C_1	20	15	75	-6.25	20	9	45	12.5	15	7	47	-35.6	20	20	100	0
C_2	20	14	70	-12.5	20	9	45	12.5	15	8	53	-27.3	20	20	100	0
C_3	20	10	50	-37.5	20	10	50	25.0	15	5	33	-54.8	20	20	100	0
C_4	20	10	50	-37.5	20	11	55	37.5	15	3	20	-72.6	20	20	100	0

Table III. Effect of pharmaceutical effluent on shoot length

Treatment	Okra			Data shak			Ridge gourd			Black mustard		
	A	B	C	A	B	C	A	B	C	A	B	C
C_0	2.06	-	-	2	-	-	1.78	-	-	2.72	-	-
C_1	1.22	59.22	-40.8	0.6	30	-70	1.24	69.7	-30.3	0.86	31.6	-68.3
C_2	0.82	39.80	-60.2	0.62	31	-69	0.94	52.8	-47.2	0.68	25	-75
C_3	1.1	53.39	-46.6	0.8	40	-60	1.10	38.2	-61.8	0.72	26.5	-73.5
C_4	0.76	-36.9	-63.1	0.54	27	-73	0.5	28.0	-71.9	0.60	43.3	-54.7

Table IV. Effect of pharmaceutical effluent on root length

Treatment	Okra			Data shak			Ridge gourd			Black mustard		
	A	B	C	A	B	C	A	B	C	A	B	C
C_0	6.34	-	-	2.24	-	-	6.36	-	-	7.86	-	-
C_1	7.6	119.8	19.87	3.1	138.4	38.4	6.1	127.3	27.35	6.7	115.7	16
C_2	6.66	105.0	5.04	2.68	119.6	19.7	5.7	126.1	26.10	5.98	102.0	2.0
C_3	7.92	124.9	24.92	2.75	1	-2.67	7.2	83.3	-16.67	7.99	89.67	-11
C_4	4.36	0.69	-31.23	2.26	100.9	0.89	2.76	43.3	-56.6	3.98	67.91	-32.

germination. The percentage of germination for different varieties of crops under pharmaceutical industry effluents have been shown in Table II and Figure 1. The effect of industrial effluent may vary from crop to crop because each species has its own tolerance limit (Nath *et al.,* 2009).

The impact of the pharmaceutical industry effluents on root and shoot length for various crops has been displayed in Table III-IV as well as in Figure 2-3. In terms of Okra the highest shoot length (2.06 cm) was recorded in control compared to all other treatment and the lowest one (0.76 cm) was recorded in 100% of effluent concentration. For Data

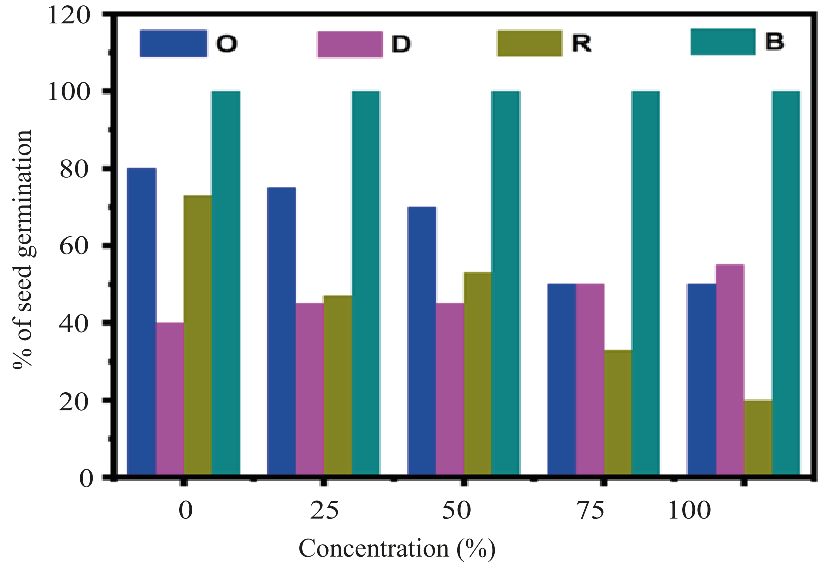

Fig. 1. Percent of seed germination with effluent concentrations for various crops [Here O, D, R and B stands for Okra, Data Shak, Ridge Gourd and Black Mustard respectively]

