Determining the Effect of Tannery Effluent on Seeds Germination of Some Vegetables in Ejersa Area of East Shoa, Ethiopia

Aklilu Asfaw*, Mengistu Sime*, Fisseha Itanna**

*Department of Plant Sciences, School of Agriculture, Adama Science and Technology University, Adama, Ethiopia, P.O.Box 1888; e-mail:akhir@ethionet.et; aklilplanet49@gmail.com; simemengistu@gmail.com; msimeb@yahoo.com
**Department of Plant Biology & Biodiversity Management, Addis Ababa University, Addis Ababa, Ethiopia, P.O.Box 1176, E-mail: fissehai@yahoo.com

Abstract: This study was conducted to determine the effect of tannery effluent on seed germination of six different vegetable crops seeds under laboratory condition. The major objective of this research work was to make a comprehensive study on the status of vegetable seeds germination using different effluent treatments located in East Shoa, Ethiopia. The treatments were made by mixing measured amount of tannery effluent in distilled water i.e. 0, 25, 50, 75 and 100% concentrations on seed germination of six vegetable crops seeds, namely: onion (Allium cepa L.), carrot (Daucus carota L.), beet root (Beta vulgaris L.), Swiss chard (Beta vulgaris L.), tomato (Lycopersicum esculentum L.) and cabbage (Brassica oleracea L.). The seed germination experiment was carried out in Completely Randomized Design (CRD) with five effluent concentrations (treatments), each replicated three times. All vegetable crops seeds were grown in different effluent concentrations and the effects of different concentrations of effluents were compared to that of distilled water (control). Parameters considered to study the effect of effluents were percentage germination, shoot length (cm), root length (cm), seedling length (cm), fresh weight per seedling (mg), dry weight per seedling (mg) and relative toxicity (%). The results indicated that, application of effluent did not show any inhibitory effect on seed germination and other morphological parameters at low concentration except in onion, carrot and tomato, which were found susceptible with 75 and 100% effluent mixtures but, Swiss chard, beet root and cabbage were found resistant to all effluent concentrations mixtures. Based on the tolerance to tannery effluent, the vegetable crop seeds studied are arranged in the following order: Swiss chard > cabbage > beet root > tomato > carrot > onion. With the increase in effluent concentration, all plant parameters decreased accordingly. Different physicochemical parameters of water such as:- p^H, temperature, electrical conductivity (EC), biological oxygen demand (BOD), chemical oxygen demand (COD),total dissolved solids (TDS), Cd, Cr, Cu, Fe, Pb, and Zn were analyzed. From the result obtained, most of the results were found under the optimum values on water body except EC, COD and Cr for safe aquatic environment.

Index Terms- Heavy Metals, Morphological Parameters, Seed Germination, Tannery Effluents, Vegetable Seeds

I. INTRODUCTION

The tannery industry in Ethiopia is among the country's largest external income earners. Consequently, during the past 20 years the industry has had significant government support and has multiplied throughout Ethiopia. With the ever increasing demand on irrigation water supply, farmlands are frequently faced with utilization of poor quality water. In many parts of Ethiopia, wastewater, which is disposed to wells, ponds, streams and treatment plants, is used as a source of irrigation water as well as for drinking. But, the continued application of poor quality irrigation water can reduce the yield of farmlands (Eskindir Zinabu, 2002).

Studies have documented that direct disposal of effluents to land and water bodies has potential to contaminate air, surface, ground water as well as soils and crops grown on these soils which will have bearing on human health (Khurana and Pritpal, 2012). Environmental pollution is a matter of great concern and has been accepted as a global problem because of its adverse effects on human health, plants, animals and exposed materials. Land pollution occurs from different degradable and non-degradable materials. These materials may be solid wastes, trash, chemicals and leaf litter etc. Usually, the industries through their effluents pollute different water bodies e.g. rivers, canals, seas etc. Pollutants may be toxic organic and inorganic or dissolved and suspended solids (Moeller and Dade, 1992).

