Biology, Medicine, & Natural Product Chemistry
Volume 15, Number 1, April 2026 | Pages: 1203-1212 | DOI: 10.14421/biomedich.2026.151.1203-1212
ISSN 2089-6514 (paper)
ISSN 2540-9328 (online)

Application of Some Selected Plants Biomasses in Treatment of Wastewater

Jabir Danyaya Aliyu[1]*, Ibrahim Abubakar[2], Sani Maliki[3], Siddiku Umar Gwadangaji[3]
[1]Biochemistry Unit, Department of Science Technology, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria
[2]Department of Biochemistry, Federal University Gusau, Zamfara State, Nigeria
[3]Chemistry Unit, Department of Science Technology, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria.

Corresponding author*
aliyujabir55@gmail.com

Manuscript received: 23 March 2026. Revision accepted: 13 June 2026, Published: 30 June 2026.

Abstract

Wastewater contains several different hazardous substances and its consumption causes various diseases. Different plants biomasses have phytoremediation potential with significant application in wastewater treatment. The heavy metals contents of the treated and untreated wastewater sample were estimated using atomic absorption spectroscopic method. The physicochemical properties of the treated and untreated wastewater sample were determined using standard equipment and analytical methods. The total and faecal coliforms count was performed using membrane filtration method. In comparison, with the untreated wastewater, *T. domingensis* and *P. glaucifolium* exhibited significant ($p < 0.05$) decrease in pH, turbidity, conductivity, total hardness (TH), total suspended solids (TSS), total dissolved solid (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity (TA), chloride, sulphate, phosphate, and nitrate level in the wastewater sample with high percentage removal of the physicochemical contaminants. The wastewater sample treated with *T. domingensis* and *P. glaucifolium* displayed significant ($p < 0.05$) reduction in the level of Ni, Mn, Cr, Pb, Cd, and Co in the wastewater sample compared with the untreated sample. the coliforms load in the wastewater sample. The total and faecal coliforms load in the wastewater sample treated with *T. domingensis* and *P. glaucifolium* was significantly ($p < 0.05$) reduced compared with the untreated wastewater sample. The *Typha domingensis* demonstrated high significant ($p < 0.05$) removal efficiency against the physicochemical contaminants, heavy metals, andtotal and faecal coliforms population in the wastewater compared to the *Pennisetum glaucifolium*.

Keywords: Heavy metals; Phytoremediation; *Pennisetum glaucifolium*; *Typha domingensis*; Wastewater.

INTRODUCTION

Water remains the most widely available substance in the world covering large portion of the Earth. Water is a vital substance required for life sustainability, growth, and development of living organisms. The essential functions of water include consumption by human and animals, absorption byplants for photosynthesis, and domestic and industrial activities. According to World Health Organisation a water quality for human consumption must be free from pathogens, parasites, toxic chemicals, and other harmful substances (WHO, 2023). A safe drinking water must be colourless and odourless and characterizes by a pH 6.5 – 8.5 and minimal recommended values of chemicals (WHO, 2023). Consumption of quality and safe water promotes hygienic measures thereby preventing microbial infections including acute respiratory infections and neglected tropical diseases (UN, 2021). Ineffective treatment of wastewater leads to production and distribution of contaminated drinking water risking life of millions of people (WHO, 2023). Report by World Health Organisation showed that in 2022 about 1.7 billion people consume water contaminated with faeces (WHO, 2023). Water contaminated with faeces is associated with microbial infections such as diarrhoea, cholera, and typhoid (WHO, 2023, UN, 2021). Almost 80% of diseases coupled with 33% of deaths in low and middle income countries are due to consumption of poor quality water (Azuamaha *et al.,* 2023). It has been estimated that consumption of water contaminated with microorganisms causes about one million deaths annually worldwide (WHO, 2023, UN, 2021).

Biomasses are major component of the Earth's ecosystems and serves important role in sustenance of life. They are important elements of bioeconomy and vital materials for addressing societal and industrial problems. Biomasses are any organic materials originated from plants or animals. The global demand for biomass has been increased due to high population and increase in industrials activities. Plants are the primary sources of biomass and provide significant contributions in energy production, wastewater treatment, and environmental conservation. Plant biomasses are natural organic materials originated from different plants, weeds, shrubs, trees, crops, and algae. They comprise different parts of plant including leaves, stems, roots, and flowers. The composition of plant biomass varied among the plant species. However, plant biomass is mainly composed of cellulose, hemicellulose, and lignin. Other components of plant biomass include extractives, lipids, proteins, carbohydrates, ash, and fiber. Plant biomasses serve as important resources for ecological, domestic and industrial activities. Plant biomass can be categorized as agricultural biomass (wastes such as leaves, stalks, stem, husks), forest biomass, aquatic biomass (algae and aquatic weeds), and biomass from byproducts, wastes, and residues. Plant biomasses serve important function in improving anaerobic digestion.

Wastewater or raw sewage water from anthropogenic activities contains several toxic substances that have been documented with adverse health effects (Aliyu *et al.,* 2026). The use of conventional techniques in treatment of wastewater is ineffective, expensive, requires complex operation, and generates toxic products. Hence, more effective, less expensive and safe method for wastewater treatment should be developed to produce quality water for consumption and domestic activities. Phytoremediation is the use of plants or plants derived materials for treatment of wastewater. The technique is simple, less expensive, and generates non toxic materials. Plant biomasses have been used as effective phytoremediation agents. The application of plant biomass in wastewater treatment is an effective and safe water treatment method and could improves the finding solution to environmental problems particularly lack or inadequate of quality water.

