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Original Article

In vitro EFFECTS OF TANNERY EFFLUENTS ON SEED GERMINATION AND GROWTH PERFORMANCE OF MAIZE (*Zea mays*), SPINACH (*Spinacia caudatus*) AND LETTUCE (*Lactuca sativa*)

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ABSTRACT

Tannery effluents collected from Sharada industrial area, Kano State were analyzed for their physiochemical parameters, heavy metals analysis and impact on seed germination and seedling growth of maize (*Zea mays*), spinach (*Amaranthus caudatus*) and lettuce (*Lactuca sativa*) under laboratory conditions. Different concentrations of the effluents were prepared using standard methods in a Completely Randomized Designed (CRD) with the five treatments viz: 20, 40; 60, 80, and 100% concentrations in three replicates. The mean percentage germination, phytotoxicity, seedling length (cm), root length (cm), dry weight (gm) and fresh weight (gm) of all the seed revealed considerable reduction at higher (80% and 100%) effluent concentrations on seed germination and other morphological parameters. While the mean values of effluent concentration on phytotoxicity follows the order; maize 82% >lettuce 75% > spinach 29% and the percentage germination showed; spinach 31% > lettuce 25%> maize 22%.This showed that maize seeds were more susceptible to the tannery effluent than the other seeds, an indication of its adverse effects on the germination and seedling growth. The mean values of physicochemical parameters and heavy metals were within the WHO standard permissible limit for irrigation water with the exception of chromium which had 1.32± 0.35 mg/L. Although some of the heavy metal concentrations were within the permissible limits but the specific problem associated with heavy metals in theenvironment is their accumulation through food chain with long term effect. The tannery effluents reflect inhibitory effect to the seed varieties at higher concentrations. It is concluded that morphological analysis of the tannery effluent at lower concentration enhances seed germination where as at higher concentration causes inhibitory effect.

Keywords: Tannery effluent, Physicochemical Parameters, Seeds Germination, Phytotoxicity, Heavy metals

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INTRODUCTION

Water pollution due to industrial discharge is obtaining greater dimension day by day in many industrialized countries (Abdulmumin *et al.*, 2014). Tannery waste is generated in huge amounts during the process of tanning by leather industries throughout the world (Nawaz and Ali, 2006). It is considered one of the most polluted industrial wastes and contains high amounts of heavy metals which are very toxic to plants, animals and soil (Sing *et al.*, 2011).The direct discharge of the untreated water especially effluents from tanneries into bodies of water has become a growing environmental problem (Sing *et al.*, 2011). Most of these wastewaters are extremely complex mixtures containing inorganic and organic compounds including heavy metals (Fu *et al.,* 1994; Bajza and Vrcek, 2001).

The pollutants from the tanneries have caused considerable damage in drinking water supply, irrigation and when allowed to stagnate they produce odour nuisance with unsightly appearance (Sangeetha *et al.*, 2012). Tannery wastewater encloses extensive amounts of perilous pollutants in which heavy metals are very common (Saranraj and Sujitha, 2013).Tannery wastes are known to reduce germination, growth and yield of grain, wheat and lettuce crops (Jamal *et al.,* 2006). It has been reported that plant uptake metals such as chromium from tannery wastes become available in roots, shoots, leaves, flowers and fruits (Mandakini and Khillare, 2015).

In Nigeria, cities like Kaduna, Lagos, Kano and Aba depend usually on its river for water supplies (Nwachuku *et al.,* 1989). However, the rush by many African countries to industrialize has resulted in discharge of partially treated or raw wastes into the surrounding bodies of water since the development of treatment facilities cannot keep pace with the rate at which the wastes are generated by the industries (Nwachuku *et al.,* 1989). The rapid population growth, industrialization and economic development of Kano metropolis necessitate people to use contaminated water including land and soil for irrigation activities to cater for the ever increasing population of the area (Muhammed *et al.*, 2015). Heavy metals are continuously introduced to water bodies via several pathways including industrial activities, irrigation, fertilization, atmospheric deposition and point source where metals are produced as a result of refining and refinishing products (Mohammed *et al.,* 2015). Monitoring and assessment of heavy metal concentrations in irrigated water bodies are required to evaluate the potential ecological risk of irrigated water and soils contaminated due to toxic heavy metals (Hang *et al.*, 2009). Heavy metals are known to accumulate in living organisms with tendency of take up subsequently through food chain (Abdulmumin *et al.*, 2014). Murkumar and Chaun (1987) have reported that the higher concentration of tannery effluent decrease enzyme dehydrogenase activity that is considered as one of the biochemical change which can disrupt germination and seedling growth. Therefore, it is necessary to study the impact of these effluents on crop system before they are recommended for irrigation (Thamizhiniyan *et al.,* 2009). In view of the forgoing this research was conducted to determine the effect of tannery effluent on seed germination and growth performance of maize, lettuce and spinach seeds under laboratory condition.

MATERIALS AND METHODS

Seeds collection

Maize variety (Comp 1), spinach (Comp 2) and lettuce (EVDT) seeds were collected from International Institute of Tropical Agriculture (I. I.T.A.), Kano Centre.

