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Backyard Culturing of Duckweed (*Lemna minor*) Plants under Different Chicken Manure Concentrations

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Abstract: *This study was undertaken to investigate the growth performance of Lemna minor (duckweed) when planted in various chicken manure concentrations. Sixteen (16) containers were arranged in a completely randomized design having four experimental groups. The four groups consisted of Lemna minor plant grown in various levels of chicken manure mixed with tap water at levels, 0g/l,5g/l,10g/l, and 15 g/l and were designated as treatments, T1/control, T2, T3 and T4 respectively with four replicates each. The containers used to culture Lemna minor had a capacity of 12 liters and surface area of 0.12 m^2. Each container was planted with 4 g of Lemna minor as the initial weight.The data collected was analyzed for ANOVA with an aid of statistical analytical programme (SPSS) and treatment means were separated with Duncan Multiple Range Test. The results showed that there was significant difference ($P<0.05$) in the average relative growth rate and average fresh yield.Duckweed has multipurpose use therefore, it is important to identify ways on how this plant can be grown in backyard.*

Key words*: Duckweed, Lemna minor, chicken manure, growth performance, backyard*

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I. Introduction

Livestock production especially poultry has become an integral component of the people's livelihood. Poultry particularly chickens are among the first domesticated animals to reach Papua New Guinea (PNG) perhaps 2000-3000 years ago [1] and hence chickens are commonly found in PNG especially in the coastal regions. In PNG, broiler chicken is one of the successful sub-sectors of poultry farming. According [2] every year around 6 million birds are produced by about 60, 000 householders on a small to semi-commercial scale. This sub-sector therefore has great potential to generate income, meet food and nutrition needs of the people and thus improve the living standard of the 85% of the population dwelling in rural areas[3].However, the intensification of broiler chicken production in confined areas results in the mass production of manure that could cause environmental and socioeconomic issues if not managed properly. Traditionally, poultry manure is used as inorganic fertilizer but it is advisable to identify some other alternative users. One way of utilizing broiler chicken manure is by using it as a medium for culturing aquatic plants. Besides the many aquatic plants, *Lemna minor* from *Lemnaceae*family that are commonly known as duckweeds [4]are suitable due to the plants special growth characteristics. *Leman minor*is a tiny aquatic plant that grows in still or shallow waterbodies. According to [5],duckweed is one of the fastest growing plants in the world.Researchers have mentioned that duckweed plants have the potential to be utilized in wastewater treatment and feed production [6, 7, 4].According to [5] duckweed plants thrive in wastewater rich in nutrients and dissolved organic compounds.In PNG,duckweed plants are naturally found in lakes, ponds and ditches however there is very limited knowledge on how duckweed plants can be cultured in backyard using chicken manure as a growing medium. Hence, this study was conducted to investigate the growth performance of duckweed when grown in backyard using various chicken manure concentrations.

II. Materials and Methods

2.1. Study site

This study was undertakenat the University of Natural Resources and Environment, Vudal campus, East New Britain Province. The study took 10 days and at the final day the plant biomass was harvested and parameters determined.

2.2. Manure and Lemna minor collection, and media preparation

The chicken manure was gathered at the University Poultry Unitand fresh *Lemna minor*plants were collected at the nearby pond and utilized in this study.Prior to the study, the *Lemna minor*plants were separately cultured to increase plant biomass in order to cater for the 16 containers.

Thechicken manurewas mixedwithwaterinaratio ofone-literwaterforeverymanureconcentration(0g/l,5g/l,10g/l, 15 g/l) using containers having 12 liters capacity and a surface area of 0.12 m^2. After the preparation of the media,each container was planted with 4gramsof duckweed as the initial weight.

2.3. Data collection

The relative growth was calculated as W2 – W1 / T2 – T1, where W1and W2 are the initial and final fresh weight respectively, and T1 and T2 is the experimental period[8]. The average fresh yield of *Lemna minor*plants was determined according to the technique mentioned by [9].

2.4.Experimental design and treatments

Thesixteen (16) containers were arranged in a completely randomized design having four experimental groups. The four groups consisted of *Lemna minor* plant grown in various levels of chicken manure mixed with tap water at levels, 0g/l,5g/l,10g/l, and 15 g/l and were designated as treatments, T1/control, T2, T3 and T4 respectively with four replicates each.

2.5.Statisticalanalysis

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.

III. Results

Table 1 contains the results of RGR of *Lemna minor* when grown under various chicken manure concentrations. It was observed that at the end of the experimental period (10 d), groups T2, T3, and T4 had higher RGR (7.20 g/day, 5.45 g/day and 4.95 g/day respectively) compared to the control (T1) group (0.95 g/day).