Typha species are the most abundant aquatic weeds and have potential removal of pollutants from aquatic environments (Futughe *et al.,* 2020). *Typha domingensis*, commonly called cattail is a perennial plant growing in aquatic environments and belongs to the family Typhaceae (Aliyu *et al.,* 2025; WCSPF 2023). *Typha domingensis* is abundantly available in tropical countries (Sesin *et al.,* 2021; WCSPF 2023). *Typha domingensis* is widely found in Northern region of Nigeria and is commonly called Shala in Hausa. *Typha domingensis*is used forprevention of flooding, conservation of natural resources, and removal of pollutants from aquatic environments (Kennedy *et al.,* 2025). *Pennisetum glaucifolium*, commonly known as Desho grass is a perennial grass belonging to the family Poaceae (Mengistu *et al.,* 2021). *Pennisetum glaucifolium* is an Ethiopia native plant rapidly distributed in other tropical countries. *Pennisetum glaucifolium* is an important source of feed for animals and used for conservation of natural resources (Keba, 2023; Fuglie *et al.,* 2021). *Pennisetum glaucifolium* is an important biomass material and vital source of dry matter (Wana *et al.,* 2021; Hidosa *et al.,* 2020). In Nigeria, *Pennisetum glaucifolium* is commonly known as Kyasuwa in Hausa and serves as feedstock for animals in many local communities in the country. The aim of this study is to evaluate the potential of *Typha domingensis*and *Pennisetum glaucifolium* in treatment of wastewater from Kebbi state water treatment plant.

MATERIALS AND METHODS

Study Site

This research was performed in Argungu in Kebbi State, Nigeria. Argungu is one of the local government areas in Kebbi State, Nigeria. The average humidity, annual rainfall, and annual temperature in Argungu is approximately 24 %, 800 mm, 33.55 °C, respectively (HWD, 2023; ACW, 2023). Argungu has been the major agricultural area in Kebbi state with production ofvarious different food items such as rice, wheat, and millet. Argungu is the major fishing practice area in Nigeria hosting Argungu Fishing Festival an annual international fishing festival in Nigeria.

Plants sample

The roots of *Typha domingensis* and *Pennisetum glaucifolium* were collected from adjacent site of Argungu River in Argungu, Kebbi state, Nigeria. The *Typha domingensis* (UDUH/ANS/1115) and *Pennisetum glaucifolium* (UDUH/ANS/1092) samples were identified at Herbarium Unit, Department of Plant Science, Usmanu Danfodiyo University, Sokoto. The voucher numbers were deposited in the herbarium.

Wastewater sample

The wastewater sample was collected in clean plastic bottles from the Argungu River. The bottles were wrapped in black plastic bags to prevent the access of light to the sample. The sample was transported to the Laboratory Unit, Department of Science Technology, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria at 4 °C on ice for analysis.

Determination of Physicochemical Properties of the Water

pH

The pH of the treated and untreated wastewater sample was measured using digital pH meter standardized with buffer solutions of pH 4 and 9. The pH values were recorded in triplicate and then the mean value was calculated.

Temperature

The temperature of the treated and untreated wastewater sample was determined using digital thermometer. The temperature values were measured in degree Celsius (°C) and recorded three times followed by calculation of mean value.

Electrical Conductivity

The electrical conductivity of the treated and untreated wastewater sample was measured using digital conductivity meter calibrated with 0.01 N of potassium chloride solution by immersion the sensor into the water samples. The measurements were recorded three times and the average value was calculated.

Turbidity

The turbidity of the treated and untreated wastewater sample was determined by Nephelometric method using turbidity meter. The sample (10 mL) in a cuvette was taken into the turbidity meter and turbidity was measured in triplicate and then the average value was obtained.

Total Hardness

The total hardness of the treated and untreated wastewater sample was determined using EDTA titration method. A 0.1 M EDTA solution was put into the burette up to the mark 0 mL. Fifty miles of the wastewater sample was transferred into a flask. The ammonia buffer (1 mL) was added into the flask followed by addition of five drops of Ericrome black–T as an indicator. The solution was titrated against the EDTA solution. The initial and final readings were recorded. The total hardness was obtained using the following equation:

$$\text{Total hardness (mg/L)} = \frac{\text{Volume of EDTA used}}{\text{Volume of Sample}} \text{ X } 1000$$

Total Suspended Solids

The treated and untreated wastewater sample was evaluated for total suspended solids (TSSs) content using gravimetric method of AOAC (2000). The water sample (100 mL) was filtered using glass fibre filter apparatus. The residue was dried in oven at 104 ^{o}C for 24 hours and then weighed. The TSSs content was calculated using the following equation:

$$\text{Total suspended solids (mg/L)} = \frac{\text{Weight of dried residue}}{\text{Volume of sample}} \text{ X } 1000$$

Total Dissolved Solids

The total dissolved solids (TDSs) content of the treated and untreated wastewater sample was estimated using gravimetric method of AOAC (2000). The water sample (100 mL) in dish was dried in oven at 104 ^{o}C for 24 hours and then weighed after cooled. The TDSs content of the samples was obtained using the following equation:

$$\text{Total dissolved solids (mg/L)} = \frac{\text{W2} - \text{W1}}{\text{Volume of sample}} \text{ X } 1000$$

Where; W_1 is the weight of empty dish, and W_2 is the weight of empty dish and dried sample.

Dissolved Oxygen

The dissolved oxygen (DO) value of the treated and untreated wastewater sample was measured using digital dissolved oxygen meter. The DO value was read three times and the mean value was calculated.

Biological Oxygen Demand

A 5-Day BOD Test method was employed for estimation of biological oxygen demand (BOD) in the treated and untreated wastewater sample. The water sample (100 mL) was overflowed in 500 mL airtight bottle. The dissolved oxygen (DO_1) of the sample was measured using digital dissolved oxygen meter. The bottle was incubated at 20^{o}C for five days after which the dissolved oxygen (DO_2) was finally measured. The BDO value was obtained using the following equation:

$$\text{BOD5 (mg/L)} = \frac{\text{DO2} - \text{DO1}}{\text{Volume of Sample}}$$

Where; DO_1 is the initial dissolved oxygen, $DO_2$is the final dissolved oxygen, and B is the volume of sample used.