Collection and Analysis of Tannery Effluents

The tannery effluent was collected in a dark 30 liters container from the outlet of a tannery industry, located at Sharada Industrial Area, Kano where a significant proportion of tanneries and textile mills factories operate. The effluents were analyzed for the following physicochemical parameters in three replicates: Colour, pH, Total Dissolved Solid (TDS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Electrical Conductivity, using standard methods as described by APHA (1995). Cadmium, Chromium, Copper, Lead and Zinc were analysed using Atomic Absorption Spectrophotometer (Buck Scientific VGP 210) at Soil Science Department, Bayero University Kano using the method described by Gregg (1989). The procedure involved transferring of 100cm^3 of acidified water sample [pH=2] into a Pyrex beaker with 10cm^3 of conc. HNO_3.The sample was always boiled slowly and evaporated on a hot plate to the lowest possible volume (about 20cm^3) before precipitation occurred. The beaker was allowed to cool for another 5cm^3 conc. HNO_3 was also added and returned to the hot plate and covered with a watch glass. The temperature of the hot plate was increased to obtain a desired refluxing action. Heating was continued with addition of concentrated HNO_3 as necessary until digestion was complete by the formation of a light colored solution. The sample was evaporated to dryness (but not baked) the beaker was allowed to cooled , and 5cm^3 of 1:1 HCl. Solution was added and warmed a gained, followed by the addition of 5cm^3 of sodium hydroxide (NaOH). The wall of the beaker and watch glass were washed with distilled water and filtered. Blank was prepared in the same way as above with 100cm^3 of distilled water) instead of the sample solution .The filtrate was transferred to 100cm^3 volumetric flasks and diluted to mark with Distilled water. The pH of the resulting solution was adjusted to 4 by drop wise addition of 5ml (NaOH) Solution. The above solution was analyzed for the presence of Cadmium, Chromium, Copper, Lead and Zinc using atomic absorption spectrometer by determining the absorbance of the element at 217nm wavelength as described by the manufacturers. Concentration of the elements was obtained from standard calibration plot for absorbance against the standard Cadmium, Chromium, Copper, Lead and Zinc concentrations.

Seed Sterilization, Germination and Treatment

Before planting, the maize, spinach and lettuce seeds were sterilized in 250ml beakers containing 10% sodium hypochloride (NaOCl) solution for few minutes and rinsed with several changes of sterile distilled water (Jibrin, 2006). Three sets of six petri dishes were arranged in a row which were numbered from zero to five and labeled clearly at the bottom of each petri dish. Five test solutions (20, 40, 60, 80% and 100% v/v) were prepared by diluting tannery effluent with distilled water while the sixth solution 0% served as a control, which contains ordinary water only. Ten physically healthy and undamaged seeds of maize, spinach and lettuce, of equal size were evenly placed in each sterile Petri dish. The petri dishes were arranged in a Completely Randomized Design with three replicates in each. In the first row, a cotton wool was placed in each petri dish, 10 seeds of the maize were evenly spread on the cotton wool, 5 ml of 20% tannery effluent was pipetted in to the first petridish to wet the cotton wool, 5 ml of 40% tannery effluent was pipetted in to the second petri dish, 5 ml of 60% was also pipetted in to the third Petri dish, 5 ml of 80% was pipetted in to fourth Petri dish, 5 ml of 100%(undiluted tannery effluent) was pipetted in to fifth Petri dish and 5 ml of sterile distilled water was pipetted in to sixth petri dish which was used as a control. The same procedure was repeated for spinach and lettuce seeds. These petri dishes were set up and observed for germination every 24 hours for fifteen (15) days, the emergence of coleoptiles was taken as a sign of germination for each seed type. The number of seeds germinated in each treatment was counted on 15th day after sowing and the percentage germination was calculated as described by Aklilu *et al.* (2012). After observation, the root length, seedling length, dry weight, fresh weight, and phytotoxicity of the seeds for each group were recorded as described byMalaviya and Richa (2013). Total number of germinated seeds was counted at 24 hours intervals, starting from the second day of sowing up to 15th day when germination percentage was obtained

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$$\text{Percentage germination} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

The phytotoxicity (%) was calculated using the formula as described by *Chou et al.* (1978).

$$\text{Percentage of phytotoxicity} = \frac{\text{length of control(cm)} - \text{length of test (polluted sample in cm)}}{\text{length of control(cm)}} \times 100$$

Data Analyses

Analysis of variance using SPSS version 16.0 was used to determine significant difference between treated seed varieties or otherwise and Duncan multiple test was used to separate the means.