Water pollution is a large set of adverse effects upon water bodies such as lakes, rivers, oceans and ground water caused by human activities. Water pollution is a result of addition of large amounts of toxic materials. The major causes of water pollution can be classified as municipal, agricultural and industrial wastes. Industries discharge a variety of pollutants in their wastewater including heavy metals, resin pellets, organic toxins, oils, nutrient and solids. Discharge can also have thermal effects, especially those from power stations, and these to reduce the available oxygen. All sectors of our society generate waste: industry, agriculture, mining, energy, transportation, construction and consumers. Waste contains pollutants which are discarded materials, process materials or chemicals. Pollution could be caused by these pollutants when they are released beyond the assimilation capacity of the environment. Industrial wastes are generated from different processes and the amount and toxicity of waste released varies with its own specific industrial processes (Alebel Abebe, 2010).

Tannery industry uses an extensive amount of water for processing of hides. For 1kg of hide the necessary requirement is 50-60 lt of water during the process of tanning. But often at present times these tanneries use three times much water than normally required for 1kg of hide (Indira and Ravi, 2006). The discard of these wastes causes serious problems because effluents of tannery without treatment have high chemical oxygen demand (COD), biological oxygen demand (BOD) and high quantities of salts like chromium, sulfide and chloride, which are highly alkaline (Bajza and Vrcek, 2001). During the production of hides, 1,000 kg of fresh skin is salted with 350 kg of sodium chloride and the skin absorbs 200 kg of salt, releasing much water. Salted skin has about 400 kg of dry matter, 235 kg of NaCl and 325 kg of water (Luciano et al., 2010). Wastewater generally has about 80 gm/l of NaCl. During tanning process, chromium is applied to 90 % of leather produced in the world. Chromium is used to convert the skin into leather, and is used excessively to improve the quality of the tanning process (Bajza et al. 2005; Ram et al. 1999). However, only 60 - 80% of chromium is absorbed by the leather and the remaining is usually discharged in sewage system. This metal accumulated in vegetables is toxic and even in small concentrations causes health risks such as cancer, mutation, or miscarriages (Arfaoui et al., 2005; Fahim, 2006). The purpose of this research is to determine the effect of tannery effluent on seed germination and other parameters of some vegetables. This research work may create better awareness to all tanneries and other industries which are discharging effluents in large amounts without considering an approximate method of discharging wastewater to the environment.

II. Materials and Methods

2.1 Location and climatic condition: The research was conducted at Ethiopia Tannery Share Company, in Ejersa area which is located 90 km Southeast of Addis Ababa with grid reference of 8º47´30´´ longitude and 39º06´87´´ latitude (Fig. 1). This area is characterized by a semi-arid climate having an altitude of 1630m.a.s.l, an average annual rainfall of 800mm and the minimum and maximum temperature of 17.5ºC and 26ºC, respectively. The area is part of the Southern Rift Valley of the country, which includes the zone from Lake Chewbahir on the Kenyan border to Lake Koka on the Southeast of Addis Ababa (Kefyalew Assefa et al., 2011).

