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Influence of Untreated Noodle Wastewater on Physicochemical, Enzymatic and Bacteriological Dynamics of Soil

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Abstract

The study was designed to determine the influence of untreated noodle wastewater on physicochemical, enzymatic, and bacteriological dynamics of soil. The methodology of physicochemical analysis involved APHA standard, while plant growth indices, enzyme assays, and bacteriological analyses were determined using standard microbiological techniques. The results revealed that almost all the physicochemical characteristics of the untreated noodle effluent and irrigated soil samples were found to be higher than the permissible levels according to WHO (2004) and FEPA (1996) standards. The results revealed significant ($p < 0.05$) increases in the mean height and leaf numbers relative to their controls of maize crop, while there were non-significant ($p > 0.05$) increases in the wet and dry weight during irrigation at increasing concentrations of the untreated noodle effluent. The lead metal (Pb) had the highest value of 0.46 ± 0.02, while zinc metal had the least value of 0.15 ± 0.03 absorbed in the maize plant at 100% contamination levels and were above acceptable limits. The results showed non-significant ($p > 0.05$) changes in the soil urease activity ranging from 4.80–21.40 mg/g; 18.00–34.20 mg/g in the soil phosphatase activity; 1.68–13.96 mg TPH/g/h in the soil dehydrogenase activity; and 0.21–0.30 mol/L in the soil catalase activity, respectively. Bacteriological profiling showed non-significant ($p > 0.05$) reductions in the rhizobia bacterial count ranging from 185–7.10 × 10^3 CFU/g and 15.7–5.50 × 10^3 CFU/g in the actinomycetes count, while there was a significant ($p < 0.05$) reduction in the phosphate-solubilizing bacterial count ranging from 17.50–9.8 × 10^3 CFU/g, respectively, after the 8 weeks from 0%–100% noodle effluent contaminations. Therefore, noodle industry effluent at various concentrations influences soil physicochemical, enzymatic, and bacteriological properties and seed germination and seedling growth of *Zea mays* studied.

Keywords: *Contamination, bacteriological dynamics, irrigation water, noodle effluent, soil.*

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1. Introduction

Water effluents are referred to as wastewater which has been adversely affected in quality by anthropogenic influences and it comprises liquid waste discharged by domestic residences, commercial properties, industries, and/or agriculture and can encompass a wide range of potential contaminants and concentrations. Wastewater is also termed as a valuable source of plant nutrients and organic matter. Nevertheless, it contains certain undesirable chemical constituents and pathogens that pose negative environmental and health threat (Benit *et al.*, 2015).

The increase in world population has not only put pressure on limited water resources but also increased the volume of waste generation. However, most of the wastes generated are either not treated at all or partially treated, falling below the recommended standards before they are discharged into rivers, streams and lakes. The increased competition for freshwater among urban and semi-urban centres, industries and agriculture has put agriculture, particularly irrigated agriculture under severe pressure as irrigation has been the largest user of water (Abegunrin *et al.*,2013). Therefore, the use of treated, partially-treated or untreated wastewater has received more attention (Yao *et al.*, 2013). Kauser (2007) reported that at least one-tenth of the world's population is now consuming food produced by wastewater and it is estimated that about 200 million hectares in 50 countries are irrigated with raw or partially-treated wastewater (United Nations, 2003). The direct and indirect use of untreated wastewater in irrigated agriculture is increasing as a result of increasing global water scarcity, inadequate and inappropriate wastewater treatment and disposal, increased food insecurity and escalating fertilizer costs (Jimenez and Asano, 2008). However, innovative approaches such as the conversion of plastic bottles into nanofilters for wastewater treatment offer sustainable solutions to safeguard public health (Egbosiuba *et al*., 2025).

In Nigeria, most of the streams dry-up during the four to five months of drying season. Since this is a yearly occurrence, a large proportion of the farmers rely on wastewaters for vegetable production. Such untreated wastewater is used without recourse to soil and water pollution, with the latter occurring after the onset of rainfall. Despite the widespread use of wastewater as an important source for irrigation in Nigeria, the impact of wastewater on soil properties is not fully studied and understood, thus the need for research that highlights influence of noodle wastewater on plant growth, yield and soil physicochemical and bacteriological properties. This study is designed to determine the influence of untreated of noodle wastewater on physicochemical, enzymatic and bacteriological dynamics of soil.

2. Materials and Methods

Sampling site description

Nnewi is a commercial and industrial city in Anambra State, south-eastern Nigeria. It is the second largest city in Anambra State after Onitsha. Nnewi as a metropolitan area has two local government area, which are Nnewi North and Nnewi South. Nnewi North comprises four quarters: Otolo, Uruagu, Umudim and Nnewichi. Its coordinates are 6°1’0”N and 6°55’0”E. It occupies a landmass of 200square miles (520 kilometer square). The effluent of Kotec noodle industry located at Nnewi was used for the present investigation. Soil samples from field nearby the factories will be taken and used for the present investigation.

Sampling of the Industrial Effluent and Soil

The effluent was collected directly from the outlet of the industries, which was considered as concentrated for the present study. Effluent sample was aseptically collected in 10 L plastic container after overnight sterilization with 70 % ethanol. For the preliminary analysis, effluent sample was acidified with nitric acid (HNO_3) at the time of collection. The sample container was first rinsed with the effluent several times before collection. In the same vein, soil sample was aseptically collected using hand trowel and placed into sterile polythene bags and transported to the Microbiology Laboratory of the Department of Microbiology, Chukwuemeka Odumegwu Ojukwu University Uli for further analysis (Dibua, 2025).

Test Seeds

The *Zea mays* seeds were selected and purchased on the basis of crops cultivated by the local people which are affected by the factory effluents. The seeds will be stored inside airtight plastic bottles at room temperature.

Seed and Soil Preparation

According to Uba *et al*. (2020a; 2021), the *Zea mays* seeds were put in a plastic rubber and water was added to the seed and the seeds that floated were removed while the ones that sedimented was used. Then, 70 % ethanol was used to wash the *Zea mays* seeds 3 times together with distilled water to remove the pathogens and alcohol. The soil sample was sieved using 2 mm mesh before experiment in order to remove debris.