RESULTS

Physicochemical and Heavy Metals analysis of the Tannery Effluents

The mean values and standard deviation of physicochemical parameters of the tannery effluents revealed that pH had 9.06± 0.20, Electrical conductivity (1570±266.54µS/cm), Dissolved Oxygen (3.22± 1.08mg/L), Biochemical Oxygen Demand (1.17±0.61mg/L) Total Dissolved Solids

(410±132.08mg/L) and temperature (29.33± 1.52°C).The values recorded above with exception of Dissolved Oxygen and Biochemical Oxygen Demand were within the FEPA and EPA standard limits for irrigation waters (Table 1). The results of heavy metals concentrations revealed that Cadmium had 0.03± 0.01mg/L, followed by Chromium with 1.32± 0.35 mg/L, Cu (0.04± 0.04mg/L), Pb (0.01± 0.005mg/L), and Zn with 0.02± 0.01mg/L. The values recorded above with the exception of Chromium were within the maximum limit set by EPA for surface fresh waters and statistically no significant difference with Cd, Cr, Cu, Pb and Zn on seeds germination at $p<0.05$ (Table 1). Chromium had the highest concentration with 1.32± 0.35 mg/L while Lead had the least with 0.01± 0.005mg/L. The heavy metal concentrations in tannery effluent decreased in the order of Cr > Cu > Cd > Zn> Pb.

Table1: Mean Values of Physicochemical Parameters and Heavy Metals Concentration of Tannery Effluent obtained from Sharada Tannery Industry Kano State, Nigeria.

Parameters	Concentration Results	Maximum Discharge Limits		
		FEPA (1991)	EPA (2003)	WHO (2011)
Temperature(^{0}C)	29.33± 1.52	<40	40	20-35
pH	9.06± 0.20	-	-	7.8-8.5
DO (mg/L)	3.22± 1.08	-	-	5.0-9.0
BOD (mg/L)	1.17±0.61			3 – 6
TDS (mg/L)	410±132.08	2000	-	
Electrical conductivity(µs/cm)	1570±266.54	2500	-	-
Cadmium (mg/L)	0.03± 0.01	-	-	0.05
Chromium (mg/L)	1.32± 0.35	-	-	0.05
Copper (mg/L)	0.04± 0.04	-	-	0.05
Lead (mg/L)	0.01± 0.005	-	-	0.01
Zinc (mg/L)	0.02± 0.01	-	-	0.05

Key: DO, Dissolved Oxygen, BOD, Biochemical Oxygen Demand, TDS, Total Dissolved Solids.

Percentage Germination and Growth Performance of the Treated Seeds

Maximum percentage germination of 82.4% ± 0.74, 95.1% ± 0.42 and 91.5% ± 0.15 for Maize, Spinach and Lettuce respectively was recorded in 20% effluent treatment, followed by 40% and decreased gradually as the concentration increased. Percentage germination was suppressed at 100% tannery effluent concentration with 22.9± 6.85, 31.7± 0.18 and 25.1± 0.39 for maize, spinach and lettuce respectively (Table 2, 3 and 4). Significant difference ($p< 0.05$) was recorded with percentage germination in each of seeds treated. Seedling length on 100% effluent revealed remarkable decrease of 1.03 cm, 0.95cm, and 0.8cm for maize, spinach and lettuce respectively when compared with control treatment with 4.51cm, 5.1 and 3.21cm for maize, spinach and lettuce respectively. Statistically there was no significant difference between the treatments at $p > 0.05$.

Root length of maize seeds when applied on lower concentration of the tannery effluent of 20% and 40% exhibited higher root lengths of 1.50cm and 1.30cm respectively. Twenty percent (20%) of the effluent indicates slight difference in length compared with the control treatment. In higher concentrations of 60%, 80% and 100%, root length of all the maize seeds treated was reduced to 1.00±0.3cm, 0.5±0.2cm and 0.10± 0.0cm respectively (Table 2).

Root length of Spinach seeds differed with variation in concentration of tannery effluent. Lower concentration of 20% and 40% exhibited higher root lengths of 0.47cm and 0.21cm respectively. In higher concentrations of 60%, 80% and 100% root length of all spinach seeds reduced to 0.1±0.0cm, 0.08±0.0cm and 0.05±0.0cm respectively (Table 3).

The root length of the lettuce seeds differed withvarying concentration of tannery effluent. Lower concentration of 20% and 40% exhibited higher root lengths of 0.93cm and 0.90cm respectively. Twenty percent (20%) of the effluent showed slight difference in length compared with control. In higher concentrations of 60%, 80% and 100% there was reduced length of the root with 0.4±0.0cm, 0.22±0.0cm and 0.03±0.0cm respectively (Table 4).

Table 2: The Mean Values for the Effect of Tannery Effluent Concentrations on Seed Germination of Maize (*Zea mays*)

Concentrations (%)	Phytotoxicity (%)	Seed Germination (%)	Fresh Weight (gm)	Dry Weight (gm)	Seedling Length(cm)	Root Length (cm)
M_0 (0)	0.0±0.00	100.0± 0.00	7.36±1.87	1.04±0.4	4.51±1.56	2.20±1.5
M_1 (20)	22.8±4.45	82.4± 20.74	5.79±1.44	1.00±0.3	4.42±1.22	1.50±1.4
M_2 (40)	32.2±9.95	72.7± 18.55	2.64±1.98	0.51±0.2	3.23±1.26	1.30±0.8
M_3(60)	42.8±11.38	61.7± 10.75	2.05±1.88	0.40±0.3	3.16±1.78	1.00±0.3
M_4 (80)	61.8±13.19	42.1± 10.4	0.87±0.36	0.12±0.1	2.07±1.57	0.50±0.2
M_5 (100)	82.5±15.40	22.9± 6.85	0.53±0.13	0.05±0.0	1.03±0.32	0.10±0.0