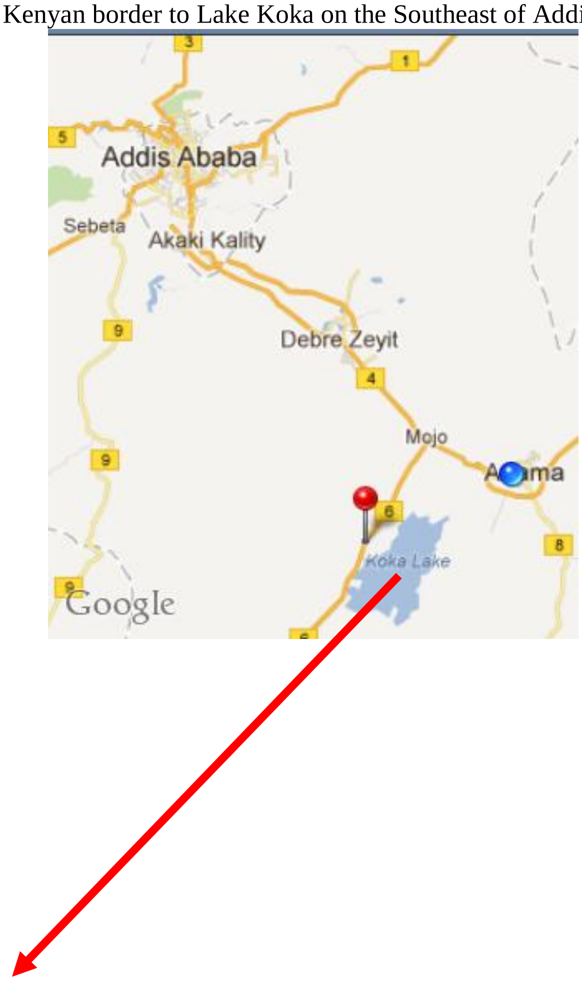

Figure 1: Location map of the Ejersa area and Koka Lake

2.2 Vegetable Seeds Germination Test. The present study was conducted with seeds of six types of vegetable crops, namely: onion *(Allium cepa L., Var. bombay red),* carrot *(Daucus carota L., Var. nantus), b*eet root *(Beta Vulgaris L, Var. detroit dark red.),* Swiss chard *(Beta Vulgaris L., Var. fordhook giant),*tomato *(Lycopersicum esculentum L., Var. roma VF) and* cabbage *(Brassica oleracea L., Var. Copenhagen market). The seeds* were purchased from vegetable seed importers by keeping the higher standard of purity and quality of germination. The effluents was obtained from Ethiopia Tannery Share Company. The effluents was collected in plastic containers directly from the outlet of the tannery and prepared in different concentrations (treatments). The treatments were made by mixing measured amounts of wastewater in distilled water i.e. undiluted (100%) or diluted (25%,50%,75%) effluent. The following treatments were used in the experiments: T_0 = distilled water (control), T_1 = 25% effluent concentration, T_2 = 50% effluent concentration, T_3 = 75% effluent concentration, T_4 = 100% effluent concentration (undiluted). Germination experiments were carried out in sterilized 10 cm diameter petri dishes lined with Whatman N^o 41 filter paper at 26 ± 2^0C in the dark. Fifty seeds from each type of vegetable seeds were kept for germination in each of 10 cm petri dishes containing 5 ml of different concentrations including distilled water (Ghimire and Bajracharya, 1996).

The total number of germinated seeds was counted at 24 hrs interval starting from the 3^{rd} day of sowing up to 11 days and germination percent was obtained. For the study of different morphological parameters like:- germination percentage, seedling length, shoot length, root length, fresh mass, dry mass and relative toxicity, ten days old seedlings were measured. For each treatment six independent experiments were carried out, consisting of three replications in completely randomized design (CRD) arrangement.

The collected effluent sample was also transported to Jije Analytical Service Laboratory and Addis Ababa University, Earth Science Department Laboratory. Samples were analyzed for various physico-chemical properties following the method given by APHA (1998) using FAAS (Flame Atomic Absorption Spectrometer) and GFAAS (Graphite Furnace Atomic Absorption Spectrometer) AAnalyst 600 Perkin Elmer, used to determine heavy metals such as Cd, Cr, Cu, Fe, Pb, and Zn and other parameters. p^H was determined by p^H meter, EC (electrical conductivity) by EC meter, TDS (total dissolved solids) by gravimetric (determination by weight), BOD (biological oxygen demand) by dissolved oxygen meter (incubator), and COD (chemical oxygen demand) by open reflux method (volumetric).

To determine the presence of heavy metals in the collected effluent samples 100ml of each of the effluent samples were filtered using Whatman No. 41 filter paper then transferred into Pyrex beakers containing 10ml of concentrated HNO_3. The samples were boiled slowly and then evaporated on a hot plate to the lowest possible volume (about 20ml). The beakers were allowed to cool and another 5ml of concentrated HNO_3 was added. Heating was continuous with the addition of concentrated HNO_3 as necessary until digestion was complete. The EPA (2003) vigorous digestion method described by Gregg (1989) was also adopted for determining heavy metals.

The samples were evaporated again to dryness (but not baked) and the beakers were cooled, followed by the addition of 5ml of HCl solution (1:1 v/v). The solutions were then warmed and 5ml of 5M NaOH was added, then filtered. The filtrates were transferred to 100ml volumetric flasks and diluted to the mark with distilled water. These solutions were then used for elemental analysis. A total of six metallic elements Cd, Cr, Cu, Fe, Pb and Zn were determined in the pre-treated samples of water using Atomic Absorption Spectrophotometer as described by Gregg (1989).

