CULTURING OF DUCKWEED (*Lemna minor*) WITH VARYING CHICKEN MANURE CONCENTRATION FOR PHYTOREMEDIATION

ABSTRACT

The research on the Culturing of Duckweed (*Lemna minor*) Plants under Different Chicken Manure Concentrations in the Laboratory was conducted to determine relative growth rate of duckweed and to determine the physicochemical parameters of the experimental water. The experimental design was based on an assumption that duckweed spores are contained in the bottom of flood plain stagnant pools. The sprouting of duckweed (*Lemna minor*) was monitored under media chicken manure concentrations of 5g per 10lit. for treatment one. Treatment two was 7.5g per 10lit of water. Treatment three, 10g per 10lit of water, treatment four, 12.5g per 10lit of water, andfor treatment five 15g per 10lit of water was used. 75lit plastic bowls were used for this experiment. Each bowl were inoculated with 100 pods of duckweed. Water quality in tanks treated with chicken manure and phytoremediated using duckweed shows that there was no significant difference in water quality across the treatments ($p>0.05$). However, the pH varied over the weeks of experimentation with increase in pH being observed from an initial value of 7.92 to a final value of 10.25 in week 4. There was a high percentage increase of 45% in DO for T2 while all other treatments recorded declines in DO. Each treatment was randomly assigned and carried out using 75-liter plastic containers, giving a total of 12 experimental containers. To every plastic container 100g of wet soil that was collected was introduced along with 10 liters of domestic water supply. The various chicken manure levels were weighed and randomly assigned to the experimental containers in replicate. The control treatment also carried in replicates. Under favorable climatic conditions and nutrient balance in growth media, *Lemna minor* can double its biomass within seven days. The plot of numerical abundance of duckweed stems in the culture media revealed that duckweed in T2 were more than all other treatments with number in T5 being least throughout the duration of the experiment.

Keywords: *Culture, Numerical abundance, Phytoremediation, biomass, flood plain,Physiochemical parameters*

INTRODUCTION

Background of the Study

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. As of now only earth is the planet having about 70% of water. But due to increased human population, industrialization, use of fertilizers in agriculture and man-made activity, it is highly polluted with different harmful contaminants. Natural water contains different types of impurities which are introduced into aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metalbased materials.Industrial development (either new or existing), results in the generation of industrial effluents. And if untreated, results in water, sediment, and soil pollution [1].

Duckweed species are small floating aquatic plants found worldwide and often seen growing in thick, blanket-like mats on still, nutrient-rich fresh and brackish waters [2]. They are monocotyledons belonging to the botanical family Lernaceae and are classified as higher plants or macrophytes, although they are often mistaken for algae. The family consists of four genera; Lenumn, Spirodela, Woiffia, and Wolffiella, among which about 40 species have been identified so far [3]. All species occasionally produce tiny, almost invisible flowers and seed but what triggers flowering is unknown. Many species of duckweed cope with low temperatures by forming a special starchy "survival" frond known as a turion. With cold weather, the turion forms and sinks to the bottom of the pond where it remains dormant until rising temperatures in the spring trigger resumption of normal growth [4].

Justification

The increasing importance of duckweed in animal feeds are sought out for, from the wild. However, the yield from the wild is of unpredictable quality and may not meet the requirements of animal, the surest and most reliable source of supply, therefore, it is more profitable to establish their growth condition right from spore stage till they grow to mature colonies.

This work is further justified by the need to grow the plant all the year round using cheap locally available materials without necessary waiting on the yearly emergence of wild colonies.

Objectives of the study

1. To determine the physicochemical parameters of the experimental water.
2. To determine relative growth rate of duckweed.

MATERIALS AND METHOD

Experimental Condition

The experiment involving the influence of varying chicken manure level on the growth of duckweed was carried out in the Fisheries Laboratory of the Joseph SarwuanTarka University Makurdi.

Source of Manure

The chicken manure used was obtained, sun dried and air dried, to a given level and stored in a sealed bag until when required.

Source of Duckweed

Soil collected from a flood plain area along Ankpa ward, Makurdi, which previously supports a wild duckweed culture was used as source of duckweed spore. The flood plain contains a stagnant pool which is usually filled with water duckweed every year during the rainy season and dries up completely between February to April of every year.

METHODOLOGY

The experimental design assumed that duckweed spores are present at the bottom of floodplain stagnant pools.

Duckweed sprouting was monitored under chicken manure concentrations of 5g, 7.5g, 10g, 12.5g, and 15g per 10 liters of water as treatments 1 to 5 (T1 – T5).Each bowl was inoculated with 100 pods of Duckweed.