Table 3: Effect of Tannery Effluent Concentrations on Seed Germination of Spinach (*Amarantus caudatus*)

Concentrations (%)	Phytotoxocity (%)	Seed Germination (%)	Fresh Weight (gm)	Dry Weight (gm)	Seedling Length(cm)	Root Length (cm)
S_0 (0)	0.0±0.00	100.0± 0.00	6.92±2.33	1.20±0.5	5.10±1.54	1.01±0.9
S_1 (20)	5.3±1.33	95.1± 0.42	5.51±1.97	0.94±0.2	4.42±1.34	0.47±0.1
S_2 (40)	19.0±6.44	81.3± 0.59	3.64±1.56	0.71±1.4	4.24±1.87	0.21±0.0
S_3(60)	33.9±10.55	67.1± 0.10	2.43±1.34	0.40±0.0	3.50±1.89	0.10±0.0
S_4 (80)	45.2±17.31	56.1± 0.18	1.04±0.65	0.21±1.7	2.09±0.45	0.08±0.0
S_5 (100)	59.2±10.24	31.7± 0.18	0.93±0.44	0.09±0.0	0.95±0.03	0.05±0.0

Table 4: Effect of Tannery Effluent Concentrations on Seed Germination of Lettuce (*Lactuca sativa*).

Concentrations (%)	Phytotoxocity (%)	Seed Germination (%)	Fresh Weight (gm)	Dry Weight (gm)	Seedling Length(cm)	Root Length (cm)
L_0 (0)	0.0±0.00	100.0± 0.50	8.14±2.23	0.91±1.7	3.21±1.99	1.21±0.8
L_1 (20)	8.9±2.48	91.5± 0.15	6.53±2.11	0.50±1.7	2.90±1.76	0.93±0.5
L_2 (40)	28.7±7.23	72.4± 0.40	3.29±1.44	0.06±1.4	2.23±1.55	0.90±0.3
L_3(60)	42.0±12.45	58.7± 0.90	1.87±1.89	0.04±1.6	1.90±0.54	0.40±0.0
L_4 (80)	54.0±13.18	46.2± 1.03	0,92±1.76	0.01±1.0	1.01±0.34	0.22±0.0
L_5 (100)	75.0±22.18	25.1± 0.39	0.63±1.23	0.01±1.1	0.80±0.20	0.03±0.0

DISCUSSION

Physicochemical and Heavy Metals analysis of the Tannery Effluents

Physicochemical analysis of the tannery effluents revealed that the pH value recorded of 9.06 ± 0.20 is within the limit set by FEPA (1991) for irrigation water. Conductivity indicates presence of dissolved ions in water. The electrical conductivity recorded during the study period of 1570±266.54µS/cm is beyond the maximum discharge limit of 1000µS/cm set by EPA (2003) and FME (2001). Dissolved oxygen of 3.22± 1.08mg/L recorded in the tannery sample is below the standard limit of 5mg/l which can support aquatic life as reported by Ibrahim (2009). TDS in water consist of inorganic salts and dissolved materials and high values of TDS may lead to change in water taste and deteriorate plumbing and appliances (Pandey *et al.*, 1997). The TDS values recorded of 410 ± 132.08mg/L falls within the maximum limit of 600mg/L set by FEPA (1991). The values of temperature observed of 29.33°C ± 1.52 is within the normal range of 30°C recommended for standard for surface waters by FEPA (1991). From the concentrations of the heavy metals concentrations recorded Chromium had the highest value of 1.32± 0.35mg/L in analyzed samples while Pb had the least concentrations of 0.01± 0.005mg/L. The higher concentration recorded could be due to the presence of chromium sulfate which is one of the basic chemical used in tanning as reported by Vajpayee *et al.* (2001). Similar observation was reported by Peralta *et al.* (2001) who reported that physiological process of seeds germination were affected by high concentrations of Chromium. The collected water samples concentration of chromium recorded was above the permissible limit of fresh water set by WHO (2011) of 1.0mg/L. The heavy metals concentrations in the effluent samples decreased in the order of Cr> Cu> Cd> Zn> Pb> with the exception of chromium the remaining concentrations in the study were within the standard limits set by FEPA (1991), APHA (1995). Although the concentrations of Cu, Cd, Zn and Pb recorded in this work were within the permissible limits but the specific problem associated with heavy metals in the environment is their accumulation through food chain with long term effect (Dimari e*t al.*, 2008). Similar observation was reported by Akan *et al.* (2007) and Adelekan and Abegunde (2011) who worked on characteristics of pollutants in effluent from five tannery industries in Kano metropolis and revealed that the effluent significantly chromium concentration varied between 1.02±0.13 to 1.56 ±0.06 mg/L above the limit set by FEPA (1991) and WHO (2011) of 1.0mg/L. Similarly, Dimari *et al.* (2008) reported that many dissolved elements which enter rivers are adsorbed onto colloid particulates and at high alkalinity the metals, particularly lead and cadmium, precipitate by forming complexes, which dramatically influence the metal toxicity. Van and Clijsters (1983) and Andaleeb *et al.* (2008) reported that heavy metals have the capacity to inhibit of an enzymatic step and induce deficiency of an essential nutrient in plants.