Chemical Oxygen Demand

The chemical oxygen demand (COD) of the treated and untreated wastewater sample was estimated using colorimetric method of ASTM (2011) and APHA (2005). The water sample (2 mL) was treated with 3 mL of H_2SO_4solution in test tubes and then heated at 150 ^{o}C for 2 hours. The tubes were cooled at room temperature and the absorbance was measured using colorimeter at 600 nm wavelength. The COD was calculated using the following equation:

COD (mg/L) = (Absorbance of sample − Absorbance of standard) × Dilution factor

Total Alkalinity

The total alkalinity of the treated and untreated wastewater sample was determined using titration method as described by APHA (2005) and ASTM (2004). The water sample (50 mL) was respectively transferred into labelled 250 mL conical flasks followed by addition of2 drops of 0.5 %w/v phenolphthalein indicator. The solutions were thoroughly mixed and then titrated with 0.05M H_2SO_4 to pinkish colour recorded as titre value (V_1). Two drops of 0.5 % w/v methyl orange indicator were added into the pinkish solution. The solution was thoroughly mixed and then titrated with 0.05M H_2SO_4 solution to pale red colour recorded as titre value (V_2). The total alkalinity was calculated using the following equation:

$$\text{Total alkalinity (mg/L)} = \frac{\text{Molarity x (V1 + V2)}}{\text{Volume of Sample(mL)}} \text{ X } 1000$$

Chloride

The treated and untreated wastewater sample was analyzed for chloride content using titration method as described by APHA (2005). The water sample (50 mL) (V) was treated with 3 mL of $Al(OH)_3$ and pH of the solution was adjusted 8.0. Potassium chromate solution (1 mL) was added and then titrated with $AgNO_3$ solution until reddish brown precipitate was observed and the titre volume (V1) was recorded. The experiment was also repeated for blank (distilled water) and the titre volume (V2) was recorded. The concentration of chloride was obtained using the following formula:

$$\text{Chloride Concentration (mg/L)} = \frac{\text{V1} - \text{V2 x N x 35.46}}{\text{Volume of Samlpe (mL)}} \text{ X 1000}$$

Where N = normality of $AgNO_3$ = 0.98

Sulphate

The level of sulphate in the treated and untreated wastewater samplewas estimated using Turbidimetric method described by APHA (2005). The sample (20 mL) was measured in a separate 100 mL flask containing 1 mL of the conditioning reagent. The HCl solution (1 mL) and distilled water (9 mL) was added into the flask. The $BaCl_2$ (0.3 g) was gently added into the flask and gently stirred. The absorbance of the sample against a blank was measured using spectrophotometer at 420 nm wavelength. The level of sulphate in the samples was obtained from the constructed standard curve.

Nitrate

Spectrophotometric method was employed for determination of nitrate level in the treated and untreated wastewater sample as described by APHA (1995) and USEPA (1983). The water sample (5 mL) was acidified with 1N HCl to prevent interference from hydroxide or carbonate concentrations. The contents were dried in oven. The dried sample was treated with 2 mL of phenoldisulphonic acid, lightly washed, warmed, and then allowed to cool. The mixture was treated with 10 mL of conc.NH_4OH solution and then washed. The standard curve was constructed. Absorbance of the sample and standard was measured using spectrophotometer at 410 nm and the nitrate concentration was obtained from the standard curve.

Phosphate

Colorimetric method was employed for determination of phosphate level in the treated and untreated wastewater sample as described by ASTM (2004) and APHA (1998). The water sample (50 mL) was transferred into three separate conical flasks each containing 20mL of ascorbic acid. The solutions were mixed well and then incubated at 25°C for 5 minutes. The standard curve was constructed using prepared standard solution. The absorbance was read at 650nm wavelength and the phosphate level was extrapolated from the standard curve.

Determination of Heavy Metals Content

The concentration of nickel, manganese, cobalt, chromium, lead, and cadmium in the treated and untreated wastewater sample was determined using atomic absorption spectroscopic (AAS) method described by AOAC (2005). The water sample (100 mL) was treated with1 mL of conc. HNO_3 solution and 2 g of anti-bump. The solution was incubated at 65 °C for 5 min, cooled and then filtered. The standard solutions of concentration from 0.1 mg/L to 10 mg/L were prepared from the metals diluted stock solution. The calibration curves for the metals were constructed. The absorbance was read at 450 nm wavelength and the concentration of the metals was obtained from the calibration curves.

Bacteriological Analysis

The treated and untreated wastewater sample was analyzed for Total Coliforms (TC) and Faecal Coliforms (FC) count using standard membrane filtration method as described by (APHA, 1998). The water sample (100 mL) was introduced into a sterile stainless steel and filter holder system fitted with membrane filter of 0.45 µm pore size. The membrane filter was placed on a prepared m-Endo agar and then incubated at 35 °C for 24 hours. The red colour bacteria colonies (Faecal Coliform and Total Coliform) were counted and expressed as Colony Forming Units (CFU) per 100 mL.

Determination of the Percentage of Contaminant Removal

The percentage pollutant removal efficiency of the sample and for each parameter analyzed was obtained using the following equation:

$$\text{\% Removed contaminant} = \frac{\text{CU} - \text{CT}}{\text{CU}} \text{ X 100}$$

Statistical Analysis

The statistical analysis of the results using SPSS Statistics version 23 and the results were expressed as mean ± standard error of mean. The significant differences between the mean values was determined by one-way analysis of variance (ANOVA) at $p< 0.05$ level of significance using Tukey Post Hoc test for multiple comparisons test.

RESULTS

Physicochemical Properties of the Water Sample

Table 1 indicates the physicochemical properties of the treated and untreated wastewater sample. The untreated wastewater sample displayed high value of pH, turbidity, conductivity, TH, TSS, TDS, BOD, COD, TA, chloride, sulphate, phosphate, and nitrate coupled with low temperature and dissolved oxygen (DO) value. Treatment of the wastewater with *T. domingensis*and *P. glaucifolium* significantly ($p < 0.05$) reduced the pH, turbidity, conductivity, TH, TSS, TDS, BOD, COD, TA, chloride, sulphate, phosphate, and nitrate level of the water sample. However, the high decrease in the level of the contaminants was observed in the wastewater sample treated with *T. domingensis* than that treated with *P. glaucifolium* (Table 1).