2.3 Morphological Studies

Germination percentage:- The number of seeds germinated in each treatment was counted on 10th day after sowing and the germination percentage was calculated by using the following formula.

$$\text{Germination \%} = \frac{\text{No. of seeds germinated}}{\text{Total No. of seeds sown}} \times 100$$

Root and shoot length:- Five seedlings were taken from each treatment and their shoot and root lengths in cm were measured by using a measuring ruler and the values were recorded.

Fresh and dry weight:- Five seedlings were collected from each treatment and their fresh weights in mg was measured with the help of an electrical single pan balance. Their dry weights in mg was taken after keeping them in a hot air oven at 80°C for 24 hours by using an electrical single pan balance.

Relative Toxicity (% RT):- Relative toxicity on seed germination and seedling growth of each vegetable was calculated to determine the degree of inhibition over control, by using the following formula (Chapagain, 1991).

$$RT(\%) = \frac{(X-Y)}{X} \times 100\%$$

Where:

X= Germination percentage or seedling length in control at particular hour of incubation

Y= Germination percentage or seedling length in the presence of effluent at the same hour of incubation

The collected data were subjected to statistical analysis as per the design and Duncan's Multiple Range Test (DMRT) was used to compare treatment means following methods described by SAS software package 2010.

III. Results and Discussions

Federal Democratic Republic of Ethiopia-Environmental Protection Authority (EPA, 2003) limits for surface water and United States Environmental Protection Authority (USEPA, 2004) guidelines for maximum limits for irrigation water are compared (Table 1). The physicochemical analysis result of the tannery effluent was found higher in COD, EC, Pb and Cr from the recommended discharge limit, but the result for other parameters remained under the recommended discharge limit (Table 1).

Table 1: Physicochemical characteristics of tannery effluent collected from the outlet

Parameters	Concentrations (Results)	Maximum discharge limit USEPA (2004)
Temperature (ºC)	23.9	40.0
P^H	7.14	6 - 9
Electro Conductivity, EC (µs/cm)	9420	1000
Biological Oxygen Demand, BOD (mg/l)	147.29	300.0
Chemical Oxygen Demand, COD (mg/l)	930.60	500
Total Dissolved Solid, TDS (mg/l)	319	500
Cadmium, Cd (mg/l)	0.0056	0.2
Copper, Cu (mg/l)	0.0093	73.3
Chromium, Cr (mg/l)	3.91	2.0
Iron, Fe (mg/l)	1.70	5.0
Lead, Pb (mg/l)	0.98	0.3
Zinc, Zn (mg/l)	0.21	99.4

The concentrations of Cd, Cu, Zn, and Fe were found less than the maximum limit. Chromium generally has the highest concentrations in the analyzed sample while Cd was found the least from all. The metal concentrations in effluent samples in this study decreased in the order of Cr > Pb > Fe > Zn> Cu > Cd with the exception of chromium and lead. The analyzed effluent sample concentrations in this study were within the limits and therefore posed no danger to consumers as far as these specific heavy metals are concerned. Normally chromium is known to have chronic toxicity (above 5 mg/l) in drinking water (Adelekan and Abegund, 2011).
In the analyzed effluent sample the electrical conductivity was recorded higher than the standard limits, which indicates the presence of high concentration of salts in the solution and bears direct relation with osmotic potential. Result of statistical data analysis for six different vegetable crops seeds on germination and other morphological parameters in different effluent concentrations are illustrated below on (Tables 2-7)

Table 2: Some growth parameters of onion *(Allium cepa L.)* seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00^{a}	5.43^{a}	2.00^{a}	7.43^{a}	8.36^{a}	0.33^{a}	0^{e}
T_1	76.00^{b}	4.30^{b}	1.00^{b}	5.30^{b}	4.88^{b}	0.32^{b}	22.33^{d}
T_2	55.33^{c}	2.43^{c}	0.80^{c}	3.27^{c}	1.87^{c}	0.12^{c}	44.67^{c}
T_3	35.33^{d}	1.67^{d}	0.58^{d}	2.25^{d}	0.96^{d}	0.04^{d}	64.67^{b}
T_4	20.67^{e}	0.87^{e}	0.35^{e}	1.22^{e}	0.68^{e}	0.03^{e}	79.33^{a}
CV(%)	8.9	2.4	0.6	2.3	0.6	3.1	11.7

Means followed by different letters within the same column are significantly different at 5% probability level.