Experimental Setup

Six treatments were set up and labeled control noodle effluent, 5% noodle effluent, 25% noodle effluent, 50% noodle effluent, 75% noodle effluent and 100% noodle effluent, Then, 6 plastic buckets were filled with 5 kg of the collected soil sample. Control setup was treated with tap water while the other treatment sets were treated with different concentrations of the effluent sample (5, 25, 50, 75 and 100 %).

Preparation of the Various Concentration of the Effluent for Crop Irrigation

Different effluent concentrations were prepared according to Mahalingam *et al*. (2014). The untreated noodle effluent samples were considered as 100 % concentration. Other concentrations were prepared by diluting the effluent with appropriate volume of tap water to make 100 ml. The following design was adopted for the dilution of noodle effluents as follows:

A = 0 % Noodle Effluent: 100 ml tap water (control)
B = 5 % Noodle Effluent: 5 ml effluent + 95 ml of tap water
C = 25 % Noodle Effluent: 25 ml effluent + 75 ml of tap water
D = 50 % Noodle Effluent: 50 ml effluent + 50 ml of tap water
C = 75 % Noodle Effluent: 75 ml effluent + 25 ml of tap water
E = 100 % Noodle Effluent: 100 % effluent + 0 ml tap water.

Planting and Irrigation of the *Zea mays* Seed during the Germination Experiment

The germination experiment was carried out in the Microbiology Laboratory of Chukwuemeka Odumegwu Ojukwu University, Uli Campus. Then, 5 seeds viable, sterile and uniform sized seeds were sown at equidistant into the soil contained in the experimental plastic buckets. Five hundred milliliters of the different effluent concentrations and controls were sprinkled into their respective setups twice a week for a period of twelve weeks (Mbonu *et al*., 2022). During these intervals, the physicochemical, bacteriological, biochemical and plant growth analyses were carried out on each set ups, respectively.

Physicochemical Analysis Before and After Irrigation

The following physicochemical parameters such as pH, conductivity, total dissolved solid, phosphate, ammoniacal nitrogen, chloride, dissolved oxygen, biological dissolved oxygen, chemical oxygen demand and total alkalinity were determined before and after irrigation, respectively by adopting the methods of APHA (1998); APHA, (2012); FSSAI (2015); Adelowo and Agele (2016) and Oladeji *et al*. (2016).

Heavy Metal Analysis Before and After Irrigation

The method described by APHA (1998) was used to determine the heavy metals content (Zinc, lead, copper cadmium, nickel and cobalt) of the effluent. In this method 2 mL effluent sample was introduced into 1.5 mL concentrated nitric acid and diluted with deionized distilled water, filtered through a Whatman filter paper into a 100 mL volumetric flask and subsequently made up to the mark using distilled water. Metal concentrations (Zinc, lead, copper, cadmium, nickel and Cobalt) were analyzed using Atomic Absorption Spectrometer.

Microbiological Analysis of the Soil before and after Irrigation

Quantification of rhizobial species

The composition of the Yeast extract mannitol agar include: yeast extract 1g, mannitol 10g, dipotassium phosphate 0.500g, magnesium sulphate 0.200g, sodium chloride 0.100g, calcium carbonate 1g, agar agar 20g, 0.05 % bromocresol purple and final pH (at 25ºC) 6.8±0.2. The media was sterilized in an autoclave for 15 minutes at 121ºC at 15 psi and allowed to cool at palm feel temperature. The medium was poured into sterile Petri dishes and allow to gel. Then, 1 g of each soil samples were introduced into 9 mL of sterile distilled water and serially diluted (10^1-10^{10}) and 0.1 ml of appropriate serial dilution of the brewery and noddle contaminated soil samples were inoculated into intointo the Yema media using spread plate method. The inoculate plate were incubated at 37ºC for two days. Visible discrete colonies on inoculated plate were enumerated after incubation (Ofunwa *et al*., 2024).

Quantification of phosphate solubilizing bacteria

The composition of the Pikovslakia medium include: 10g glucose 0.5g yeast extract, 0.5$(NH_4)2SO_4$, 0.1g $MgSO_4.7H_2O$, 5g $Ca_3(PO4)_2$, 0.2g KCl, 0.002g $MnSO_4.2H_2O$, 0.002g $FeSO_4.7H_2O$ and 20g of agar agar. The insoluble $Ca_3(PO_4)_2$ was washed with distilled water and centrifuged to remove soluble phosphate contaminants. The supernatant was discarded, and wet $Ca_3(PO_4)_2$ was dried by using a vacuum flask apparatus. The medium was sterilized in an autoclave for 15 minutes at 121ºC at 15 psi and allowed to cool at palm feel temperature. The media was added 0.05 % ketoconazole and poured into sterile Petri dishes and allow to gel. Then, 1 g of each soil samples were introduced into 9 mL of sterile distilled water and serially diluted (10^1-10^{10}) and 0.1 ml of appropriate serial dilution of the brewery and noddle contaminated soil samples were inoculated into the media using spread plate method and incubated in an incubator for 24 hours at 37ºC. Visible discrete colonies on inoculated plate were enumerated (Ofunwa *et al*., 2024).

Quantification of actinomycetes

The composition of the starch casein nitrate medium include: 10g glycerol, 0.3g casein, 3g KNO_3, 2g K_2HPO_4, 2g $NaCl_2$, 0.05g $MgSO_4$, 0.02g $CaCO_3$, 0.01g $FeSO_4$, 20g agar agar. The media was sterilized in an autoclave for 15 minutes at 121ºC for 15psi. The media were added 0.05 % gentamycin, 0.05 % ketoconazole, 0.01 % cycloheximide and poured into sterile Petri dishes and allow to gel. Then, 1 g of each soil samples were introduced into 9 mL of sterile distilled water and serially diluted (10^1-10^{10}) and 0.1 ml of appropriate serial dilution of the brewery and noddle contaminated soil samples were inoculated into the media for at 37 ℃ for 4 days. Visible discrete colonies on inoculated plates were enumerated. Colonies obtained will be expressed as colony forming units (CFU/g). Pure isolates will be preserved in slants. Identification of bacterial isolates will be based on classical and molecular characterization (Ofunwa *et al*., 2024).