Table 1. Physicochemical Properties of the Water Sample.

Parameter	Untreated	*T. domingensis*	*P. glaucifolium*
pH	8.70 ± 0.26^a	6.36 ± 0.22^b	7.13 ± 0.35^a
Temperature (°C)	21.33 ± 0.88^a	27.00 ± 0.11^b	24.00 ± 0.11^c
Turbidity (NTU)	71.00 ± 0.23^a	28.00 ± 0.34^b	42.66 ± 0.34^c
Conductivity (µS/cm)	1321.33 ± 0.20^a	983.00 ± 0.32^b	994.33 ± 0.40^c
Total Hardness (mg/L)	876.66 ± 0.20^a	184.33 ± 0.26^b	240.33 ± 0.20^c
Total Suspended Solids (mg/L)	979.33 ± 0.43^a	219.66 ± 0.31^b	318.00 ± 0.33^c
Total Dissolved Solids (mg/L)	2438.00 ± 0.40^a	523.00 ± 0.34^b	739.33 ± 0.22^c
Dissolved Oxygen (mg/L)	5.60 ± 0.34^a	23.33 ± 0.31^b	10.93 ± 0.31^c
Biological Oxygen Demand (mg/L)	87.20 ± 0.43^a	20.76 ± 0.40^b	36.76 ± 0.37^c
Chemical Oxygen Demand (mg/L)	460.66 ± 0.29^a	79.66 ± 0.20^b	124.33 ± 0.23^c
Total Alkalinity (mg/L)	150.33 ± 0.23^a	58.33 ± 0.35^c	67.33 ± 0.25^b
Chloride (mg/L)	563.00 ± 0.17^a	211.00 ± 0.13^b	322.33 ± 0.29^c
Sulphate (mg/L)	44.10 ± 0.37^a	26.20 ± 0.32^b	27.26 ± 0.06^b
Phosphate (mg/L)	9.70 ± 0.15^a	3.33 ± 0.26^b	5.00 ± 0.22^c
Nitrate (mg/L)	15.23 ± 0.31^a	5.96 ± 0.23^b	6.66 ± 0.20^b

Values are mean ± SEM (n = 3)
Values in the same row with different letters are statistically significant.

Figure 1 shows the percentage removal efficiency of *T. domingensis* and *P. glaucifolium* against physicochemical contaminants from the wastewater sample. The result showed thatthe *T. domingensis* and *P. glaucifolium* demonstrated significant ($p < 0.05$) removal efficiency of physicochemical contaminants. However, *T. domingensis* exhibited high significant ($p < 0.05$) removal capacity compared to the *P. glaucifolium* (Figure 1).

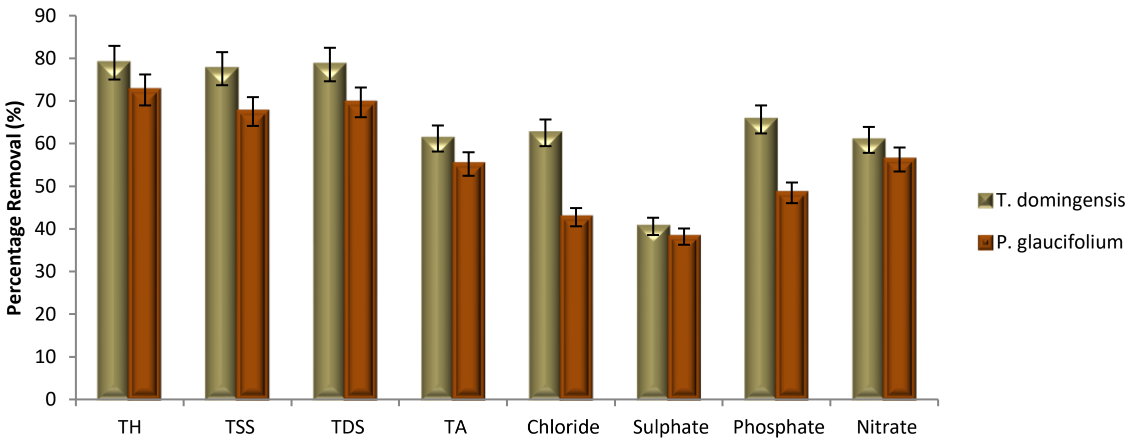

Figure 1. Percentage Removal Efficiency of Physicochemical Contaminants.

The heavy metals contents of the treated and untreated wastewater sample are shown in Table 2. In comparison with the untreated wastewater sample, *T. domingensis* and *P. glaucifolium* demonstrated significantly ($p < 0.05$) decrease in the level of Ni, Mn, Cr, Pb, Cd, and Co (Table 2).

Table 2. Heavy Metals Content of the Water Sample.

Parameter	Untreated	*T. domingensis*	*P. glaucifolium*
Nickel	0.79 ± 0.007^a	0.12 ± 0.006^b	0.13 ± 0.013^b
Manganese	1.86 ± 0.011^a	0.25 ± 0.001^b	0.31 ± 0.002^b
Chromium	2.99 ± 0.039^a	0.70 ± 0.031^b	0.76 ± 0.014^b
Lead	1.15 ± 0.027^a	0.28 ± 0.024^b	0.38 ± 0.022^b
Cadmium	0.93 ± 0.005^a	0.19 ± 0.002^b	0.21 ± 0.013^b
Cobalt	0.58 ± 0.012^a	0.13 ± 0.015^b	0.18 ± 0.006^b

Values are mean ± SEM (n = 3)
Values in the same row with different letters are statistically significant.

The percentage removal efficiency of *T. domingensis* and *P. glaucifolium* against heavy metals contaminants from the wastewater sample is presented in Figure 2. High percentages of all the detected heavy metals were significantly ($p < 0.05$) removed from the wastewater sample following treatment with *T. domingensis* and *P. glaucifolium*. However, the wastewater sample treated with *T. domingensis* displayed high significant ($p < 0.05$) percentage of the heavy metals removed compared with the wastewater sample treated with *P. glaucifolium* (Figure 2).