The effect of tannery effluent on germination of onion *(Allium cepa L.)* was observed highest in treatment T_1(25% effluent concentration) and lowest in treatment T_4 (100% effluent concentration), which was recorded 76.0% and 20.67% respectively. This shows the lowest psercent inhibition in case of T_1 (25% effluent concentration), which increased with increasing in effluent concentration (76%, 55.33%, 35.33% and 20.67%). The average shoot length in all concentrations was greater than the average root length (Table 2). Similar results were also reported by (Ramamoorthy *et al*,1992). The average percent of germination shoot length, root length and seedling length of the germinated seeds decreased with increasing effluent concentrations. Highest stimulation was observed in at T_4 treatment (20.67%, 0.87cm, 0.357cm and 1.227cm) respectively, lowest stimulation at T_1 treatment (76%,4.3 cm,1.00 cm, and 5.3 cm) respectively. Decreasing in root length, shoot length, seedling length, fresh mass and dry mass was found with the increase of concentration compared to T_0, control (% effluent) Table 2.

The effluent in different concentrations imposed inhibitory effect on both shoot and root growth However, the inhibition on shoot growth was more significant than that of root growth. In the present study, relative toxicity analysis on the seed germination revealed that there was a significant differences in the sensitivity of carrot seed to the tannery effluent. The relative toxicity increases in increasing of effluent concentrations in T_1, T_2, T_3 and T_4 which was (22.33%, 44.67%, 64.67%, 79.33%) respectively.

Table 3: Some growth parameters of carrot *(Daucus carota L.)* seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00^{a}	4.53^{a}	3.67^{a}	8.20^{a}	5.46^{a}	0.16^{a}	0^{e}
T_1	87.33^{b}	3.93^{b}	1.77^{b}	5.67^{b}	3.81^{b}	0.09^{b}	12.67^{d}
T_2	55.33^{c}	2.93^{c}	1.46^{c}	4.40^{c}	2.21^{c}	0.07^{c}	44.67^{c}
T_3	41.33^{d}	2.40^{d}	0.70^{d}	3.10^{d}	1.28^{d}	0.05^{d}	58.67^{b}
T_4	32.67^{e}	0.45^{e}	0.35^{e}	0.80^{e}	0.67^{e}	0.03^{e}	67.33^{a}
CV (%)	8.9	3.7	5.9	2.7	3.9	5.5	11.6

Means followed by different letters within the same column are significantly different at 5% probability level.

Similar data were also observed in the case of carrot (*Daucus carota L.)*. The relative germination rate of was maximum with T_1 (87.33%) and minimum with T_4 (32.67%) as well as withT_2 and T_3 55.33% and 41.33%. The decreasing trend of germination value of the plants with increasing effluent concentrations may be attributed to increasing toxicity (Table 3).

The average percent of germination shoot length, root length and seedling length of the germinated seeds decreased with increasing effluent concentration. Lowest germination observed in at T_4 treatment (32.67%, 0.450cm, 0.353cm and 0.803cm) and highest vegetative growth with T_1(87.33%, 3.933cm, 3.667cm and 8.20cm) respectively. Regarding the fresh weight and dry weight the weight of seedlings was observed decreasing in increasing effluent concentrations (Table 3).

The Relative toxicity decreases in increasing of effluent concentrations from T_1-T_4 (25% - 100%) which is
(12.67% - 67.33%). In the present study, relative toxicity analysis on the seed germination revealed that there was a significant differences in the sensitivity of carrot seed to the tannery effluent.

Table 4: Some growth parameters of beet root *(Beta vulgaris L.)* seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00^a	3.57^a	2.20^a	5.70^a	8.16^a	0.48^a	0^e
T_1	96.00^b	3.03^b	1.77^b	4.80^b	5.24^b	0.24^b	4.00^d
T_2	89.67^c	2.53^c	1.40^c	3.93^c	3.32^c	0.18^c	10.33^c
T_3	87.33^d	1.53^d	1.20^d	2.73^d	2.2^d	0.12^d	12.33^b
T_4	84.00^e	0.73^e	0.87^e	1.60^e	1.26^e	0.08^e	16.00^a
CV (%)	2.4	2.5	2.7	0.4	0.43	0.7	3.4

Means followed by different letters within the same column are significantly different at 5% probability level.