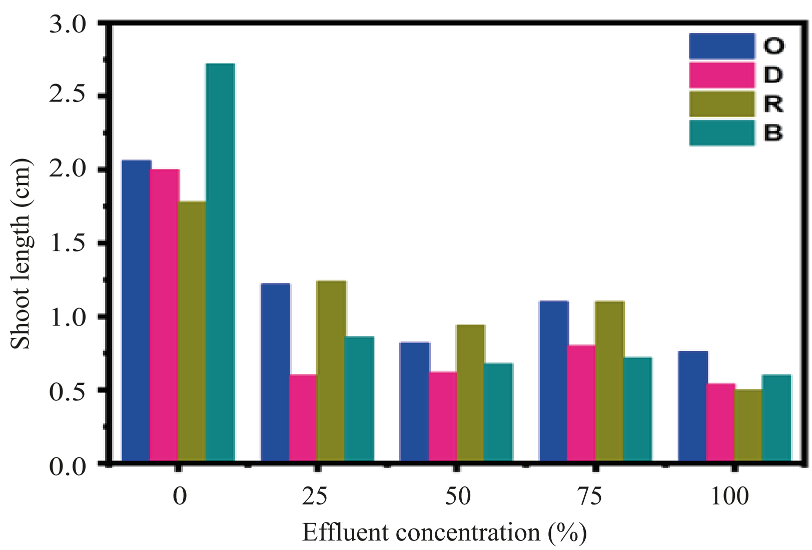

Fig. 2. Variation of shoot length with effluent concentrations for various crops [Here O, D, R and B stands for Okra, Data Shak, Ridge Gourd and Black Mustard respectively]

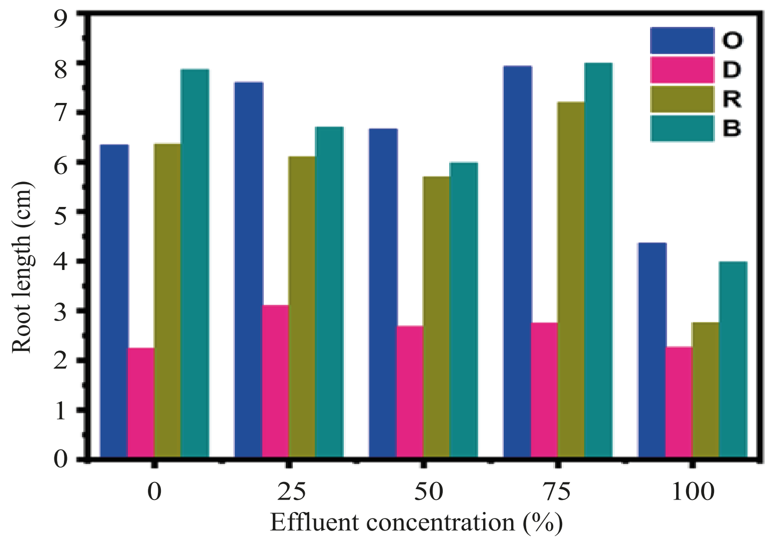

Fig. 3. Variation of root length with effluent concentrations for various crops [Here O, D, R and B stands for Okra, Data Shak, Ridge Gourd and Black Mustard respectively]

shak the highest shoot length was recorded at control (2 cm) and the lowest shoot length was recorded at 100% concentration (0.54 cm), the trend was similar as Okra. Also a similar trend was observed in terms of Ridge gourd and Black mustard. The overall finding reveals that most elongated shoot was counted for Black mustard (2.72 cm). Similar trend was observed for shoot length of all of the selected plants. But a point to be noted that the most elongated root was observed for Okra (7.92 cm).

Conclusion

This study concludes that physico-chemical parameters such as pH, electrical conductivity, COD, TS, TDS, and TSS were relatively high in pharmaceutical effluent and severely affected seed germination. The untreated pharmaceutical effluent could possibly lead to soil deterioration and low productivity. The effect may vary from crop to crop because each plant species has its own tolerance of the different effluent concentrations. So as the effluents are toxic, finally it is suggested that long term experiments should be conducted to explore the effect of wastewater on above suggested aspects before its use for irrigation. This study contributes to enhance the knowledge about how the pharmaceutical industry effluents effects on seed germination, seedling growth, root and shoot length of some common cultivated crops which might be a milestone for future researchers to do same kind of works.

References

American Public Health Association (APHA), (1989), Standards methods for the examination of water and waste water, 17th Ed. Washington DC.

Amina K, Muhammad F, Faiza S, Muhammad UH, Laila S and Gul ZG (2020), Effect of industrial wastewater on wheat germination, growth, yield, nutrients and bioaccumulation of lead, Scientific reports **10** (11361) 1-9. DOI: org/10.1038/s41598-020-68208-7.

Arai S (2002), Global view on functional foods: Asian perspectives, *British journal of nutrition* **88:** 139-143. DOI: org/ 10.1079/BJN2002678.

Duncun DB (1957), A significance test for difference between rank treatments in an analysis of variance, *Virgina Journal of science* **2:** 171-189

Ghafoor A, Raur A, Arif M and Muzaffar W (1994), Chemical composition of effluents from different industries of the Faisalabad city, *Pakistan journal of agricultural science* **3**(4): 367-370.

Islam MR, Rahman GKMM, Saleque MA and Uddin MJ (2017), Effect of industrial effluents on seed germination and seedling growth of rice, *Dhaka university journal of biological science* **26**(1): 59-68.