Biochemical Analysis Before and After Irrigation

The following physicochemical parameters such as urease enzyme assay, Phosphatase enzyme assay, Dehydrogenase test and catalase enzyme assay was adopted in this study as described by Wu *et al.*, (2016) and Uba *et al.* 2018).

Plant growth analysis

The vegetative growth parameters of the plants were measured during and after the growth period. Number of leaves and plant height were measured on a weekly basis, while root length, fresh and dry weight of the plants were measured after the growth period (Mahalingam *et al.* 2014; Uba *et al.* 2020b; Mbonu *et al.*, 2022)

Heavy Metal Analysis of the Harvested Plant Sample

One gram of seed plant sample harvested from different soil treatments will be accurately weighed into a porcelain crucible. Then, 2 ml of concentrated sulphuric acid will be added to the weighed sample and subsequently heated on a heating hot plate until the whole content dried up. 1.5 ml of nitric acid will each be added to the various maize sample in drop-wise manner to prevent the sample from splashing and foaming. The dried samples will then be subjected to a two-stage muffle furnace heating program until completely ashed (450 ^{0}C for 2 h and 550 ^{0}C for another 2 h). The resulting sample will be introduced into 1.5ml concentrated nitric acid and diluted with deionized distilled water, filtered through a whatman filter paper into a 100 ml volumetric flask and subsequently made up to the mark using distilled water. Metals (iron, lead, copper, chromium, cadmium and nickel) concentration will be analyzed using Atomic Absorption Spectrometer (Mbonu *et al.*, 2022)

Statistical Analysis

Analysis of variance (ANOVA) was adopted in this study for testing the statistical significance of the variance of mean at 5 % level using GraphPad Prism 8.0.

3. Results and Discussion

The noodle industry plays an important role in the economic growth of Nigeria but on the other hand its effluent is considered as one of the environmentally unfriendly industrial wastes to plants and the microbial biome. Noodle cluster is utilizing a huge amount of water at various stages of production process, such waters are disposed untreated on the open field or in the nearby water bodies. The contaminated water is utilized for irrigation in agricultural fields by the local farmers. In this study, in order to evaluate the effects of industrial effluents on plant growth, yield, and soil physicochemical and biological properties, the samples were analyzed for several physico-chemical parameters and the results were compared with values of World Health Standards (WHO, 2004) and FEPA (1996) standard for industrial effluents. All the physico-chemical characters of the noodle effluent were shown in Table 1. As it indicated in Table 1 nearly almost all the physicochemical characteristics were higher than the permissible level according WHO (2004) standard. The Result also showed that the quality of industrial effluents is significantly deteriorate, this could be as a result of holding time in the effluents tank before discharge or the previous discharge batch remaining in the discharge pipe and base.

Table 1: Physiochemical and heavy metal profile of waste water sample

Parameter	Raw noodle waste water	WHO standard (2004)/FEPA (1996) standard
Nitrate (mg/L)	100.00 ±0.80	34
Phosphate(ppm)	2.71 ±0.20	5.00
Chloride (mg/L)	494.53 ±3.50	350.00
Alkalinity ($CaCO_3$)	190.00±3.30	20 – 200
Ammonia (µg/mL)	4.93 ±0.10	
Conductivity (mS/cm)	1.54 ±0.02	0.75
Total dissolved solid (mg/L)	1,254.00 ±4.50	1000
COD (mg/L)	194.52±1.50	150.00
BOD (mg/L)	150.00 ±1.30	80.00
pH	4.80 ±0.20	6.00 - 9.00
Lead	4.55 ±0.50	<1.00
Copper	1.57 ±0.02	<1.00
Zinc	1.50 ±0.05	<1.00
Nickel	3.68 ±0.03	<1.00
Cadmium	2.15 ±0.01	<1.00
Cobalt	1.86 ±0.01	1.00

The BOD and COD are used as important criteria for determining the quality of any waste water. As shown in Table 1, BOD had increased value 150 mg/L ±1.30 which was above the WHO recommended standard 80 mg/L while the COD value was 194.52 mg/L ±1.50 which was above 150 mg/l WHO standard. The impact of this industrial effluent will be great in the microbial biome of soil as it is directly discharged on it. Therefore, high concentrations of BOD and COD in this effluent indicated that the effluents are heavily polluted. Our finding was agreed with the results of Tariq et al., (2020) and Khan and Noor, (2002), they found that TSS, BOD, and COD in industrial effluents exceeded the permissible limits set by WHO standard. The COD value in most case higher than BOD value, because some organic compounds in the effluent that are resistant to microbial oxidation, could be easily oxidized chemically (Aniyikaiye et al., 2019).

TDS is a measurement of the total amount of organic and inorganic compounds in a given volume of effluent. However, TDS is not typically regarded as a major pollutant; it is used as indicator of the presence of a wide range of chemical pollutants (Iwuozor et al., 2018). The result in Table 1 showed TDS value of 1,254 ±4.50 mg/mL which is above 1,000 mg/mL WHO standard. This result agreed with the result of Ronak & Mustafa (2022) that reported higher TDS from factories in Iraq which was above NEQS standard of 3,500. Water alkalinity is a measure of its capacity to neutralize acids. It can be referred to as the buffering capacity of water. Waters with high alkalinity are undesirables. The obtained alkalinity value for noodle effluent waste water sample was 190 mg/L (Table 1). The value obtained was within WHO (2004) permissible limit of 20-200 mg/L. The value obtained was above the values (18 mg/l to 74 mg/l) recorded by Torimiro et al. (2014). The phosphate value observed in the effluent water sample was recorded 2.71 ppm (Table 1) which is below W.H.O permissible limit of 5.00 ppm and also within to the values (2.25 mg/l to 4.50 mg/l) reported by Agbaire et al. (2015). Chloride ion is a common constituent of all-natural water and it's generally regarded as a non-harmful constituent (Nduka, 2008). Though chloride is present in all natural water bodies, high concentration is an indication of pollution from sewage, industrial or intrusion of seawater or saline water into fresh water aquifer (Nduka, 2008). Chloride content obtained from the waste water sample was 494.53 mg/l (Table 1). This value is above the WHO (2004) permissible limits of 350 mg/l and contrary to values (7.22 mg/l to 10.74 mg/l) obtained by Agbaire et al. (2015). Ammonia content obtained from the waste water sample was 4.93 mg/l while the nitrate content obtained from the waste water sample was 100.00 mg/l (Table 1). This nitrate value is above the WHO (2004) permissible limits of 34 mg/l.

