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Capacity of Micro and Saprophytes to Remedpate wastewater for Irrigation

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Abstract :-
Phytotechnology was appled to assess the capacity of microphytes (algae)andmacrophytes (duckweed) to reinediate wastewater from the tanjaro river in order to meet irrigation standards. The results showed dear differences between the initial and treated wastewater. Physiochemical measurements include : temperature, pH, dissolved oxygen, biological oxygen demand, total dissdeved salts, electrical conductivity, turbdity and chlorophyll a, NO3, $PO_4^{3-} SO_4^{2-} HCO_3^{-} CO2_3^{2-}$, Ca^{2+}, Mg^{2+}, $N^{a+,}$ K^{+}, Fe, Co, Cd, Ph, Cr, Eu, Zn and mn. Wastewater treated by alegae and duckweed showed decines in each variable, exceft for dissolved oxygen and chlorophyll a, Nutrient removing efficiencies of the algae and duckweed indicated the ability to remove 100% of the Fe, Cd, Ph, Cr and As in the waste water. Algae showed a higher efficiency to remove Co, Cr, Zn and Mn in amparison with duckweed ; duckweed showed adequate efficiency to remove PO_4^{3-} , Cl, HCO_3^{-}, CO_3^{2-} The calculated value of irrigation water quality idex (IWQI), 11 of the initial waste water (low suitability for irrigation) improved after treatment with algae and duckeweed to 14 and 15, respectively. Thus, irrigation water quality index (IWQI) improved 36.4 and 27.3% over initial values by duckeweed and algae, respectively. These finding indicated the potential of phyto technology to be applied in environmental remediation in an agriculturally important region in Iraq.

Keywords: **(Macrophytes (duckweed), MicrophytesLalgae) Phytochnology, Tanjaro River, Waste water)**

1. Introduction :-

Land application of wastewater (sludge and excretal is wide spread around the world with countries, using sludge as fertilizer or directly using wastewater for irrigation (14, 44). Nearly 7% of the total irrigated land in world uses polluted water or wastewater without treatment for irrigation (49) amounting to nearly 20 million he globally (47). According to world health organization (48), the benefit of using wastewater for irrigation depends on the quality of waste water.

Phytotechnology is the use of living photosynthetic organisms to mitigate environmental pollutants (16). Phytoechnology includes the use of macrophytes and inicrophytes, the byproducts of which can be used in compost fertilizer and biofull production (20, 24).

The mocrophytes (algae) represent varuous groups of organisms, which have the capability to grow under different conditions, alge can grow in both condictions of high and low temper pH, and salt concentration (42)

Renedietion of wastewater has been documented for the past 40 years (11) Algae has he capability to remove both organic and inorganic pollutation especially macronutrients and heavy metals in the wastewater. They also have the ability to destroy organic compounds in the polluted water throught bio- transformational processes (23, 43).

The growth rate of the algae depends on several conditions such as chemical inutrient concentration carbon di oxide) Physical (Light for photosynthesis processes, temperature and humidity) and biologiial (vinus infections and competition between species) (37).

In addition to microphytes, green algae and blue green algae, auatimacrophytes (e.g. duckweed) can also be used to improve the water quality and remediation of wastewater Macrophytes accumulate heavy metal and other toxic nutrients, and most of them can dirate the water providing oxic or suboxic conditions. They also have the ability to grow quickly and are easy to collect and cultivate (41). Duckweed species have been used to recover nutrients in wastewater for the past 30 years (10, 30). Furthermore, because duckweed is a source of protein and starh for animal feed, it has also been used in the application of bioethanol and compost (30).

In addition, macrophytes have potential to naturally purify water converting wastewater and sewage into pure water and edible duckwerd with little regulting sludge. Moreover, several environmental factors such as ligh intensity salinity, temperature pH, nutrient, competition with other plants and tixns in the water have been shown to influence the distribution and growth rate of duckweed, macrophytesLemnaceae species, respectively (13).

Plants (macrophytes) irrigated by waste water have been shown to accumulate heavy metals in root and shoot parts as well as bringing that waste water closer to irrigation water quality standards (18, 27). All thought these studies showed the potential of plant bioremediation of waste water before mixing with Tanjaro river water, it did not emphasize the bioremediation capacity of micro phytes (Algae) nor compare it with macrophytes (Duckweed). Thus, out study aims to use algae and duckweed in the phytoremediation of Tanjaro River water. Algae and duck weed grow naturally in the Tanjaro River especially in the summer season under high swer discharge from the sulaymaniysh city.