The data presented in Table 4 shows the effect of tannery effluent on seed germination of beet roots *(Btea Vulgaris L.)*. The germination was stimulated by varying doses of applied effluent. The highest record of percent germination (96%) was observed in case of treatment T_1 (25% effluent concentration). It was followed by T_2 (89.67%) and T_3 (87.33%) and lowest in T_4 (84.0%). It is evident that there was a decrease in germination percentage from T_0 (i.e. control) to T_1 (i.e. 25% effluent), but there was a decline in the values with further increase in the effluent concentrations. The average percent of germination shoot length, root length and seedling length of the germinated seeds decreased with increasing effluent concentration. Lowest growth was observed with T_4 treatment (84.0%, 0.733cm, 0.867cm and 1.60cm), highest growth with T_1 (96.0%, 3.033cm, 1.767cm and 4.80cm) respectively. The same decreasing results were recorded at T_2 and T_3 effluent concentrations.

The Relative Toxicity (4.0%, 10.33%, 12.33%, 16.33%) decreases with increasing effluent concentrations T_1, T_2, T_3 and T_4 (25%, 50%, 75% and100%) were respectively. Regarding the fresh and dry weight of seedlings it was observed that they decreased with increasing effluent concentrations. The result of relative toxicity was also observed to decrease with increasing effluent concentrations (Table 4).

Table 5: Some growth parameters of Swiss chard (Beta vulgaris L.) seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00^a	4.87^a	2.00^a	6.87^a	8.89^a	0.68^a	0^a
T_1	97.33^b	3.50^b	1.53^b	5.03^b	6.48^b	0.14^b	2.67^d
T_2	91.67^c	2.57^c	0.83^c	3.40^c	4.77^c	0.12^c	8.33^c
T_3	90.67^d	2.33^d	0.50^d	2.83^d	2.39^d	0.09^d	9.33^b
T_4	88.00^e	1.80^e	0.40^e	2.20^e	1.89^e	0.06^e	12.00^a
CV(%)	0.84	3.0	4.4	2.3	3.3	0.9	1.2

Means followed by different letters within the same column are significantly different at 5% probability level.

The highest record of germination percent (97.33%) was observed in case of treatment T_1 (i.e. 25%) effluent concentration from the treated samples. It was followed by T_2 (91.67%) and T_3 (90.67%) and lowest in T_4 (88%). It is evident that there was an increase in germination percentage from T_4 (i.e. 100% effluent) to T_0 (i.e. control).

In this case the germination rate in all effluent concentrations didn't show significant difference (Table 5). The average percent of germination shoot length, root length and seedling length of the germinated seeds decreased with increasing effluent concentrations. Highest stimulation observed in at T_4 treatment (88.0%), lowest stimulation at T_1 (97.33%). The Relative toxicity decreases with increasing effluent concentrations in 25%, 50%,75% and100% were 2.67%, 8.33%, 9.33%, 12.0% respectively. From this result we can conclude that the Beet root seeds were not that much sensitive in all effluent concentrations.

Table 6: Some growth parameters of tomato *(Lycopersicum esculentum L.)* seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00[a]	4.57[a]	2.57[a]	7.13[a]	4.49[a]	0.98[a]	0[e]
T_1	88.00[b]	3.00[b]	2.00[b]	5.00[b]	3.50[b]	0.44[b]	12.00[d]
T_2	62.00[c]	2.50[c]	1.67 [c]	4.17[c]	1.71[c]	0.10[c]	38.00[c]
T_3	54.66[d]	2.00[d]	1.33[d]	3.33[d]	0.50[d]	0.07[d]	45.33[b]
T_4	24.66[e]	0.90[e]	0.47[e]	1.37[e]	0.26[e]	0.03[e]	74.00[a]
CV (%)	10.27	1.24	2.53	2.37	0.94	1.24	12.22

Means followed by different letters within the same column are significantly different at 5% probability level.

The value of germination index was found to be highest in T_1 (88%) treated with lowest (i.e. 25%) effluent concentration. However, germination index was lowest in T_4 (24.67%) treated with highest effluent concentration (100% concentration). This may be attributed to the toxicity caused due to increasing amount of various organic and inorganic compounds present in higher concentrations of effluent. Decrease in the values of germination was observed in T_2 and T_3 treatments (Table 6). Decrease in shoot length, root length, seedling length, fresh weight and dry weight was found in all treatments with the increase of effluent concentration as compared to control T_0 (0% effluent).