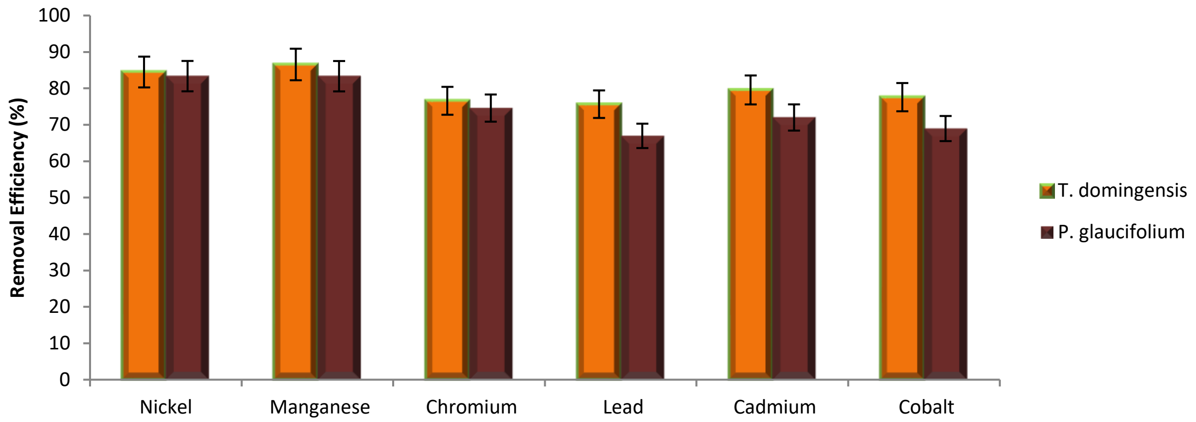

Figure 2. Percentage Removal Efficiency of Heavy Metals.

Figure 3 presents the mean count of total coliforms and faecal coliforms in the treated and untreated wastewater sample. Treatment of the wastewater sample with *T. domingensis*and *P. glaucifolium* significantly ($p < 0.05$) reduced the coliforms load in the wastewater sample. However, *T. domingensis* exhibited significant ($p < 0.05$) decrease in the total and faecal coliforms counts than the *P. glaucifolium* (Figure 3).

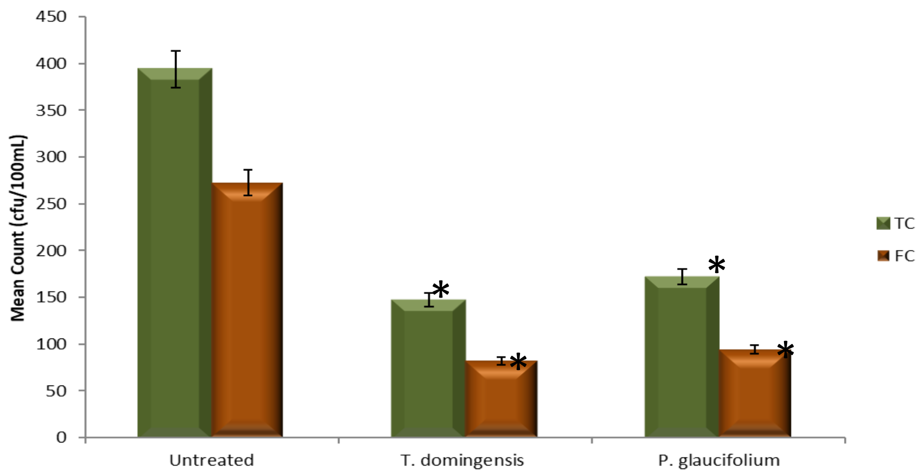

Figure 3. Total Coliforms and Faecal Coliforms Load. *$p < 0.05$ statistically significant compared with untreated.

Figure 4 indicates the percentage removal efficiency of *T. domingensis* and *P. glaucifolium* against total and faecal coliforms load from the wastewater sample. It was observed that high percentage of total and faecal coliforms was significantly ($p < 0.05$) removed in the wastewater sample treated with *T. domingensis* and *P. glaucifolium*. However, the percentage removal of total and faecal coliforms was significantly ($p < 0.05$) high in the wastewater sample treated with *T. domingensis* than that treated with *P. glaucifolium* (Figure 4).

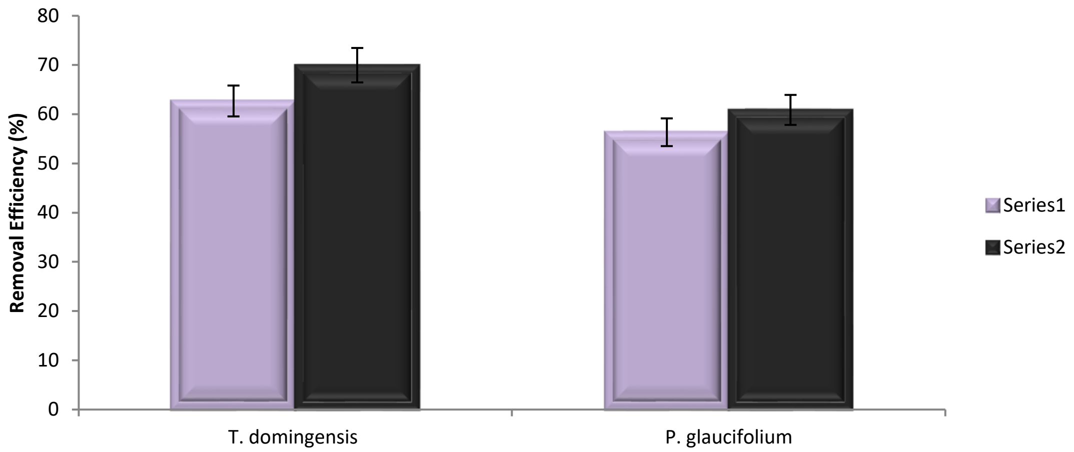

Figure 4. Percentage Removal of Total Coliforms and Faecal Coliforms.