The current research study was conducted to test the ability of phytotechnology application specifically, micro/macrophyte, to remediate wastewater in order to meet international irrigation standards. In addition, the ultimate goals of this research were to: contribute to reversing the degradation of natural water and soil resources in Kurdistan Region Governarate (KRU); improve the sustainability of water resources; strengthn water resource, mangamentenhaceenviormental quality and expand and improve the health and well being of KRG citizens, through effective science based wastewater treatment. Our study also aims to contribute to better managing, remediating and reason of Tanjaro River wastewater as a source of irrigation.

2. Materials and method

2.1:- Study area and sampling location

The study focused on the Tanjaro River in sulaymaniyah governorate. Kurdistan, Iraq. The Tanjaro River starts between the Azmar and Baranah Mountains and runs near the NW to SE border of sulaymaniyah city towards Darbandikhanlake. The river passes through the TAnjaro Valley. Crossing many unban and agricultural regions with a catchment area of 1167.3 km2 a length of 667 km, and an average slope of 11%.

Darbandikhan lake water discharges to the diyala river one of the major tributaries of the Tigris River. The city of sullymaniyahsupplpes the Tanjaro River with approximately 265,000 m3 of wastewater daily and mixes with sources from the Dokan Dan (112,000m^3a^{-1}) and sarchnar spring (48,000 $^3a^{-1}$). The domestic water consumption per capita including water losses in 0.42^3a^{-1}. Nearly, ale of which is converted into sewage. This sewage is eventually combined with rainwater and discharged through sewer pipelines into the Tanjaro River (36). The collection of water sample from Tanjaroriver is showed.

2.2:- Experimental design

The Study was setup as a completely randomiced design repeated measures experiment with three repilicates in octoober 2018. Statistical analyses was conducted using the R 3Ω3 software (34) to compare the efficience of the micro bytes green algae (Chlorophyta) and blue green algae (Cyanobacteria) and macrophyte duckweed (LeemmnaGibba) six glass basins (50x35x50 cm) were used to grow the algoe and duckweed in triplicate during the experiment.

These basins were filled with 50L of waste water from the Tanjaro River. Light and temperature were semi controlled in the green house. Algae and duckweed were harvested 3 times 0, 5, 10 and 15 days over the coure of the experiment in order to measure and evaluate the effect of harvesting frequency on waste water remediation (29).

2.3 Waste water Laboratory measurements :-

Water laboratory measurements convisted of the following physiochemical measurements : pH, total dissolved solieds (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), temperature (0C) Turbidity (NTU) C, Ca^{2+}, $Mg^{2+,}$ Na^{+}, K^{+}, Fe, Co, Cd, Pb, Cr, Cu Zn and Mn. The laboratory measurements were conducted in the college of Agricultural engineering science in the department of natural resources and at the Kurdistan Institution for strate PC studies and scientific research following APHA (1998)

Temperature and pH were measured using portable pH meter HANNA HI 8314as described by APHA 1998. Electircal conductivity LU and total dissolved solids (TDS) were measured at the 250C using an EC meter (WIW, Multi ril at the time of sampling following APHA (1998) (3).

Turbidity was measured with a turbiditymeter (WTW, Photo Flex Turb 4301 after cilbration with turbidity standards the results were expressed in terms of nephelometrpc turbidity unit (NTU) following APHA (1998). Dissolved oxygen was measured at the time of sampling using a special oxygen sensitivemembrane electrode (WTW, Multi

197i) and the results were expresses in (mg O2L-1) following APHA (1998) (3). The biological oxygen demand was determined from dissolved oxygen decreases in a 5 day in cubation at 27^0C using and oxitop control 6 measurement system/ German standard method 2000) (19). Carbonate and bicarbonate in the water sample were determined using an acid base terimetric method following. APHA (1998) (3). Potassium and sodium were measured by PFPI flame photometer Jenaway also following APHA (1998) (3).