The Heavy metals Lead (pb), Copper, Zinc, Nickel cadmium and Cobalt obtained from the noodle waste water was above permitted WHO limit of > 1.00 (Table 1). The abundance of these Heavy metals in these wastewaters has a significant value on the soil health and the pH. When the amount of pb exceeding the permissible level, it has the potential to harm public health, to the persons exposed to them. Ahaneku and Opara (2010) noted that these metals may accumulate in soil and impact negatively on plant life when present in high concentrations.

The result in Table 2 revealed a significant ($p < 0.05$) variations in the physicochemical and heavy metal contents of the noodle wastewater irrigated soil at different concentrations relative to their controls with nitrate, phosphate, chloride, ammonia, conductivity, pH, lead, copper, zinc, nickel, cadmium, cobalt parameters having the highest values of 100.00±0.50 mg/l, 2.71±0.50 ppm, 494.53±2.50 mg/l, 4.93±0.10 mg/l, 1.54±0.04 µS/cm, 4.80±0.10, 4.55±0.05 mg/l, 1.57±0.10 mg/l, 1.50±0.00 3.68±0.00 mg/l, 2.15±0.03 mg/l and 1.86±0.01 mg/l at 100 % contamination level. The increasing level of these parameters in the irrigated soils could be due to the high contents of these characters in the noodle industrial wastewater and corroborated with the publication of Mbonu et al. (2022).

Table 2: Physicochemical and heavy metal profile after irrigation with noodle effluent

Parameter	**Control**	**5%**	**25%**	**50%**	**75%**	**100%**
Nitrate (mg/L)	0.50±0.01	10.00 ± 0.10	15.00±0.00	31.00±0.20	61.00±0.50	100.00±0.50
Phosphate (ppm)	0.20±0.01	0.30 ±0.01	0.78±0.10	1.20 ±0.10	1.89 ±0.10	2.71±0.50
Chloride (mg/L)	5.00 ±0.50	35.00±1.5	100.00±5.00	208.00 ±2.50	312.00±3.50	494.53±2.50
Ammonia (µg/mL)	0.14±0.03	0.56±0.02	0.93±0.02	1.48±0.10	2.89±0.06	4.93±0.10
Conductivity (mS/cm)	0.08±0.00	0.45±0.05	0.78±0.06	0.97±0.04	1.09±0.05	1.54±0.04
pH	6.20±0.30	5.89±0.50	5.20±0.10	5.10±0.10	4.92±0.10	4.80±0.10
Lead (mg/L)	0.10±0.01	0.67±0.00	1.50±0.03	2.00±0.04	3.25±0.07	4.55±0.05
Copper (mg/L)	0.12±0.01	0.90±0.00	0.45±0.01	0.44±0.01	0.45±0.01	1.57±0.10
Zinc (mg/L)	0.04±0.01	0.44±0.01	0.51±0.02	0.52±0.02	1.08±0.01	1.50±0.00
Nickel (mg/L)	0.10±0.01	0.50±0.01	0.70±0.03	1.26±0.07	2.55±0.00	3.68±0.00
Cadmium (mg/L)	0.05±0.00	0.17±0.05	1.02±0.01	1.33±0.01	1.54±0.00	2.15±0.03
Cobalt (mg/L)	0.15±0.02	0.51±0.03	0.53±0.00	1.40±0.04	1.48±0.00	1.86±0.01

The results in Figures 1 and 2 revealed that there were significant ($p < 0.05$) increases in the mean height and leave numbers relative to their controls of maize crop during irrigation at increasing concentrations of the untreated noodle effluent. These changes could be to the elements and nutrient components such as nitrogen etc of the noodle waste water thereby supporting the growth of the maize seeds and is in conformity with the reports of Sumathi et al. (2018) and Cox et al. (1993) who reported that higher rate of nitrogen promotes leaves development during growth period. The growth promoting effect of the lower concentrations of the effluent was attributed to the decreased concentration of various chemicals present in the effluent (Hari et al., 2000).

The result in Figure 3 showed the weight of the maize increased during irrigation with noodle effluent concentration with higher concentrations (100 and 75 %) having highest dry and wet weight values of 1.97 g and 10.3 g, respectively. The same trend was observed early in textile effluent on seedling weight of wheat cultivars (Kaushik et al., 2005). The non – significant ($p>0.05$) increase in the wet and dry weight at higher concentrations of noodle effluent may also be due to the effect of higher number of elements present in the effluent which resulted in the reduced yield during effluent irrigation (Kumawat et al., 2001).

Result obtained from the heavy metal analysis of the maize harvested from the soil treated with different concentrations of the noodle effluent showed varying concentration although none of heavy metal concentration of the maize crop was above WHO (2006) standard (Table 3). The lead metal (Pb) had the highest value of 0.46±0.02 while zinc metal had least value of 0.15±0.03 absorbed in the maize plant at 100 % contamination levels, respectively. There were traces of heavy metal in the maize harvested from the soil after the irrigation with the various effluent concentrations. The heavy metals however, were above acceptable limits, and thus the harvested crops are considered toxic as reported by Mensah et al. (2009). Concentrated effluent had presence of heavy metals in heavy quantity which may also retard the growth of the plant and yield by interfering with nutrient uptake and physiological process. This finding agreed with Lone et al. (2013) that reported that the use of sewage water for irrigation substantially increases the accumulation of heavy metals Zn, Cu, Pb and Cd in soils of different cities of Punjab as the accumulation was higher in soils receiving sewage water of industrial cities.