Percentage Germination and Growth Performance of the Treated Seeds

In the present study, the effects of tannery industrial effluent at different concentrations were tested on varieties of maize, spinach and Lettuce seeds. When grown in 100% effluent there was significant inhibition of seed germination and seedling growth this could be due to the osmotic pressure caused with high concentration of nutrients as reported by (Dhanam, 2009). But lower inhibition was recorded in lower concentration of the tannery effluent especially at 20% which perhaps support seed germination and growth. The seed germination and seedling growth were reduced with increasing concentration of effluent. Similar observation was reported by Pandey *et al.* (1997) on their study to test the effect of distillery effluent on maize. Murkumar and Chaun (1987) reported that the higher concentration of effluent decreases enzyme dehydrogenase activity that is considered as one of the biochemical changes which disrupts germination and seedling growth. The root and shoot fresh weights of Maize, Spinach and Lettuce seeds were severely affected due to increase in the tannery effluent concentrations (Table 2, 3 and 4). The result indicated that tannery effluents have significantly affected the fresh and dry weight of both shoot and root as reported by Yu and Gu (2007). Besides the dry shoot weight of Maize, Spinach and Lettuce seeds were also significantly decreased with increase in tannery effluent concentrations. Similar observations were reported by Katerji *et al.* (1994) and Sangeetha *et al.* (2012).

With regards to percentage germination, there was 100% seed germination in control treatment for all the seed varieties while that of the effluent treatment, maximum percentage germination was in 20% followed by 40% and decreased gradually as the concentration increased. Similar observation was reported by Aklilu *et al.* (2012). Germination percentage was suppressed at 100% effluent concentration which may be due to phytotoxic effects the concentrated effluent as reported by Sahu *et al.* (2007). Seedling length of spinach, maize and lettuce differed remarkably with varying concentrations of tannery effluent on 15th day after sowing (Table 2). Lower concentration of 20-40% exhibited higher seedling length. Higher concentrations of 60%, 80% and 100% showed reduced length of seedling which indicates the toxic effects of concentrated effluents on seeds varieties. This is in tandem with the findings of Sundaramoorthy and Lakshmi (2000) in their work on the effect of tannery effluent on ten varieties of groundnut in which they found maximum germination response at lower concentration (10%) of tannery effluent. Studies of different industrial wastewaters with several plants have been carried by various workers who suggested that higher concentrations of effluent can to cause negative impact on seeds germination (Reddy and Borse, 2001; Vijayarengan, 2003; Yusuff and Sonibera, 2004 and Malaviya *et al.*, 2012).

Moreover, Maximum phytotoxicity of 82.5±15.40%, 59.2±10.24% and 75.0±22.18% for maize, Spinach and Lettuce recorded in the present study indicates toxicity of the tannery effluent on the seed germination at higher percentage. This corroborates with the findings of Sahu *et al.* (2007) who carried out toxicity assessment of tannery effluent in terms of percentage phytotoxicity and shoot/root dry weight ratio in Jajmau area of Kanpur (Uttar Pradesh), India. The present finding is also in tandem with the work of Indira and Ravi (2010) who reported the toxicity of tannery effluent on the growth, physiological and biochemical contents of blackgram. Seedling growth on 100% effluent revealed remarkable decreased of 1.03 cm, 0.95cm, and 0.8cm for maize, Spinach and Lettuce respectively, when compared with control treatment of 4.51cm, 5.1 and 3.21cm for maize, Spinach and Lettuce respectively. Similar observation was made by Murkumar and Chaun (1987) and Chaun *et al.* (2010). Inhibition of seed germination at higher concentrations of the effluent may be due to high levels of dissolved solids which enhance the salinity and conductivity of absorbed solute by the seeds (Sundaramoorthy and Kunjithapatham, 2000). Similar observation was reported by Kannan and Upreti (2008) who studied the effect of tannery effluent on seed germination, seedling growth and chloroplast pigment content in mung bean (*Vigna radiata* L. Wilezek).The root length of the maize seedlings control treatment differed with varying concentrations of the tannery effluent. Lower concentration of 20% and 40% exhibited higher root lengths of 1.50cm and 1.30cm as repoted by Aklilu *et al.* (2012). In higher concentrations of 60%, 80% and 100% there was reduced length of root which might indicate the toxic effects of concentrated effluents on maize seeds root as reported by Mandakini and Khillare (2015). According to Malla and Mohanty (2005) that salt content outside the seed is known to act as liming factor and causes less absorption of water by osmosis and inhibit the germination of seeds. Roa and Kumar (1983) reported that plant growth could be affected due to the pH, presence of higher dissolved solids and heavy metals in the tannery effluent. The root which continuously remains in direct contact with the effluent have the higher concentrations of the effluent and certainly affect cell multiplication or the growth (Kannan *et al.*, 2008). Nandy and Kaul (1994) also reported that the toxicity of trace elements of polluted water was more on roots than hypocotyls. Heavy metals found to be more toxic for root growth because they accumulate on the root and retard cell division and cell elongation, probably by the interference of the hormonal system (Nawaz and Ali, 2006; Shafiq *et al.*, 2008). Altaf and Masood (2008) reported that tannery effluents severely affect the mitotic process and reduce seed germination in extensively cultivated pulse crops. The present study also conforms to that of Joshi *et al.* (1999) and Farhad *et al.* (2005).