According to DMRT the average RGR value attained by T1 (0.95 g/day) was statistically significant (P<0.05) to T2 (7.20), T3 (5.45) and T4 (4.95) as shown in Table 1. Even T2 average value also posed significantly different (P<0.05) to T3 and T4. However, the difference between T2 and T3 was not significantly different (P>0.05). Figure 1 shows the graphical representation of the average RGR values attained by *Lemna minor* plants.

Table 1: Effect of Various Chicken Manure Concentrations on *Lemna minor*Performance

Variables	Different Treatments			
	T1	T2	T3	T4
Average Relative Growth Rate (g/day)	0.95^{a}	7.20^{b}	5.45^{c}	4.95^{c}
Average Fresh Yield (g)	13.50^{a}	76.00^{b}	58.50^{c}	53.50^{c}

$^{a-c}$Means with different superscript along the same row indicate significant difference (P<0.05).

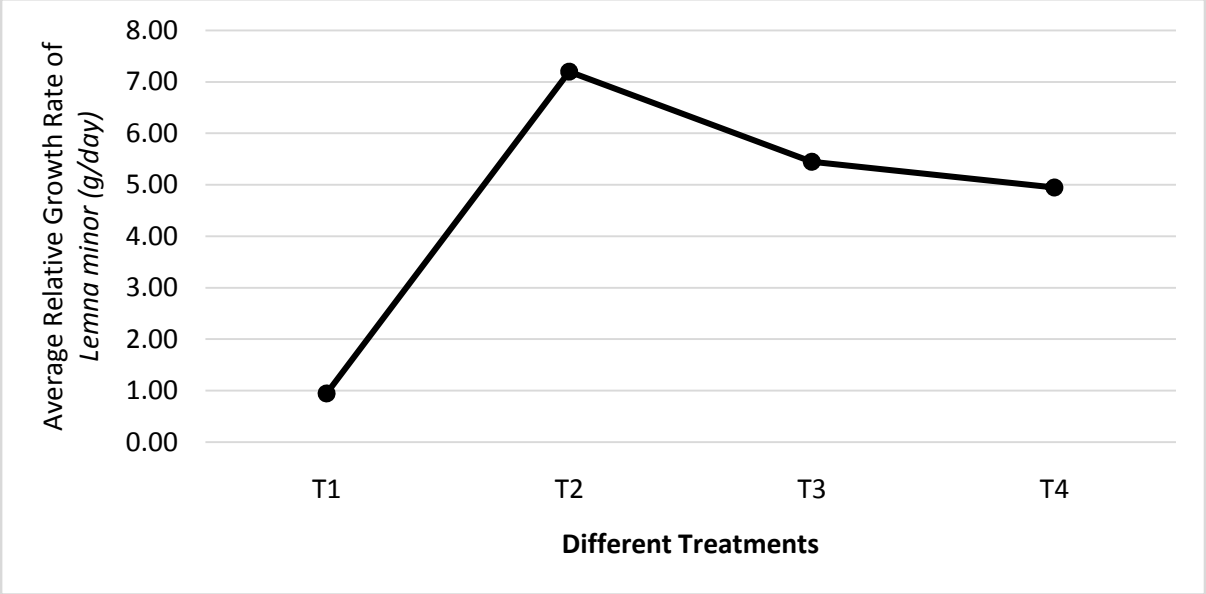

Figure 1. Effect of Various Chicken Manure Concentrations on Relative Growth Rate of *Lemna minor*

The results on the effect of different chicken manure concentrations on the average FY of *Lemna minor*are presented in Table 2. It was observed that at the end of the experimental period (10 d), by comparing the treatments,with respect to the control treatment (T1) the highest average FY, i.e., 76.00 g was attained by T2 whereas T3 and T4 also attained higher average FY values, i.e., 58.50 g and 53.50 g respectively.

According to DMRT the average FY value attained by T1 (13.50 g) was statistically significant ($P<0.05$) to T2 (76.00), T3 (58.50) and T4 (53.50) as shown in Table 1. Even the average FY value of T2 is significantly different ($P<0.05$) to T3 and T4. However, the difference between T2 and T3 was not significantly different ($P>0.05$). Figure 2 shows the graphical representation of the average FY values attained by *Lemna minor* plants at day 10.