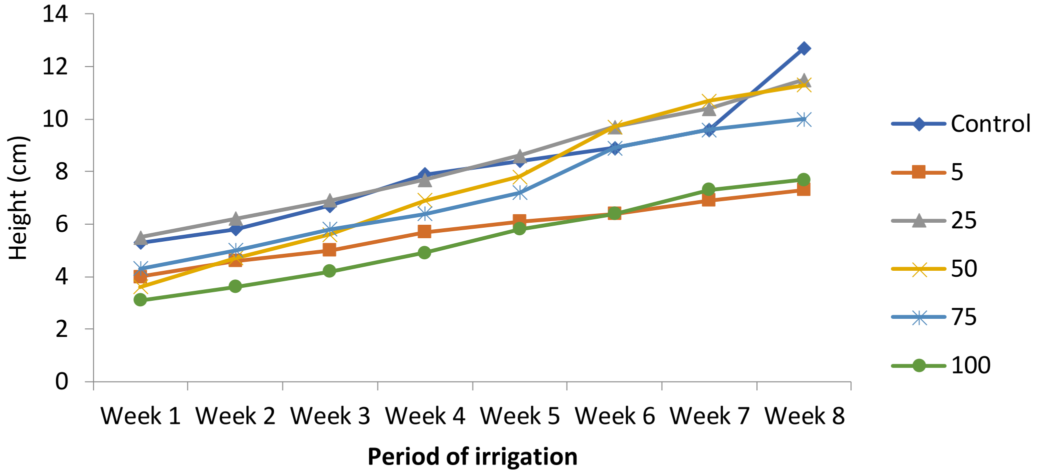

Figure 1: Mean height of maize crops during irrigation with different concentration untreated noodle effluent

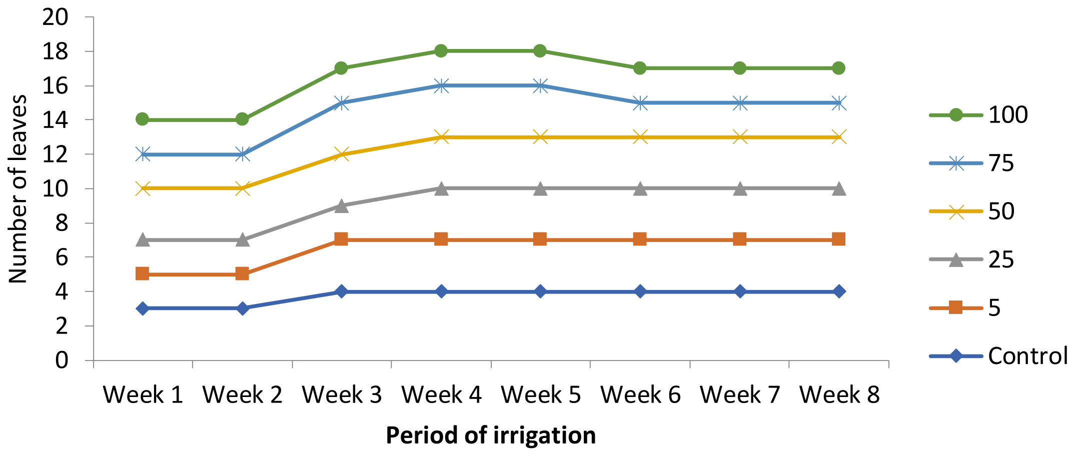

Figure 2: Mean number of leaves of maize crop during irrigation with different concentration of noodle effluent.

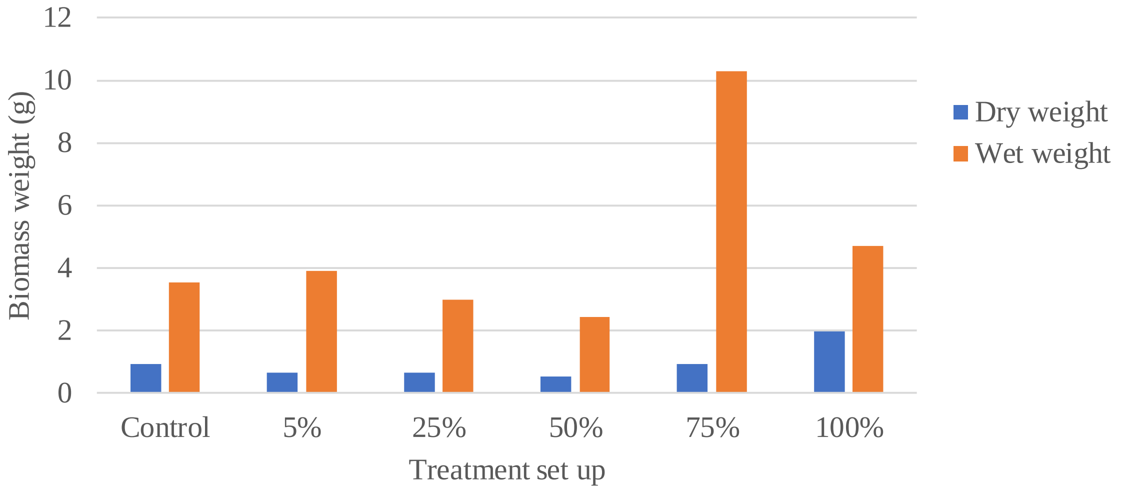

Figure 3: Dry and wet weight biomass of *Zea mays* seeds during irrigation with different concentration of noodle effluent.

Table 3: Heavy metal profile of harvested maize seeds exposed to different levels of noodle effluent after 8 weeks

Parameter	Control	5%	25%	50%	75%	100%
Lead (mg/L)	0.00±0.00	0.07±0.01	0.15±0.02	0.20±0.02	0.35±0.01	0.46±0.02
Copper (mg/L)	0.00±0.00	0.08±0.01	0.05±0.01	0.03±0.00	0.05±0.00	0.16±0.01
Zinc (mg/L)	0.00±0.00	0.03±0.00	0.05±0.00	0.05±0.00	0.11±0.04	0.15±0.03
Nickel (mg/L)	0.00±0.00	0.05±0.01	0.07±0.01	0.13±0.02	0.26±0.01	0.37±0.01
Cadmium (mg/L)	0.00±0.00	0.02±0.00	0.11±0.01	0.13±0.02	0.14±0.02	0.22±0.02
Cobalt (mg/L)	0.00±0.00	0.00±0.00	0.03±0.00	0.14±0.01	0.15±0.01	0.19±0.02

Figure 4 shows that root length of Zea mays decreased slightly at 5%–50% noodle effluent concentrations compared to the control but increased significantly at 75% and 100%, suggesting that higher effluent concentrations may enhance root elongation.