The Relative toxicity increases were 12.0%,38.0%, 45.33%, 74.0% with increasing effluent concentrations of 25%, 50%, 75% and 100% respectively. From this result, we can conclude that the beet root seed was not that much sensitive in all effluent concentrations.

Table 7: Some growth parameters of cabbage *(Brassica oleracea L.)* seed as affected by different effluent concentrations

Concentrations	Vegetative growth characteristics						
	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm	Fresh weight (gm)	Dry weight (gm)	Relative toxicity (%)
T_0	100.00[a]	6.97[a]	6.50[a]	13.47[a]	7.39[a]	0.47[a]	0 [e]
T_1	96.67[b]	4.50[b]	3.80[b]	8.30[b]	6.17[b]	0.35[b]	3.33[d]
T_2	92.67[c]	3.50[c]	2.73[c]	6.30[c]	5.17[c]	0.27[c]	7.33[c]
T_3	83.33[d]	3.00[d]	2.07[d]	5.20[d]	3.58[d]	0.18[d]	16.68[b]
T_4	74.67[e]	2.00[e]	1.57[e]	3.57[e]	2.50[e]	0.08[e]	25.33[a]
CV (%)	1.19	0.8	4.64	1.46	1.45	2.27	1.84

Means followed by different letters within the same column are significantly different at 5% probability level.

The germination rate of cabbage increased with increasing concentration of effluent, and it was recorded maximum in T_1 (96.67%) followed by T_2 (92.67%) and T_3 (83.33%) minimum in T_4 (74.67%). That means the germination rate had some inhibition with increasing effluent concentrations. On the other hand, 100% germination was recorded in control T_0 (0% effluent). Decrease in shoot length, root length, seedling length, fresh weight and dry weights was found in all effluent concentrations with increase of effluent concentrations compared to control T_0 (0% effluent). The effluent in different concentrations imposed inhibitory effect on both shoots and root growth (Table 7).

The Relative Toxicity increases with increasing effluent concentrations (3.33%, 7.33%, 16.68%, 25.33 %) respectively. Analysis of relative toxicity of the tannery effluent on seed germination of cabbage under different effluent concentrations revealed that at early period of sowing there was greater degree of toxicity which was recorded in all vegetable seeds germination at all effluent concentrations, which decreased significantly ($F=P<0.05$). In the present study, growth parameters analysis on the seed germination revealed that there were a significant difference in the sensitivity of cabbage seeds to the concentrations of tannery effluent.

It was observed that values for morphological parameters i.e. germination (%), root length (cm), shoot length (cm), seedling length (cm), fresh mass (mg) and dry mass (mg) and relative toxicity (%) were found to be highest in treatment T_1 (25% effluent concentration) and lowest in treatment T_4 (100% effluent concentration). Present investigation has clearly shown that the tannery effluent was toxic to the seed germination and other plant parameters especially to onion, carrot and tomato under T_4 (100%) effluent concentration which was recorded as 20.67%, 32.67% and 24.66% of germination respectively. Almost similar observations were made by Padhan and Sahu (2009) while working on the effect of rice mill effluent on seed germination of cereal crops.

Germination percent of vegetable seeds like, cabbage, beet root and Swiss chard showed 74.67%, 84.0% and 88.0% respectively even under T4 (100%) effluent concentration. The same result was also recorded on shoot length, root length, seedling length, fresh mass, dry mass and relative toxicity. However, the magnitude of toxicity depends upon the nature and concentration of chemicals present in the effluent. The tannery effluent imposed more pronounced toxic effect on all parameters studied. Higher concentrations of heavy metals present in this effluent associated with the extreme range of pH and high conductivity values are probably the main reasons for their greater toxic effect (Ghimire and Bajracharya, 1996).

Like seed germination, seeding length of all tested vegetable crop seeds were highly sensitive to the tannery effluent but nature of their sensitivity varied with the concentrations of effluent and types of seeds. Moreover, the sensitivity of root length and shoot length also differed accordingly. Investigations have demonstrated that the effect of high osmotic levels on seed germination and growth is due to osmotic inhibition of water absorption or due to toxicity of individual ions (Mayer and Poijakoff , 1982).