DISCUSSION

In this study, *T. domingensis* and *P. glaucifolium* displayed significant efficiency for reduction of pH, turbidity, conductivity, TH, TSS, TDS, BOD, COD, TA, chloride, sulphate, phosphate, and nitrate level in the water sample. Turbidity indicates a contamination of water with suspended hazardous particles, heavy metals and toxic organic substances (WHO, 2017). Electric conductivity indicates the total salt content of water (Sri-Dattatreya *et al.,* 2018). Total hardness of water was due to the presence of divalent cations, particularly calcium and magnesium ions. Total suspended solids and total dissolved solids of water indicate the presence of organic substances and metals in water (Adimalla & Venkatayogi, 2018). Biochemical oxygen demand determines the quality and suitability of water (Sri-Dattatreya *et al.,* 2018). Alkalinity of water indicates its carbonate (CO_3^{2-}) and bicarbonate (HCO^{3-}) contents (Igwe *et al.,* 2021). High level of chloride in water indicates the presence of pollutants in water which its consumption can cause colorectal and bladder cancer (Adimalla & Qian, 2019; DPR, 2018).

In the present study, high concentration of Ni, Mn, Cr, Pb, Cd, and Co was observed in the wastewater sample. However, treatment of the wastewater with *T. domingensis* and *P. glaucifolium* significantly decreased the level of Ni, Mn, Cr, Pb, Cd, and Co in the wastewater with high percentage of removal**.** Drinking of heavy metals contaminated is associated with neurotoxicity, carcinogenicity, reproductive organs dysfunction, and immunotoxicity (Abubakar *et al.,* 2025; Abubakar *et al.,* 2022).This finding is in agreement with the finding of relevant studies in which *T. domingensis* displayed significant removal capacity against As, Co, Cu, Ni, Pb, Zn and Hg (Compaore *et al.,* 2020; Lominchar *et al.,* 2015). This study also agrees the finding of similar studies which indicated that *T. domingensis* significantly removed certain heavy metals including Cr, Ni, Zn, Fe, Cd and Cr from aquatic environments (Dube *et al.,* 2019; Hadad *et al.,* 2018).However, it has been reportedthat Typha latifolia exhibited significant removal efficiency against Fe, Cu, Zn, Pb, and Ni from the mining effluents Riverine wetlands (Nabuyanda *et al.,* 2022; Milke *et al.,* 2020). On the other hand Vetiver grass which belongs to the same genus with Desho grass displayed significant removal caoacity against different pollutants from aquatic environments (Angassa *et al.,* 2019; Badejo *et al.,* 2018).

Wastewater and wastewater treatment plants have been the primary source of pathogens for thousand populations (Bain *et al.,* 2012). Fecal coliforms are pathogenic microbes that have been reported with potential to contaminate aquatic environmental (Osuolale and Okoh, 2015). High population of coliforms in the wastewater indicates the presence of pathogens that can cause health effects on humans and animals (Seo *et al.,* 2019). Pathogens in untreated or poorly treated wastewater cause many potential health risks including dysentery, cholera, typhoid, fever, and diarrhea (Ciss´e, 2019). In this study, treatment of the wastewater sample with *T. domingensis* and *P. glaucifolium* significantly removed high population of total and faecal coliforms from the wastewater. Wastewater treatment plants contributes significantly in reducing of microbial population from wastewater through inhibiting or killing of microorganisms or by removing organic and inorganic nutrients required by microbes for growth and proliferation (Mao *et al.,* 2015). Studies showed that plant weed particularly root exudates exhibited significant removal of microorganisms by being toxic to pathogenic microbes (Angassa *et al.,* 2018). It has been documented that total and faecal coliforms are removed from the wastewater by sedimentation, adsorption, predation by other organisms, and change in physicochemical conditions (Sartori *et al.,* 2016). Many studies showed that plants demonstrated significant efficiency for removal of bacteria from contaminated environments (Calheiros *et al.,* 2017). However, similar study showed that plants treated by horizontal flow hydroponics displayed high removal efficiency of coliforms up to 90.9 % from domestic wastewater (De Anda *et al.,* 2018).

CONCLUSION

Typha domingensis and *Pennisetum glaucifolium* demonstrated significant reduction in the level of pH, turbidity, TH, TSS, TDS, BOD, COD, TA, chloride, sulphate, phosphate, nitrate, Ni, Mn, Cr, Pb, Cd, Co, total and faecal coliforms population in the wastewater sample. However, *Typha domingensis* displayed high significant efficiency in removing the physicochemical contaminants, heavy metals, and total and faecal coliforms population from the wastewater compared to the *Pennisetum glaucifolium*. Thus, *Typha domingensis* has high phytoremediation potential for treatment of wastewater from Kebbi state water treatment plant than *Pennisetum glaucifolium*.

Conflict of Interest: The authors declared that there was no conflict of interest.

REFERENCES

Abubakar, I., Aliyu, J. D., Mohammed, A. G.,Ibrahim, I. B., Said, S. S., & Umar, S. F. (2025). Evaluation of phytochemicals, nutritional and anti-nutritional composition of the aqueous extracts of white and red onions bulbs. *Biology, Medicine, & Natural Product Chemistry*, 14(1), 443 – 450. https://doi.org/10.14421/biomedich.2025.141.443-450

Abubakar, I., Aliyu, J.D., Abdullahi, Z., Zubairu, Z., Umar, A.S., & Ahmad, F. (2022). Phytochemical Screening, Nutritional and Anti-nutritional Composition of Aqueous Rhizome Extract of Curcuma longa. *Journal of Biotechnology and Biochemistry*, 8(2), 1–9. https://doi.org/10.9790/264X-08020109

Adimalla, N., & Qian, H. (2019). Groundwater quality evaluation using water quality index (WQI) for drinking purposes and human health risk (HHR) assessment in an agricultural region of Nanganur, south India. *Ecotoxicology Environment Safety*, 176, 153–161, https://doi.org/10.1016/J.ECOENV.2019.03.066.