Spinach seeds root length in the present study differed with varying concentrations of tannery effluent (Table 4). Lower concentration of 20% and 40% exhibited higher root lengths of 0.47cm and 0.21cm and higher concentrations of 60%, 80% and 100% showed reduced root length as reported by Aklilu *et al.* (2012). This indicates the toxic effects of concentrated tannery effluents on spinach root. Similar observation was made by Vibha *et al.* (2015) who reported that tannery effluents reduced the plants growth and development. The adverse effects of the concentrated effluent may be due to the higher concentrations of suspended solids coupled with different types of dissolved chemicals as reported by Nesmann *et al.* (1980) and Fahim (2006). This could probably reveal the effect of high dissolved solids recorded present in the tannery effluent as reported by Niroula (2003) and Harshita *et al.* (2015)

CONCLUSION AND RECOMMENDATIONS

The tannery effluents collected were loaded with organic and inorganic compounds. The adverse effects to seeds germination may be due to the higher concentrations of suspended solids coupled with low dissolved oxygen. Tannery effluents reduced the percentage germination of the treated seeds during their growth and development. The seeds treated with 100% effluent showed very low growth compared with control and 20% diluted effluent. The results obtained in the present study indicated that the tannery effluents at higher concentrations decreased the germination of maize, spinach and lettuce seeds. It is therefore recommended that Government at all level and regulatory authorities should enforce pollution abatement laws in order to control the potential negative impact by the use tannery effluent in agricultural purposes.

REFERENCES

Abdulmumini, A., Gumel, S. M. andJamil, G. (2014). Industrial Effluents as Major Source of Water Pollution in Nigeria: An Overview. *American Journal of Chemistry and Applications*, 1(5): 45-50.

AdelekanB. A. and AbegundeK. D (2011): Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. *International Journal of the Physical Sciences,* 6(5):1045-1058.

Aklilu A., Mengistu. S. and Fisseha. I. (2012). Determining the Effect of Tannery Effluent on Seeds Germination of SomeVegetables in Ejersa Area of East Shoa, Ethiopia, *International Journal of Scientific and Research Publications*, 2(12): 1-10.

Altaf, M. M. and Masood, F. (2008). Impact of long-term application of treated tannery effluents on the emergence of resistance traits in rhizobium sp. isolated from *Trifolium alexandrinum. Turkish Journal of Biologyour*, 32(1): 1-8.

Akan. C., Moses, E. A., Ogugbuaja, V. O. and Abah, J. (2007). Assessmentof Tannery Industrial effluent from Kano Metropolis, *Applied Sciences*, 7(19): 2788 – 2793.

Andaleeb, F., Zia, M. A., Ashraf, M. and Khalid, Z. M. (2008). Effect of Chromium on Growth Attributes in Sunflower(*Heliathus annus* L.). *Journal of Environmental Sciences,* 20: 1475-1480.

APHA, AWWA and WEF. (1995.: *Standard methods for the examination of water and wastewater*. 19th ed. Washington

Augusthy, P. O. and Mani, A. S. (2001). Effect of rubber factory effluent on seed germination and seedling growth of *Vignaradiatus* L. *Journal of Environmental Biology*, 22: 137-139.

Bajza, Z. and Vrcek, I. V. (2001). Water Quality Analysis of Mixtures Obtained from Tannery Waste Effluent, *Ecological and Environmental Safety*,50(2):15-18.

Chou, C. S., Chang, C. and Kaw, C. I. (1978). Impact of water pollution of crop growth in Taiwan. *Bot, Bull, Bot, Sinica*., 19: 107-124.

Dimari, G. A., Abdulkarim, F. I., Akan, J. C. and Garba, S. T. (2008). Metal concentrations in Tissues of Tilapia galier, Clarias lazera, and Osteoglosidae caught from Alau Dam, Maiduguri, Borno State, Nigeria. *American Journal of Environmental Sciences*, 4 (4): 473 – 379.

Dhanam, S. (2009). Effect of dairy effluent on seedgermination, seedling growth and biochemicalparameter in paddy. *Botany Research International*, 2(2):61-63.

EPA. (2003). *Standards for Industrial Pollution Control in Ethiopia Prepared By*: The Environmental Protection Authority Ethiopia and The United Nations Industrial Development Organization Ecologically Sustainable Industrial Development (ESID) Project US/ETH/99/068/ Ethiopia.

Fahim, N. F, Barsoum, B. N., Eid, A. E. and Khalis, M. S. (2006). Removal of Chromium III from Tannery Wastewater using Activated Carbon from Sugar Industry Waste, *J. Hazard Mater.*, 136(2):303-309.