The enzymatic activity of dehydrogenase is considered a general indicator of biological activity because this enzyme has a unique role in the oxidative phosphorylation process and the respiratory metabolism of microorganisms (Karimi et al. 2021). The results in Figures 5, 6, 7 and 8 displayed the initial and final changes in urease, phosphatase, dehydrogenase and catalase activities for noodle effluent irrigated soils. In Figures 5, 6, 7 and 8, there were non – significant ($p > 0.05$) changes in the soil urease activity ranging from 4.80 - 21.40 mg/g; 18.00 – 34.20 mg/g in the soil phosphatase activity; 1.68 – 13.96 mgTPH/g/h in the soil dehydrogenase activity and 0.21 – 0.30 mol/L in the soil catalase activity, respectively after the 8 weeks noodle effluent contaminations. These enzymatic changes demonstrated the positive impact on urease, phosphatase and dehydrogenase activities and negative impact on catalase activity after the noodle effluent irrigation as these enzymes are very important in the biological machinery system of the soil. Similar observation was reported by Karimi et al. (2021) who documented that there is non – significant ($p > 0.05$) effect in the dehydrogenase activity of wastewater irrigated soil. Liang et al. (2014) showed that long-term irrigation with river water significantly increased dehydrogenase, glucosidase, urease, alkaline phosphatase, and arylsulphatase activities in the upstream and midstream soils ($P < 0.05$).

Bacteriological profiling of the soil contaminated with noodle industrial effluent sample showed that the rhizobia bacterial count, phosphate solubilizing bacterial count and actinomycetes count of profile of the soil treated varied accordingly with concentration as displayed in Figures 9, 10 and 11, respectively. The results in Figures 9, 10 and 11 depicted non – significant ($p > 0.05$) reductions in the rhizobia bacterial count ranging from 185 - 7.10 x 103 CFU/g and 15.7 – 5.50 x 103 CFU/g in the actinomycetes count, while there was significant ($p < 0.05$) reduction in the phosphate solubilizing bacterial count ranging from 17.50 – 9.8 x 103 CFU/g; respectively after the 8 weeks from 0 % - 100 % noodle effluent contaminations. The findings of this study conform with the publication of Karimi et al. (2021) who reported a non – significant ($p > 0.05$) reduction in bacteria density after wastewater irrigation. The presence of actinomycetes in the soil sample will enable fast degradation of the organic matters in the soil, which is a considerable factor for easy assimilation of the nutrients.

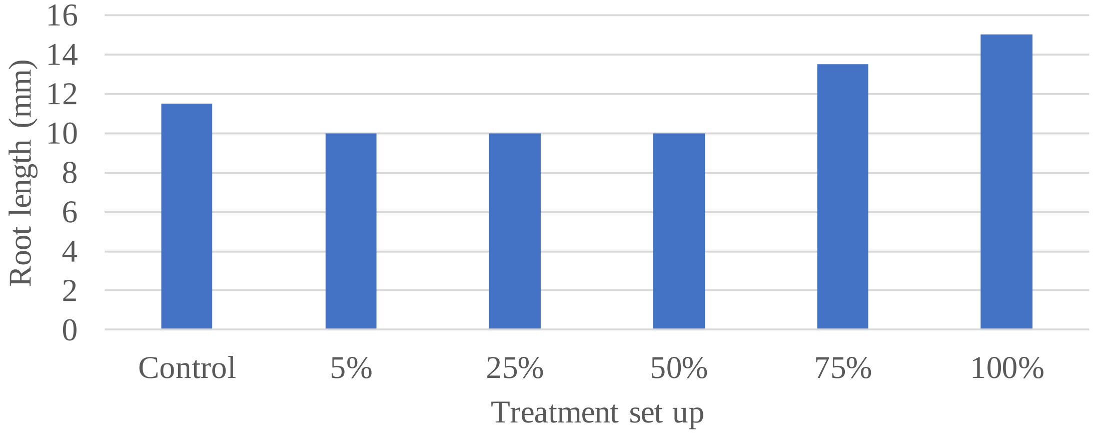

Figure 4: Root length of *Zea mays* seeds during irrigation with different concentration of noodle effluent