Adimalla, N., Li, P., & Venkatayogi, S. (2018). Hydrogeochemical evaluation of groundwater quality for drinking and irrigation purposes and integrated interpretation with water quality index studies. *Environmental Processes*, 5 (2), 363–383. https://doi.org/10.1007/s40710-018-0297-4.

Akpor, O.B. (2014). Heavy metal pollutants in wastewater effluents: sources, effects and remediation. *Advance Bioscience and Bioengineering*, 2, 37.

Aliyu, J. D., Abubakar, I., Abdullahi, Z., & Musa, S. (2026). Application of Activated Carbon Derived from *Typha domingensis* in Industrial Wastewater Treatment. *Journal of Bioresources and Environmental Sciences*. https://doi.org/10.61435/jbes.2026.20003

Aliyu, J. D., Abubakar, I.,Sahabi, M., Abdullahi, Z., Zubairu, A., and Sahabi, A. U., & Ahmad, F. (2025).Phytochemicals, nutrients and anti-nutrients composition of the aqueous roots and stem extracts of *Typha Domingensis*. *Natural and Applied Sciences Journal*.8(1), 1–17. https://doi.org/10.38061/idunas.1582691

Angassa, K., Leta, S., Mulat, W., Kloos, H., & Meers, E. (2018). Organic matter and nutrient removal performance of horizontal subsurface flow constructed wetlands planted with Phragmite karka and Vetiveria zizanioide for treating municipal wastewater. *Environmental Processes*, 5 (1), 115–130.

Angassa, K., Leta, S., Mulat, W., Kloos, H., & Meers, E. (2019). Effect of hydraulic loading on bioremediation of municipal wastewater using constructed wetland planted with vetiver grass, addis Ababa, Ethiopia. *Nanotechnology Environmental Engineering, 4*, 1–11. https://doi.org/10.1007/S41204-018-0053-Z

AOAC (2000). Association of Official Analytical Chemist Official Methods of Analysis, New York, pp 66-89.

AOAC. (2005) Official Methods of Analysis (18th ed.). Washington, DC: Association of Official Analytical Chemist.

APHA (American Public Health Association). (1995). Eaton, A. D. Clessicens, S.L Greenberg , E.A. "Standard methods for the Examination of Water and Wastewater", 19th ed. American Public Health Association, 1015 Fifteenth Street, NW, Washington, DC, pp 49-51.

APHA (American Public Health Association). (1998). Standard Methods for the Examination of Water and Waste Water. 20th Edition, American Waterworks Association, Wash ington DC.

APHA (American Public Health Association). (2005). Standard Methods for examination of Water and Wastewater. 21st Edn., American Public Health Association, Washington, DC., ISBN: 0875530478, pp: 2-61.

ASTM (American Society for Testing and Materials) (2004). Standard methods for acidity or alkality of water. Publ.D1067-70 (reapproved 1977), American soc. Testing and materials Philadelphia.pa.

ASTM (American Society for Testing and Materials). (2011). Standard Test Method for substances in Crude Oil. ASTM International, West Conshohocken, PA, 2011, doi: 10.1520/C0033-03, www.astm.org. Annual Book of Standards. 2: 287, 97, 93, 445.

Azuamaha, K.O., Appiah-Effaha, E., & Akodwaa-Boadi. K. (2023). Water quality index, ecotoxicology and human health risk modelling of surface and groundwater along illegal crude oil refining sites in a developing economy). *Heliyon*, 9, 20631. https://doi.org/10.1016/j.heliyon.2023.e20631

Badejo, A. A., Omole, D. O., & Ndambuki, J. M. (2018). Municipal wastewater management using vetiveria zizanioides planted in vertical flow constructed wetland. *Applied Water Science, 8*, 1–6. https://doi.org/10.1007/s13201-018-0756-0

Bain, R.E., Gundry, S.W., Wright, J.A., Yang, H., Pedley, S., & Bartram, J.K. (2012). Accounting for water quality in monitoring access to safe drinking-water as part of the Millennium Development Goals: Lessons from five countries. Bull. World Health Organ. 90, 228–235.

Calheiros,. C. S. C. Pereira, S. I. A., Brix, H., Rangel, A. O. S. S., & Castro, P. M. L. (2017). Assessment of culturable bacterial endophytic communities colonizing Canna flaccida inhabiting a wastewater treatment constructed wetland. *Ecological Engineering*, 98, 418–426.

Ciss´e, G. (2019). Food-borne and water-borne diseases under climate change in low-and middle-income countries: further efforts needed for reducing environmental health exposure risks. *Acta Tropica*, 194, 181–188.

Compaore, W. F., Dumoulin, A., & Rousseau, D. P. L. (2020). Metal uptake by spontaneously grown *Typha domingensis* and introduced Chrysopogon zizanioides in a constructed wetland treating gold mine tailing storage facility seepage. *Ecological Engineering*, 158, 106037. https://doi.org/10.1016/j.ecoleng.2020.106037

De Anda, J., L´opez-L´opez, A., Villegas-Garc´ıa, E., & Valdivia-Aviña, K. (2018). High-strength domestic wastewater treatment and reuse with onsite passive methods. *Water*, 10 (2), 99.

DPR (Department of Petroleum Resources). (2018). Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN). 3rd Edition, Department of Petroleum Resources, Lagos.