Farhad, M. D., Al Umme Habiba, U. B. N., Sarwar, U. A. M. C., Shafiur, R. G. M. and Mahamudul, H. M. (2015). Investigation on Physicochemical Parameters of Tannery Effluent. *Universal Journal of Environmental Research and Technology*, 5(3); 122 -130Available Online at *www.environmentaljournal.org.*

Faiz, H., Saeed, A. M., Mohammad A., Nahidah, B., Uzma, Y., Mahmoodul, H. and Seema, M. (2010). Effect of tannery effluents on seed germination andgrowth of two sunflower cultivars. *African Journal of Biotechnology,* 9(32):5113-5120.

Federal Environmental Protection Agency, FEPA. (1991). National Environmental Protection (Effluent Limitation) Regulations of 1991. Federal Environmental Protection Agency, Lagos, Nigeria.Ref.S.1-8.

FME (Federal Ministry of Environment). (2001). Guidelines and Standard for Quality in Nigeria*. Published Federal. Ministry of Environment,* p.114.

Fu, L. Stares, J and Staly, R. G. Jr. (1994). Assessing acute toxicities of pre and post treatment industrial waste waters with hydra attenata: A comparative study of acute toxicity with the fathendminnows, plimephles, promelas. *Environ. Toxicol. Chem.*, 13:563 – 569.

Gregg, L. W. (1989). Water analysis Handbook. H.A.C.H Company, USA. p.33-39.

Harshita, N., Manimita, D., Shraddha, C., Poornima, P. P., Swati, M., Y. and Archana, T. (2015). Effect of chromium generated by solid waste of tannery and microbial degradation of chromium to reduce its toxicity: A review. *Advances in Applied Science Research*, 6(3): 129-136

Hang, X. H., Wang, H. J., Zhou, C., Ma, C. Du. and Chen, X. (2009). "Risk assessment of potentially toxic element pollution in soils and rice (Oryza sativa) in a typical area of the Yangtze River Delta*," Environmental Pollution*, 157(8-9): 2542–2549.

Ibrahim, S. (2009). A Survey of Zooplankton Diversity of Challawa River, Kano and Evaluation of Some of its Physico-chemical Conditions : *Bayero Journal of Pure and Applied Sciences*, 2(1):19-26.

Indira, P. and Ravi, T. (2010). Inhibition of toxic pollutants from tannery effluent by using AM fungi and its response on greengram (Vigna radiate L.). *International journal of Current Research,* 4:142-145.

Jamal, S. N., Iqbal, M. Z. and Athar, M. (2006). Effect of aluminum and chromium on the germination and growth of two *Vigna* species. *Int. J. Environ. Sci. Technol.*, 3: 53-58.

Joshi, U. N., Rathore, S. S. and Arora, S. K. (1999). Effect of chromium on growth and development of cowpea (*Vigna unguiculata* L.). *Indian. J. Environ. Prot.*, 19: 745-749.

Jibril, H. J. (2006*). The effect of chemicals on germination of some cowpea varieties.* Unpublished B.Sc. project Department of Biological Sciences, Bayero University, Kano pp 34

Kannan, A. R. and Upreti, R. K.(2008). Influence of Distillery Effluent on Germination and Growth of Mungbean (*Vigna radiata*) seeds*. J. Hazard. Mater*., 153: 609-615.

Katerji, N., Van Hoorn, J. W., Hamdy, A., Karam, F. and Mastroruilli, M. (1994). Effect of Salinity on Emergence and on Water Stress and Early Seedling Growth of Sunflower and Maize. *Agric. Wat. Mang*., 26: 81-91; DOI: 10.1016/0378-3774(94)90026-4

Malaviya, P., Hali, R. and Sharma, N. (2012). Impact of dyeing industry effluent on germination and growth of pea (*Pisum sativum*). *Journal of Environmental Biology,* 33: 1075-1078.

Mandakini. R. M. and Khillare, Y. K. (2015). Effect of Tannery Industry Effluent On Germination and Growth of Tomato Plant*. World Journal of Pharmacy and Pharmaceutical Sciences,* (5)2: 1064-1074.

Malaviya, P. and Richa, K. (2013) Impact of tannery effluent on germination of various varieties of wheat (*Triticum aestivum* L.) *Journal of Applied and Natural Science* 5 (2): 302-305

Malla,K. and Mohanty, B. K.(2005). Effect of paper mill effluent ongermination of greengram (Phaseolus aureus Roxb.) and growth behaviour of seedlings*. J. Environ. Biol*., 26: 379- 382.

Murkumar, C. V. and Chaun, P. D. (1987). Influence of water pollutionon germination of gram (Cicer arietinum L.) In: *Current pollution Research in India*. (Eds: Triveni pk., Goel PK).

Mohammed, M. A., Yusuf, M. A., Mukhtar, S. and Zubairu, S. M. (2015). Ecological Risk Assessment of Heavy Metals Pollution on Irrigated Soil along Salanta River Valley, Kano State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 8(1): 160 – 166.

Nandy, T. and Kaul. S. N. (1994). Wastewater management for tapiocabased sago industry. *Indian J Environ Protect.,* 14: 721- 728.