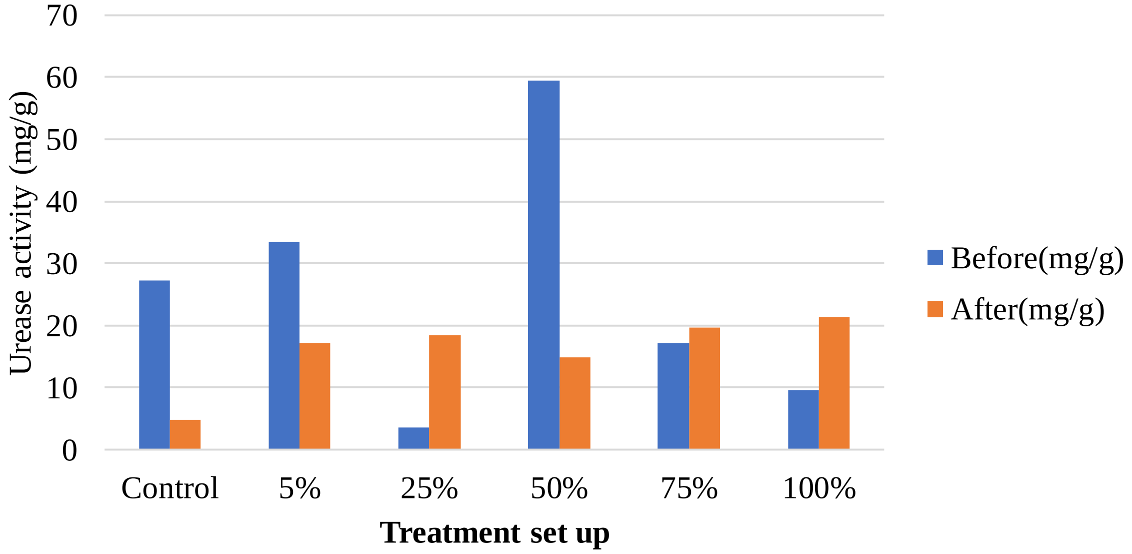

Figure 5: Initial and final urease activity for noodle effluent

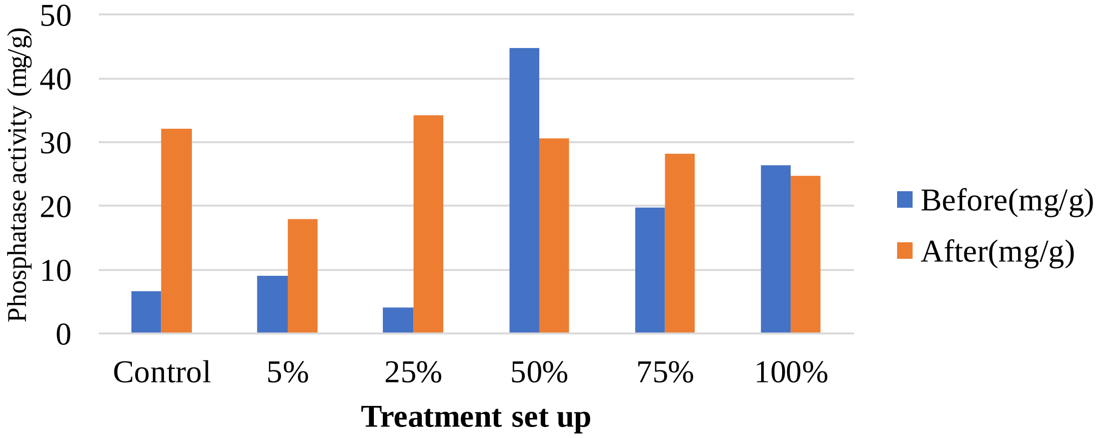

Figure 6: Initial and final phosphatase activity for noodle effluent

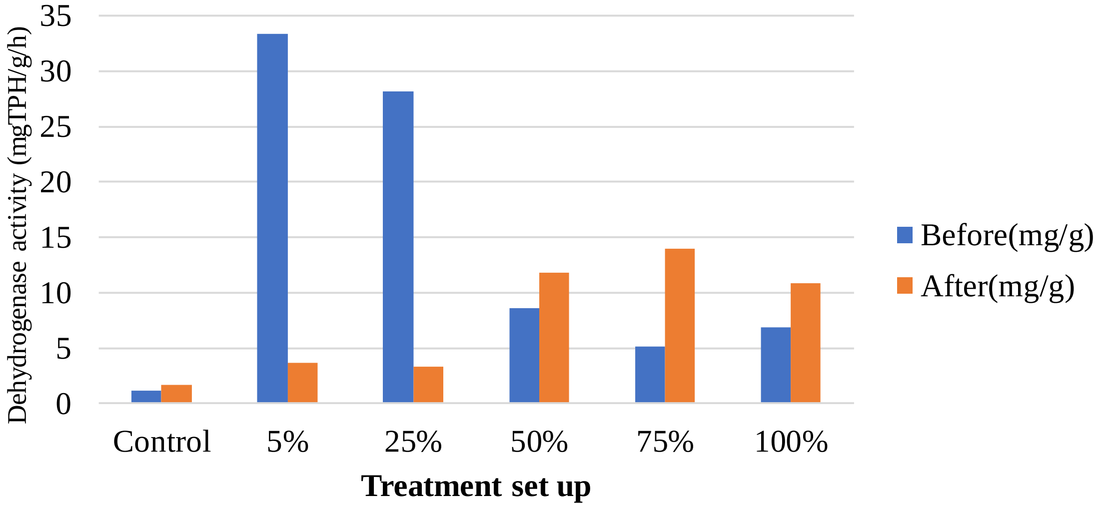

Figure 7: Initial and final dehydrogenase activity for noodle effluent

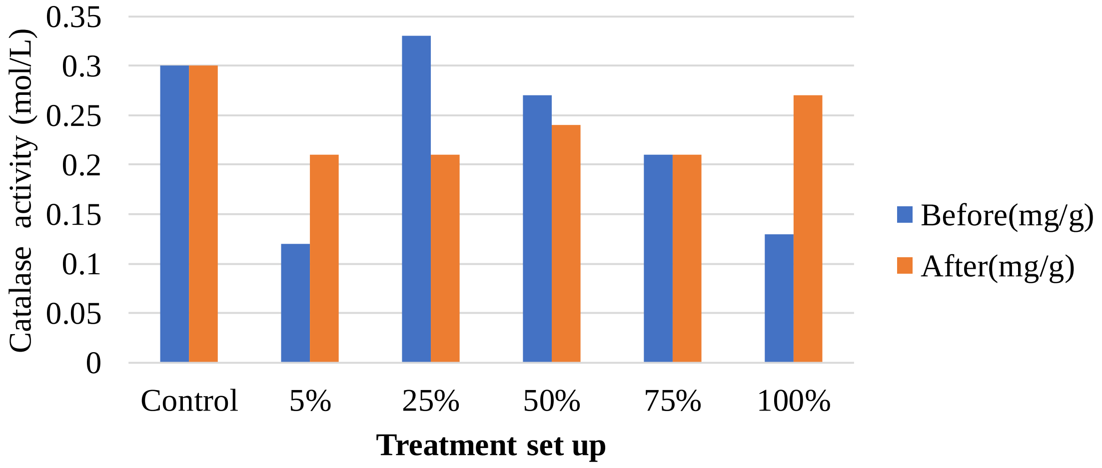

Figure 8: Initial and final catalase activity for noodle effluent

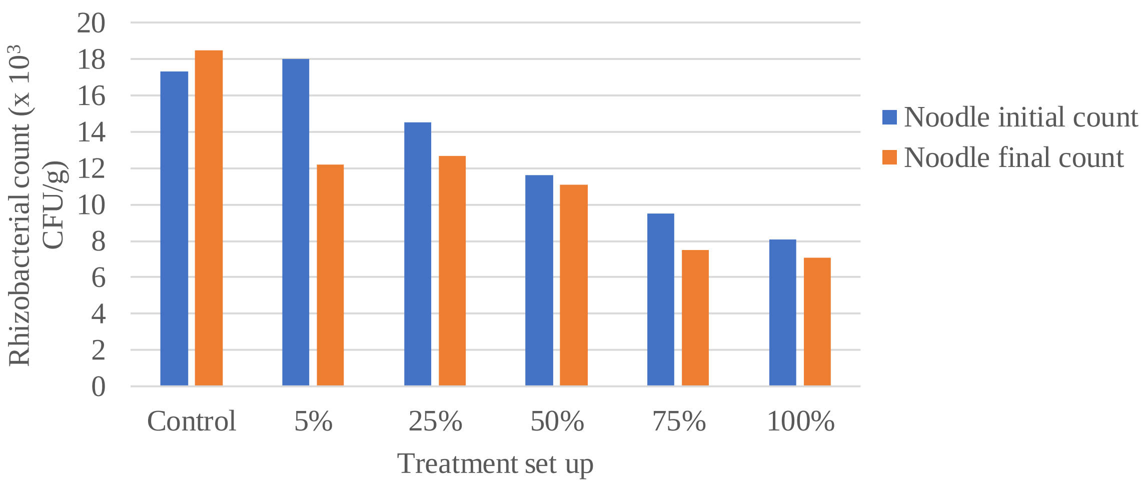

Figure 9: Rhizobacterial count profile of the soil contaminated with noodle effluent sample

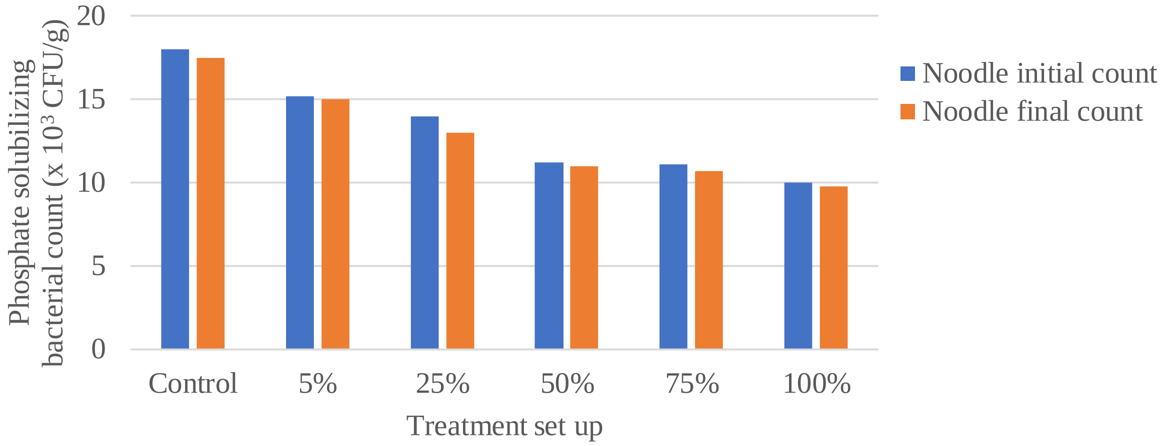

Figure 10: Phosphate solubilizing bacterial count profile of the soil contaminated with noodle effluent sample

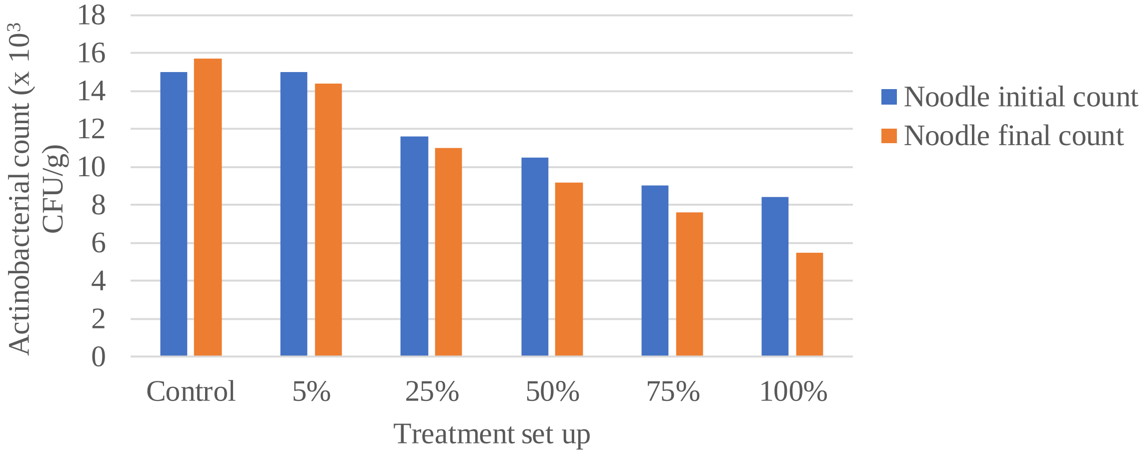

Figure 11: Actinomycetes count profile of the soil contaminated with noodle effluent sample

4. Conclusion

In this study, assessment of the effluents and contaminated soil to evaluate the effects of on seed germination, seedling growth, yield, biochemical parameters and nodulation revealed that the effluent values slightly exceed the permissible limits at significant levels. The concentration of heavy metals was very close to the permissible limit which might be due to the use of edible food grade preservatives. The inorganic insoluble salts such as Ca and Mg makes water hard and suitable for living organisms. The noodle effluent is posed as a pollutant to the environment as physicochemical parameters of effluent including pH, COD, BOD and TDS exceeded the (WHO, 2004) permissible limits. From the results, it can be concluded that seed germination, height, leaf number, biomass weights of Zea mays seeds as well as the enzymatic and bacteriological properties of the contaminated soil were affected when treated with the noodle effluent. With the increasing concentration of effluent, these parameters were reduced or negatively affected. However, on dilution, toxic effects of the effluent were reduced and its effects on growth, yield, physiological and biochemical parameters could be stimulatory rather stationary. Therefore, the noodle effluent should be treated before dumping to open place or in water bodies. Since the research has elucidated the mechanisms by which noodle industrial effluent affects plant physiology, including alterations in nutrient uptake, photosynthesis, transpiration, and hormonal balance. Understanding, these physiological responses helps in developing strategies to mitigate the negative effects on plant growth and yield.

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