Dube, T., Mhangwa, G., Makaka, C., Parirenyatwa, B., & Muteveri. T. (2019). Spatial variation of heavy metals and uptake potential by *Typha domingensis* in a tropical reservoir in the midlands region, Zimbabwe. *Environmental Science and Pollution Research*, 26, 10097–10105. https://doi.org/10.1007/s11356-019-04471-0

Fuglie, K., Peters, M., & Burkart, S. (2021). The extent and economic significance of cultivated forage crops in developing countries. *Frontiers in Sustainable Food Systems*, 5, 401. https://doi.org/10.3389/fsufs.2021.712136

Futughe, A. E., Purchase, D., & Jones, H. (2020). Phytoremediation using native plants. In phytoremediation: In-Situ Applications, edited by B. R. Shmaefsky, Springer. 285–327. https://doi.org/10.1007/978-3-030-00099-8_9

Hadad, H. R., Mufarrege, L. M., Di Luca, G. A., & Maine, M. A. (2018). Long-term study of Cr, Ni, Zn, and P distribution in *Typha domingensis* growing in a constructed wetland. *Environmental Science and Pollution Research*, 25, 18130–18137. https://doi.org/10.1007/s11356-018-2039-6

Hidosa, D., Belachew, B., & Kibiret, S. (2020). Evaluation of Desho (*Pennisetum pedicellatum*) grass varieties for dry matter yield and chemical composition in South Omo Zone, South Western Ethiopia. *Agricultural Research & Technology*, 25(2), 001–008. https://doi.org/10.19080/ARTOAJ.2020.25.556294

Igwe, O., Ngwoke, M., Ukah, B.U., & Ubido, O.E. (2021). Assessment of the physicochemical characteristics of groundwater and soils around oil-producing communities in Afam Area of Port Harcourt, Niger Delta Nigeria. *Applied Water Science*, 11(74), 93 – 96. https://doi.org/10.1007/s13201-021-01393-6

Keba, W. (2023). Determination of optimum level of seeding rate of silver leaf Desmodim intercropping with desho grass for dry matter yield and yield-related components in western Ethiopia. *Advances in Agriculture*, 2023(1), 6647745. https://doi.org/10.1155/2023/6647745

Kennedy, O. O., Agabu, S., & Concillia, M. (2025). Stephen Syampungani Spatiotemporal Response and phytopotential of *Typha domingensis* for management of aquatic metal pollution on the Central African Copperbelt. *Ecology and Evolution*, 15, e71039. https://doi.org/10.1002/ece3.71039

Lominchar, M. A., Sierra, M. J. & Millán, R. (2015). Accumulation of mercury in *Typha domingensis* under field conditions. *Chemosphere*, 119, 994–999. https://doi.org/10.1016/j.chemosphere.2014.08 085

Mao, D., Yu, S., Rysz, M., Luo, Y., Yang, F., Li, F., Hou, J., Mu, Q., & Alvarez, P.J. (2015). Prevalence and proliferation of antibiotic resistance genes in two municipal wastewater treatment plants. *Water Research*, 85, 458–466

Mengistu, S., Nurfeta, A., Tolera, A., Bezabih, M., Adie, A., Wolde-meskel, E., Zenebe, M., & Iqbal, M. (2021). Livestock production challenges and improved forage production efforts in the Damot Gale District of Wolaita Zone, Ethiopia. *Advances in Agriculture,* (2), 1–10. https://doi.org/10.1155/2021/5553659

Milke, J., Gałczyńska, M., & Wróbel, J. (2020). The importance of biological and ecological properties of Phragmites australis (Cav.) Trin. Ex Steud., in phytoremendiation of aquatic ecosystems: The review. *Water*, 12(6), 1770. https://doi.org/10.3390/w12061770

Nabuyanda, M. M., Kelderman, P., van Bruggen, J., & Irvine. K. (2022). Distribution of the heavy metals Co, Cu, and Pb in sediments and Typha Spp. and Phragmites mauritianus in three Zambian wetlands. *Journal of Environmental Management*, 304, 114133. https://doi.org/10.1016/j.jenvman.2021.114133

Osuolale, O., & Okoh, A. (2015). Assessment of the physicochemical qualities and prevalence of Escherichiacoli and vibriosinthefinaleffluentsoftwowastewatertreatmentplantsinSouthAfrica: Ecological and public health implications. *International Journal of Environmental Research and Public Health*, 12, 13399–13412.

Sartori, L., Canobbio, S., Fornaroli, R., Cabrini, R., Marazzi, F., & Mezzanotte, V. (2016). COD, nutrient removal and disinfection efficiency of a combined subsurface and surface flow constructed wetland: a case study. *International Journal of Phytoremediation*, 18 (4), 416–422.

Seo, M., Lee, H., & Kim, Y. (2019). Relationship between coliform bacteria and water quality factors at weir stations in the Nakdong river, South Korea. *Water*, 11 (6), 1171.

Sesin, V., Davy, C. M., & Freeland, J. R. (2021). Review of Typha spp. (Cattails) as toxicity test species for the risk assessment of environmental contaminants on emergent macrophytes. *Environmental Pollution*, 284, 117105. https://doi.org/10.1016/j.envpol.2021.117105

Sri-Dattatreya, P., Madhavil, K., Satyanarayana, B., Amin, A., & Harini, C. (2018). Assessment of Physico-chemical Characteristics of Mangrove Region in the Krishnapatnam Coast, India *International Journal of Current Microbiology and Applied Sciences*. 7(5), 2319 – 7706. https://doi.org/10.20546/ijcmas.2018.705.268

USEPA. (1983). R.L. Booth, "Methods for the Chemical analysis of Water and Wastes, 2nd ed. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268, pp 352.

Wana, D., Husen, N., & Abate, D. (2021). Evaluation of Desho (Pennisetum pedicellatum Trin) grasses for dry matter yield and nutritive quality for the mid Rift Valley of Oromia at Adami Tulu agricultural research center. *Journal of Scientific and Innovative Research*, 10 (2), 49–52. https://doi.org/10.31254/jsir.2021.10204

WCSPF. (2023). Plants of the World Online. Typhaceae: *Typha domingensis* [WWW Document]. World Checkl. Sel. Plant Fam. Facil. By R. Bot. Gard. Kew. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:836837

World Health organization (WHO) (2017). Guidelines for drinking water quality, WHO Press, Geneva, Switzerland 4th edition.

World Health Organization (WHO) (2017). Guidelines for Drinking-Water Quality: Fourth Edition Incorporating the First Addendum, https://www.who.int/publications/i/item/9789241549950.