Nesmann, E. R., Lee, E. G. H., Metula, T. I., Duglas, G. R. and Muller, J. C. (1980). Mutagenicity of constituents identified in pulp and paper mill effluents using the Salmonella/mammalian microsome assay. *Mutat. Res*., 79, 203-212.

Nawaz, S. and Ali, S. M. (2006). Effect of Industrial effluents on seed germination and early growth of Cicerarientum. *Jour. Biological Science.,* 6(1): 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.

Nwachuku, S. U., Akpata, T. V. I. and Essein, M. E. (1989). Microbiological Assessment of Industrial Sewage of Agbara industrial estate in Ogun Stat. *Int. J. ecol and Environ. Sci.,* 15: 109–115.

Pandey, S. N., Nautiyal, B. D. and Sharma, C. P. (1997). Pollution levelin distillery effluent and its phytotoxic effect on seedgermination and early growth of Maize and Rice.*Journal of Environmental Biology*, 29(2):267-270.

Peralta, J. R., Torresdey, J. L. G., Tiemann, K. J., Gomez, E., Arteaga, S. and Rascen, E. (2001). Uptake and effects of five heavy metals on seed germination and plant growth in alfaalfa (*Medicago sativa*) L. *Environmental Contamination and Toxicology*, 66: 727-734.

Roa, G. and Kumar, N. V. (1983). Impact of Tannery Effluent on Seed Germinability and Chlorophyll Contents of *Cicer arientinum L. Poll. Res.*, 2(1): 33-36.

Sahu, R. K., Katiyar, S., Jaya, T. and Kisku, G. C. (2007). Assessment of drain water receiving effluent from tanneries and its impact on soil and plants with particular emphasis on bioaccumulation of heavy metals. *J. Environ. Biol.*, 28(3): 685-690.

Sangeetha, R., Kamalahasan, B., Karthi, N. (2012). Useof tannery effluent for irrigation: an evaluative study onthe response of antioxidant defences in maize *(Zeamays)*. *Int. Food Res J.,* 19(2):607-610.

Saranraj P. and Sujitha, D. (2013). Microbial Bioremediation of Chromium in Tannery Effluent. *International Journal of Microbi1ological Research,* 4(3): 305-320.

Singh, S., Singh, P. K., Kumar, V. and Shuklarr, V. K. (2011). Growth and flower yield of *Tagelus patula* plants on tannery waste amended soil medium, *Rec. Res. Sci. Technol.,* 3(6), 66–69.

Sundaramoorthy, P. and Kunjithapatham, J. (2000).Effect of paper mill effluent on seed germination growth of six varieties of groundnut (*Arachis hypogaea*). *Journal of Ecotoxicology and Environmental Monitoring*, 10: 53-57.

Sundaramoorthy, P. and Lakshmi, S. (2000). Screening of groundnut varieties for tolerance to tannery effluent. *Pollution Research*, 19: 543-548.

Shafiq, M., Iqbal, M. Z. and Athar, M. (2008). Effect of lead and cadmium on germination and seedling growth of *Leucaena leucocephala*. *J. Appl. Sci. Environ. Manage.*, 12: 61-66.

Reddy, P. G. and Borse, R. D. (2001). Effect of pulp and paper mill effluent on seed germination and seedling growth of *Trigonella foenum-gramecum* L. (Methi). *Journal of Industrial Pollution Control*, 17: 165-169.

Vijayarengan, P. (2003). Pollution effects of textile mill effluent on growth and development of groundnut seedlings. *Nature Environment and Pollution Technology*, 2: 451-453.

Thamizhiniyan, P., Sivakumar, P. V., Lenin, M. and Sivaraman M. (2009). Sugar Mill Effluent Toxicity in Crop Plants. *Jour. Phytol.* 1: 68-74.

Vajpayee, P., Rai, U. N., Ali, M. B., Tripathi R. D., Yadav, V. and Sinha, S. (2001). Chromium Induced Physiological changes in *Vallisneria spiralis* L. and its role in phytore-Mediation of Tannery Effluent. *Bulletin of Envir. Contam. and Toxicol.,* 67(2): 246-256.

Van, A. F. and Clijsters, H. (1983). Multiple Effects of Heavy Metals on Photosynthesis. The Hague, 371- 382.

Vibha, S., Pramod, P., Gopi, N. and Ragesekran, C. (2015). Effect of Tannery Effluent on Seed Germination, Growth and Development of Cultivable crops in Ambur, Tamil Nadu. *International Journal of Innovative Science, Engineering and Technology*. 2: 324 - 331.

WHO. (2011). Guidelines for Drinking-water Quality Fourth Edition, pp 12

Yu, X. Z. and Gu, J. D. (2007). Accumulation and distribution of trivalent chromium and effects on hybrid willow metabolism. *Arch Environ Contam Toxicol.*, 52: 503-511.

Yusuff, R. O and Sonibare, J. A. (2004). Characterization of Textile Industries Effluents in Kaduna Nigeria and Pollution Implications. *Global Nest: the International Journal,* 6(3): 212 – 221.