Water samples were run by inductively coupled plasma (ICP) spectroscopy for determination of calium (Ca2t), agmetossoi, (MG2+) and heavy metal (Fe, W, cd, Pb, Cr, Cu, Zn and Mn) using a pertsinEimer optical enimision spectrometer optima 2100 KV following APHA (1998). Anions (NO3-, PO, SO42- and Cl-) were determined by Ion chromatography (IrssooDinoe) as recommended by APHA (1998) (3)

We calculated the irrigation water quality index (IWQI) before and after the experiment following Eq. 1 and 2 (4). The percentage of IWQI improvement was calculated using Eq. 3

$$Wp=\frac{W}{N}\sum_{1-1}^{N} Ri \qquad (1)$$

Iwq Index EWi (2)

$$\% \text{ IWQI improvement} = \frac{FIWQI-1IWQI}{ITWQI} \text{ X } 100$$

Where,

W- The involvement of each one of the water measurements, w is the weight of the water measurements,

N – The Total number parameter and

R- The rating value

iIWQI – initial irrigation water quality index

FIWQI – Final Irrigation water quality Index

The water suitability for irrigation was assessed using three classes of IWQI for irrigation; IWQ values less than 19 were specified as having a low suitability for irrigation between 19 and 32 as high suitability for irrigation Also, the metal removal efficiency (MRE) Was calculated from on Eq. 4

$$MR = \frac{ic-fc}{ic} \text{ x } 100 \qquad (4)$$

Where,

Ic – initial concentration of metal in the water sample form Tanjaro River

Fc- Final concentrations of metals after algae and duckweed treated water.

Results and Discussion

Metals removal efficiency (MRE)

The Percentages of Mre of Algae and duckweed are different with respect to different metals, Algae showed of efficiencies to remove the Co, Cu, Zn and Mn in comparison with duckweed. Algae and duckweed showed similar effeciencies to remove Fe, Cd, Pb, Cr and As. Agarwas et al. (2019), El- Dheir Et al. (2007) and falabi et at. (2002) concluded that the effect of algal and duckweed on sastewater treatment Ps the remediation of metal pollution through accumulation in their biomass

3.2 :- Physicochemical measurements in the waste water during algae and duckweed treatment.

Algae showed a positive relationsheep between pH and harvesting time, duckweed show no relationship with harvesting time. Duckweed snowed a nottceablein crease in pH on day 5 of cultivation. In general, a weak relation can be seen between pH and harvesting time. The reason for this is because Co_2 come to equillibirium at night from respiration of algae and duckweed producing HCO_3 stabilizing the pH. These results were consistent with those reported by cole (2009) (12)

The rate of which metal concentration decreased were different for algae and duckweed in Fe, Co, Cd, Pb, Cr, As, Cu, Zn and Mn Results indicate that increasing algae and duckweed cultivation times strongly affect the reduction of metal concentration in the waste water from the Tanjaro River. Sekmo et al. (2012) determined algae and duckweed ability to remove waste water from metals. Kremet at. (2013) showed that metals were included in the metabdic system in both algae and duckweed and were up taken from the growth medium as a source of micronutrients (27, 40)

3. Irrigation Water Quality Index.

The comparism between the initial and final IWQI of waste water after treatment by algae and duckweed showed a significant increase in values from 11 to 14 and 15, respectively during the 15 day of experiment.

According to Asadiet at. (2020) the water quality for irrigation is classified into three categories depending on suitability, as follows; low c 19, medium 19-32 and high 232. Results showed the improvementin water quality during the expainest with the duckweed able to improve water for irrigation to a greater degree than algae. Percentages of improvement by algae were 27.3% and duckweed were 36.4% for 50 L of waste water with in 15 days. these results are sustained by those obtained by sekmo et al. (2012) and Ramirez et al. (2018) who found that algae and duckweed were able to improve the quality of waste water for irrigation (35, 40)

4. Conclusions

The present study concluded that the Tanjaro River water contains ereess nutrients for growth of both algae and duckweed. Our finding suggest that in order to remediate this excess metals and nutrient concertration there is a need to expand the time for the remediation processes to meet international standards for irrigation. The results specifically point out the capacity algae to remove No5, Co, Cu, Zn and Mn and duckeweed to remove PO^{3-}Cl, HCO_3^{-1} and CO_3^{2-} although, generally, both algae and duckweed have a similar ability to remove Fe, Cd, Pb, Cr, As and K+. Tanjaro river waste water after trated by algae and duckweed showed a 27.3% and 36.4% improvement respectively, toward irrigation water quality standards. This study provide further evidence that phytotechnology a promising avenue for wastewater remediation in this important agricultural region of Iraq.

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