Tannery effluents are ranked as the highest pollutants among all industrial wastes. They are especially large contributors of chromium pollution. For instance, in India alone about 2000–3000 tons of chromium escapes into the environment annually from tannery industries, with chromium concentrations ranging between 2000 and 5000 mg/l in the aqueous effluent compared to the recommended permissible discharge limits of 2 mg/l (Altaf et al., 2008).

Tannery effluent toxicity was associated more with the inhibition of root growth than shoot growth. Thukural and Kaur (1987) also reported that the toxicity of trace elements of polluted water was more on roots than hypocotyls. Heavy metals are found to be more toxic for root growth because they accumulate
on the root (Wainright and Woolhouse, 1977; Woolhouse, 1983,) and retard cell division and cell elongation, probably by the interference of the hormonal system (Mukharji and Mitra 1997). Consumption of waste water irrigated agricultural products puts consumers to health risks (Karanja *et al*, 2010). Tannery effluents severely affect the mitotic process and reduce seed germination in extensively
cultivated pulse crops (Altaf et al., 2008). For the agriculture sector p^H value takes an important role in plant growth (Shameen et al. 2010). The standard p^H value needed for agriculture is 7-8. If the pH value is higher than standard value then it affects the plant growth. The temperature of industrial effluents is greater than room temperature. The high temperature reduces the solubility of oxygen in the water (Nawaz et al, 2006).

Moreover, the high conductivity values of tannery effluent indicates the presence of high levels of anions and cations, which bear direct relation with salinity and osmotic potential (Trivedy and Goel, 1986). This may be another factor for their greater toxicity. Investigations have demonstrated that the effect of high osmotic levels on seed germination and growth is due to osmotic inhibition of water absorption or due to toxicity of individual ions (Mayer and Poijakoff, 1982).

In the present study, relative toxicity analysis on the seed germination revealed that there was significant difference on the sensitivity of six types of vegetable seeds to the tannery effluent. Data from the dilution experiments confirmed a close relation between the concentration of various ions present in the effluent and degree of toxicity on seed germination and seedling growth. It is thus evident from the present investigation that all morphological parameters are highly sensitive to the concentration of the tannery effluent except cabbage, beet root and Swiss chard as compared to control.

Bosnic et al, (2000), have reported that large quantities of sodium chloride salt are used in hide and skin preservation or during the pickling process. Being highly soluble and stable, they are unaffected by effluent treatments and nature, thus remaining as a burden on the environment. Mondal et al, (2005), reported that chemicals such as sodium as sodium carbonate, sodium bicarbonate, sodium chloride and calcium chloride based in tanning causes the alkalization of soil resulting in the increase of p^H of the soil. Rajamani (1987) gives a BOD range of 100–3000 mg/l depending upon the volume of water used and on other impurities. Thus, tannery effluent can be beneficially used for irrigational purpose after proper dilutions and can be discharged safely into the soil (Ramana and Biswas, 2002). At times, it has been observed that industrial effluents are used as drinking water by few communities around Addis Ababa. However, this is a great health concern because the levels of some metals may be toxic when effluents are consumed as drinking water. The World Health Organization, (1996) set the maximum permissible limits of heavy metals in drinking water as follows; Cadmium (0.003 mg/l), Chromium (0.05mg/l), Copper (2.0 mg/l), Iron (5.0 mg/l), Lead (0.01 mg/l) and Zinc (0.02 mg/l).

IV. Conclusions and Recommendations

The outcome of the analysis of physiochemical parameter is shown in the Table 1. It shows that the values were slightly apart from the optimum values that are required in safe aquatic environment to establish an aquatic ecosystem on water body. Due to degradation in water quality, it becomes a concern when population growth and industrial development produce a concentration of society's wastes that imperil public health. If the pH value is higher than standard value then it affects the plant growth.

From the study it is revealed that, the different concentrations of the tannery effluent have significant effect on some types of vegetable seed parameters. Good growth was observed in cabbage, Swiss chard and beet root in 25%, 50% and 75% effluent concentrations, but on onion, carrot and tomato poor growth were recorded above 50% concentration.

From the above results, we conclude that, cabbage, Swiss chard, beet root and cabbage seeds have better growth than onion, carrot and tomato in all concentrations of the tannery effluent. The above findings lead to the conclusion that untreated tannery effluent enhances germination of some vegetable seeds at lower concentrations whereas higher effluent concentrations cause inhibitory effect.

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