To every plastic container, 100g of wet soil that was collected and 10liters each of domestic water supply were introduced. The various Chicken manure levels was weighed and randomly assigned to the experimental containers in replicate. The Control Treatment was also carried in replicates, which was similar to those at treatment levels but without manure. The cultures were examined at about 12-1pm daily and visible Duckweed colonies were removed and counted for all treatments. The water temperature was determined at both Control and Treatment levels using a thermometer (Jenway 9015) and pH meter (C14WPA). The various manure concentration of treatments were replenished on the seventh day and the experiment were terminated after four weeks (28 days), when no further increase in Duckweed sprouting was observed.

Data Analysis

The data collected and analyzed for ANOVA with an aid of statistical analytical programme (SPSS)and treatment means were separated with Duncan Multiple Range Test. P values at <0.05 was considered significant.

RESULTS

Water Quality

Water quality in tanks treated with chicken manure and phyto-remediated using duckweed (Table 1) shows that there was no significant difference in water quality across the treatments (p>0.05). However the pH varied over the weeks of experimentation with increase in pH being observed from an initial value of 7.92 to a final value of 10.25 in week 4.

Table 1: Water quality parameters of Chicken manure treated water with Duckweed as phytoremediation agent to improve water quality.

Treatment	**pH**	**DO (Ml/L)**	**Temp (°C)**
Control	8.62±0.74	3.96±0.22	26.60±0.31
T1	8.65±0.73	3.80±0.30	27.20±0.21
T2	9.27±0.40	4.52±0.33	27.30±0.08
T3	9.89±0.45	4.60±0.42	26.90 ± 0.29
T4	9.28±0.51	3.94±0.16	27.50 ± 0.07
T5	8.93±0.20	4.50±0.55	27.70 ± 0.35
P- value	**0.068**	**0.510**	**0.076**
Week			
Initial	7.92±0.29[a]	4.42±0.44	27.47 ± 0.25
Week 1	8.61±0.40[a]	4.33±0.24	27.02 ± 0.34
Week 2	8.63±0.45[a]	4.27±0.25	27.20 ± 0.23
Week 3	10.13±0.15[b]	3.97±0.35	27.05 ± 0.27
Week 4	10.25±0.18[b]	4.12±0.38	27.33 ± 0.17

P –vaule	**1.56×10^{-5}**	**0.895**	**0.614**

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

The change in water quality as a result of phytoremediation (Table 2) shows thatpH increased across the treatments with the highest percentage increase of 48.62% , observed in the control, and the lowest percentage increase10.06% recorded in T5. There was a high percentage increase of 45% in DO for T2, while all other treatments recorded declines in DO. Temperature change was marginal across all treatments with the highest increase of 1.48% being observed in T3, while the highest reduction of 3.15% was observed in T5.

Table 2: percentage Change in Water Quality Parameters following phytoremediation

Treatment	pH	DO	Temp
Control	48.62	16.67	-1.12
T1	41.85	-11.76	0.74
T2	14.40	45.00	-1.09
T3	29.31	-42.59	1.48
T4	35.18	-7.50	-0.72
T5	10.06	-29.51	-3.15

Duckweed Biomass

The plot of numerical abundance of duckweed stems in the culture media (figure 1),revealed that duckweed in T2 were more than all other treatments with number in T5 being least throughout the duration of the experiment.