Hoque ATMR, Uddin MB Ahmed R and Hossain MK (2003), Suppressive effects of aqueous extracts of AzadirachtaIndica leaf on some initial growth parameters of six common crops, *Asian Journal of Plant Sciences* **2**(10): 738-742. DOI: org/738-742, 10.3923/ajps.

Iqbal H, Kanwal R, Muhammad AA, Rizwan R, Javeria G, Muhammad SHA and Rohina B (2021), Effect of pharmaceutical effluents on growth, oxidative defense, seconadary metabolism and Homeostasis in carrot, *Dose response* **19**(2): 1-11. DOI: org/10.1177/1559325821998506

Lubello C, Gori R, Nicese FP and Ferrini F (2004), Municipal-treated waste water reuse for plant nurseries irrigation, *Water Research* **38:** 2939-2947. DOI: org/10.1016/j.watres.2004.03.037.

Maukeeb ARM, Mondal MF, Saha M and Hasan MK (2018), Effect of industrial on seed germination and growth of Radish, *J. Sylhet Agril. Univ* **5**(1): 51-59.

Nath K, Singh D, Shyam H and Sharma YK (2009), Phytotoxic effects of chromium and tannery effluent on growth and metabolism of Phaseolus mungo Roxb, *Journal of Environmental Biology* **30:** 227–234.

Nawaz S, Ali SM and Yasmin A (2006), Effect of industrial effluents on seed germination and early growth of Cicerarientum, *Journal of Biological Science* **6:** 49-54. DOI: org/10.3923/ jbs. 2006.49.54.

Niroula B (2003), Comparative effects of industrial effluents and sub-metropolian sewage of biratnagar on germination and seedling growth of rice and blackgram, *Our nature* **1:** 10–14. DOI: org//10.3126/on.v1i1.296.

Panasker DB and Pawar RS (2011), Effect of textile mill effluent on growth of Vignaunguiculata and Pisumsativum seedlings, *Indian Journal of Science and Technology* **4:** 266-272. DOI: org/10.17485/ ijst/2011/v4i3.15.

Pathak H, Joshi HC, Chaudhary A, Chaudhary H, Kalra N and Dwiwedi (2009), Soil amendment with distillery effluent for wheat and rice cultivation, *Water, Air and Soil Pollution* **113:** 133–140. DOI: org/10.1023/ A:1005058321924.

Ramana S, Biswas AK, Kundu S, Saha JK and Yadava RBR (2002), Effect of distillery effluent on seed germination in some vegetable crops, *Bioresource Technology* **82:** 273–275. DOI: org/10.1016/S0960-8524(01)00184-5.

Rao GM and Kumar NV (1983), Impact of Tannery Effluents on Seed Germination in CicerArintum, *Pollutant research journal* **5:** 232-233.

Rena G, Iris S, Kazuhito A, Benny C and Henryk C (2020), Pharmaceuticals in treated wastewater induce a stress response in tomato plants, *Scientific Reports* **10:** 18-56. DOI: org/1038/s41598-020-58776-z.

Rodosevich SR, Claudio GH and Jodie SH (1997), Implications for Management. Wiley Publishers, New York, USA, pp 535-568.

Salian R, Wani S, Reddy R and Patil M (2018), Effect of Brewery wastewater obtained from different phases of treatment plant on seed germination of chickpea (Cicer arietinum), maize (Zea mays), pigeon pea (Cajanuscajan), *Environmental science and pollution research* **25:** 9145-9154. DOI: org/10. 1007/s11356-018-1218-9 .

Sankar NS and Dipak P (2014), Impact of Jute mill waste water on seed germination and vigour index of Cicer Arietinum L. and Pisum Sativum L., *Journal of* *biological and scientific opinion* **2**(1): 66-69. DOI: org/10.7897/2321-6328.02115.

Saravanmoorthy MD and Ranjitha-Kumari BD (2007), Effect of textile waste water on morpho-physiology and yield on two varieties of peanut (Arachis hypogea L.), *Journal of Agricultural Technology* **3:** 335-343.

Singh R and Rathore D (2021), Effect of fertilization on textile effluents on germination, growth and metabolites of chilli (Capsicum annum L) cultivars, *Environmental Processes* **8:** 1249-1266. DOI: org/10.21203/rs.3.rs-226725/v1.

Thamizhiniyan P, Sivakumar PV and Lenin M (2009), Sugar mill effluent toxicity in crop plants, *Journal of Phytology* **1:** 68-74.

World Health Organization (WHO) (2002), Water Pollutants: Biological Agents, Dissolved Chemicals, Non-Dissolved Chemicals, Sediments, Heat, CEHA, Amman, Jordan.

World Health Organization (WHO) (2003), The World Health Report, Shaping the Future, 1211, Geneva 27, Switzerland.