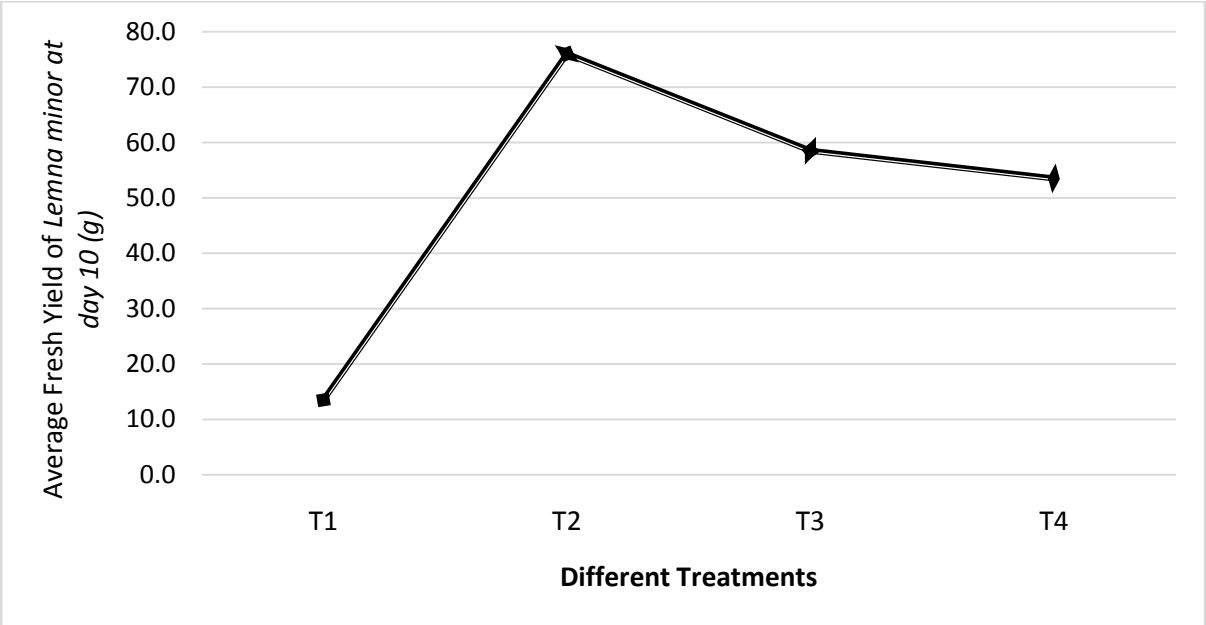

Figure 2. Effect of Various Chicken Manure Concentrations on Fresh Yield of *Lemna minor*.

IV. Discussion

According to the graphs of RGR and FY in Figures1and 2 respectively,the treatments had similar effect on these two variables. At T1 (0 g/l) level when there was nochicken manure added,the average RGR was at the lowest (0.95 g/day) and this resulted in the lowest average FY of 13.5 g at day 10. However, as the

concentration level increased to 5 g/l(T2) a phenomenal increase on average RGR (7.20 g/day) was observed and this is the growing rate where *Lemna minor*fresh yield was at the highest with 76.00 g on average.However,further increase in concentration level to 10 g/l (T3) and 15 g/l (T4) caused reduction in the average RGR to 5.45 g/day and 4.95 g/day respectively and the subsequent downward trend in the average FY with 58.5 g and 53.50 g respectively.

According to [10], the GR of duckweed plants depends on the nutrient capacity of the aqua ecosystem the plants are growing in, when there is high nutrient density available the GR increases but in low nutrient densities, reduced GR is imminent. Therefore, in the present study the increased average RGR of *Lemna minor*noticed from 0.95 g/day(T1) to 7.20 g/day (T2) and the subsequent increase in the average FY from 13.5 g (T1) to 76 g (T2) in day 10 is due to nutrient availability of the different mediums.Since T1 (0 g/l) concentration level had no chicken manure, it resulted in a low average RGR and FY but T2 (5 g/l) concentration level provided an optimum nutrientthat promoted rapid average RGR and highest average FY of *Lemna minor*at day 10. Furthermore, [7] mentioned that the growth of duckweed plants are nearly exponential if environment and nutrients are at optimum level. Hence, 5 g/l concentration level provided a conducive environment for the plants to experience rapid growth and attain the highest fresh yield.

Although the concentration increased to 10 g/l and 15 g/l, however the increase in nutrient density did not elevate the average RGR and FY of *Lemna minor* plants. Since *Lemna minor* were planted in a container with 30 cm^2surface area the rapid growth of plants caused space and nutrient to become limiting factors.Hence, the average RGR dropped at concentration levels 10 g/l and 15 g/l from 5.45 g/day to 4.95 g/day respectively with an average FY of 58.50 g and 53.5 g respectively.According to [11], space and nutrients are among the several important stress factors that impair the optimum growth of duckweed plants.These results are similar to [9] where the increase in manure concentration from 5 g/l to 10 g/lresulted in the lowered average RGR and FY of *Lemna minor*plants.

V. Conclusion

Based on the results of the present study the following conclusions are made:

1). Pure water does not have enough nutrients to promote rapid *Lemna minor*growth.

2). The 5 g/l concentration level promoted rapid growth rate and high yield of *Lemna minor*when cultured in containershaving 12 liters capacity and a surface area of 0.12 m^2.

3). Space and nutrient are important limiting factors to consider when culturing *Lemna minor*

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