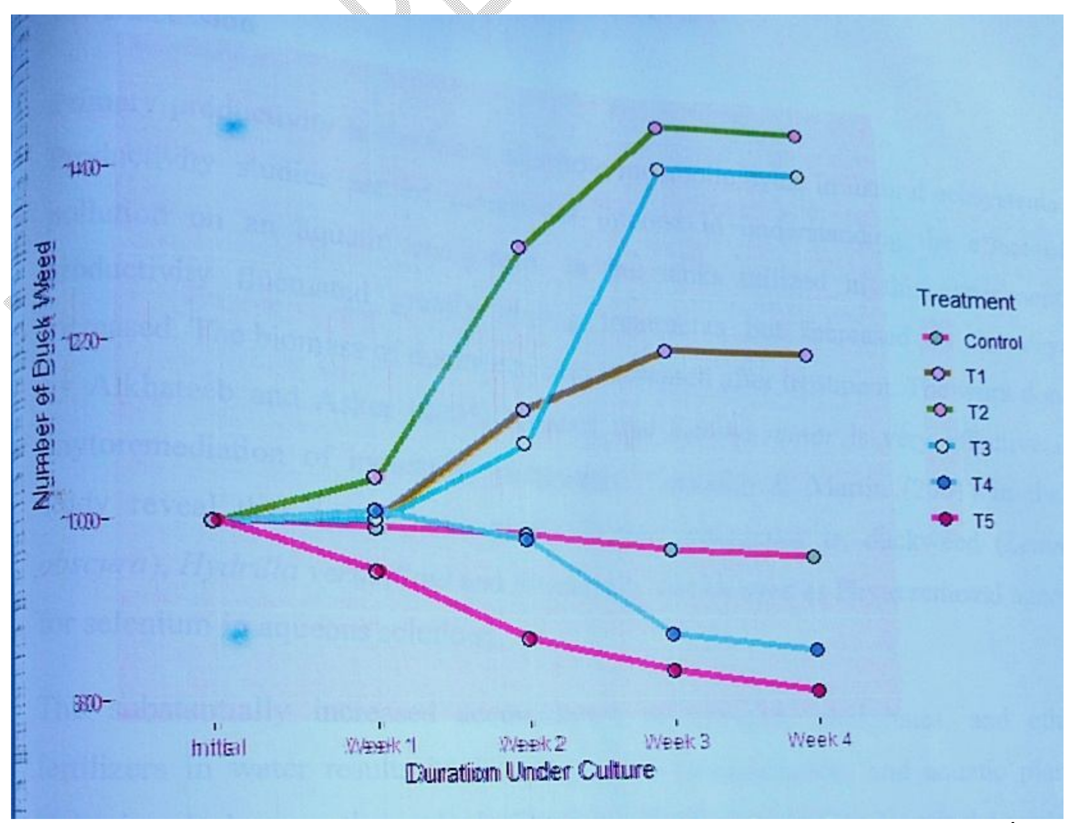

Plate 1: Number of Duckweed stems in culture tanks for each treatment

DISCUSSION

Primary productivity is the basis of whole metabolic cycle in natural ecosystems. Productivity studies are of paramount interest in understanding the effect of pollution on an aquatic ecosystem. In the tanks utilized in this experiment, productivity fluctuated greatly among treatments but increased as the days increased. The biomass of duckweed also increased after treatment. The work done by [5] showed that *Lemna minor* is very effective in phytoremediation of industrial wastewater [6], in their study reveal that four aquatic plants *Typhadomogenas*,*Lemnaobscura* (duckweed), *Hydrillaverticillata* and Swamp lily can be used as Phyto removal agents for Selenium in aqueous solutions.

The substantially increased accumulation of Nitrogen, Phosphates, and other fertilizers in water, resulting in dramatic water eutrophication, and aquatic plants blooming. It destroys the ecological balance of the water bodies, lowers the content of Dissolved Oxygen, deteriorates water quality, and even causes the death of aquatic creatures. Many studies had shown that duckweed has been employed to treat agricultural, municipal, and even industrial wastewater streams into clean non-potable water [7; 8]. The advantages of using Duckweed for the ecological restoration of eutrophic water have been highlighted: rapid growth and high biomass production, high photosynthesis efficiency, enormous nutrient uptake capacity, wide adaptation to various aquatic ecosystems, and effortless harvesting [9]. The results of the current experiment indicated that Duckweed reduced Nitrogen content in water. Duckweed can efficiently utilize Nitrogen, Phosphate, and other inorganic nutrients in water, and ameliorate the physicochemical properties and micro-environment of water [9].
Generally, Duckweed grows well at a concentration of Nitrogen ranging from 7 to 84 mg/L [10]. The optimum Nitrogen concentration for prosperous Duckweed growth is 28 mg/L [11] while Nitrogen concentration exceeding 60 mg/L exerts substantial toxicity to water body[12].

Under favorable climatic conditions and nutrient balance in growth media, *Lemna minor* can double its biomass within two days [13]. [14] reported a growth rate of L. minor close to $29gm^{-2}day^{-1}$ in high strength swine wastewater, while the total Kjeldahl Nitrogen (TKN) and Total Phosphorous (TP) absorbed by Duckweed were 90% and 88.6%, respectively.

[15] analysed the role of Duck weed (*Lemna minor)* harvesting in biological Phosphate removal from secondarily treated effluents. Orthophosphate can be efficiently removed if Duck weed is frequently harvested. The Phosphate concentration decreased from the initial value in T1, but increases were observed in the other treatments. [16] observed, during the treatment of alkaline industrial wastewater by *Azolla filiculoides* and *Lemna minor* that alkalinity and fluoride concentration decreased.

CONCLUSION

Under favourable climatic conditions and nutrient balance in growth media, *Lemna minor* can double its biomass within seven days. pH rose from an initial value of 7.92 to a final value of

10.25 in week 4. There was a high percentage increase of 45% in DO for T2 while all other treatments recorded declines in DO.

RECOMMENDATION

From the study, it is recommended that:

1. Environment related to growth and quality investigation is very important to establish the economic value of this feed for use in future formulations.Treatment 2 is recommended for use in aquaculture.

2. Duckweed increases DO content of pond water. Further research should be carried out on areas that are left out in this study.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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