Effects of doses of chicken manure on the structure and dynamic of zooplankton in ponds

Nana Towa Algrient, Efole Ewoukem Thomas, Zebaze Togouet Serge Hubert and Tchoumbou

Abstract

In order to contribute to the improvement the production of fry through larval feeding, a study on the effect of doses of chicken manure on the structure and dynamic of zooplankton was realized in 9 ponds (5.7 x 5.7 x 1 m) at a flow rate of 0.05 l/s. It was carried out from May to November 2016 at the Farm of Dschang, Western region - Cameroon. At each of the randomly selected ponds, one of the doses of 0; 800 and 1000 kg/ha was administered weekly. Different water quality characteristic and zooplankton were measured at 15 days interval. At the end of the study, the results showed that, nitrites (5.64 ± 0.19 mg/l), nitrates (6.23 ± 0.13 mg/l), phosphates (3.34 ± 0.07 mg/l), as well as the density (51858 individuals/liter) and biomass (49.3 mg PS) of zooplankton were significantly higher (p<0.05) in the treatment 1000 kg/ha. The biomasses of 32.3; 13.9 and 3.2 mg/l dry weight respectively of copepods, cladocerans and rotifers were obtained in the treatment 1000 kg/ha. In practice the treatment 1000 kg/ha could be used for a better weekly fertilization.

Keywords: Zooplankton, density, biomass, dynamic, chicken manure, pond

1. Introduction

Recent trends show a decline in the landing of catch fisheries, indicating that fish stocks are gradually declining. In fact, between 2004 and 2009 the catch fishery increased from 92.4 to 90.0 million tons [13], because of various constraints, including over-exploitation of fisheries linked to the population explosion, the pollution of aquatic environments and the climate change. On the other hand, aquaculture production has increased gradually from 41.9 to 55.1 million tons in the same period due to the different technics of production realized by different country. Faced with this situation, aquaculture is therefore a reliable alternative for increasing fish production to meet the needs of the human population. But in Cameroon, it represents less than 0.1% of total fish intakes despite water surfaces covering nearly 3.5 million hectares, distributed in 4 major river basins [32]. The lower contribution of fish farming in the coverage of national needs is imputable to various constraints including the unavailability of fry for stocking ponds. The major problem is mainly related to larval feeding [4]. In fact, the food must be accessible and available in sufficient quantity and quality for the passage from the larval stage to the fry [5]. In hatcheries, saltwater zooplankton, particularly Artemia is the most commonly used for feeding larvae. However, its availability in local markets remains difficult. Because, its production technique is very sophisticated and the cost is high [5]. It is therefore essential to produce low cost freshwater zooplankton as an alternative. Zooplankton is any microorganism of animal origin suspended in the water column that feeds mainly on phytoplankton, itself dependent on minerals and available organic or chemical matter. The production of zooplankton from organic fertilizers, including animal waste (poultry droppings, cow dung and pig droppings) is no longer demonstrated. Several authors have reported that droppings improve the physicochemical and planktonic characteristics of water [30]. In this regard, some studies have been conducted in the West African region [1, 3, 5, 7, 8], especially in the laboratory and in the tank. However, in Cameroon, some studies have been carried out on the fertilization of ponds from animal manure at various doses, 700; 840 and 1200 kg / ha / week [13]. Few studies have been carried out on the evaluation of the optimal weekly dose in pond for the efficient production of zooplankton without the risk of eutrophication or sub-production. This underlines the importance of the present study, whose the general objective is
to contribute to the improvement of the production of zooplankton for larval feeding through fertilization. More specifically, it involves assessing the effect of the doses of chicken manure on physicochemical characteristic of water, density and zooplankton biomass.

2. Material and methods

2.1 Zone and period of the study

The study was carried out from May to November 2016 at the University of Dschang Application and Research Farm (FAR) (LN: 5° 44’-5° 36’ and LE: 10° 06’-9° 85’; altitude: 1392 - 1396 m) in the Sudano-Guinean zone characterized by annual precipitations varying between 1500 and 2000 mm. Temperatures range from 14 °C (July-August) to 25 °C (February). The area is characterized by a short dry season (mid-November to mid-March) and a long rainy season (mid-March to mid-November).

2.2 Conduct of the study and data collection

Chicken manure was collected within the same farm and kept at room temperature. A sample was previously collected and analyzed. The dry matter composition was 80.2%; total nitrogen 2%; and total phosphorus 1.5%. Zooplankton production was conducted in 9 ponds (5.7 x 5.7 x 1m), with a residual flow rate of 0.05 l / s, fed from a Petri dish 90 mm in diameter for the identification and counting of rotifers, cladocerans and copepods group of zooplankton. Species identification of these different group of zooplankton was carried out through the use of key determinations and works.[9, 12, 16, 19, 28, 29, 32] The count was done by duplicating counting. At least 100 individuals were counted each time per sample using the Motic Binocular Magnifier. The density of individuals was calculated by the following formula [10]

\[ D = n / V1 \times V2 / V3 \]

Where: D is the density (individuals/liter), n: number of individuals counted; v1: volume of sub sample taken; v2: volume of the concentrated sample; v3: total volume of filtered water

Zooplankton biomass was calculated by multiplying the density of each zooplankton group by their mean dry weight (PS). Dry weights of rotifers, copepodites and adults of copepods; larval of copepods and cladocerans are 0.18; 1.36; 0.08 and 1.32 μg [17, 22].

2.3 Statistical analysis

The collected data were subjected to one-way analysis of variance (ANOVA 1). In case of significant differences between means, the Duncan test was applied to separate them at the 5% significance level. The SPSS 20.0 software (Statistical Package for Social Sciences) was used for these analysis.

3. Results

3.1 Physicochemical characteristics of water

The physicochemical characteristics of the water according to the doses of chicken manure are summarized in Table 1. It brings out that the transparency, dissolved oxygen, nitrates, nitrites and phosphates have significantly (p<0.05) varied with the treatments. For transparency and dissolved oxygen, the highest values were recorded in the control treatment (unfertilized pond). Nitrite and nitrate were significantly (p<0.05) higher in a fertilized pond. However, no significant differences (p>0.05) were observed between the doses of the fertilized ponds. As for the conductivity and the temperature no significant difference (p>0.05) was observed between the treatments. However, the conductivity values increased with the treatment dose.

<table>
<thead>
<tr>
<th>Table 1: Physicochemical characteristics of water according to doses of chicken manure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physicochemical characteristics of water</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Transparency (cm)</td>
</tr>
<tr>
<td>Temperature (°C)</td>
</tr>
<tr>
<td>O₂ (mg/l)</td>
</tr>
<tr>
<td>pH (UI)</td>
</tr>
<tr>
<td>NO₂- (mg/l)</td>
</tr>
<tr>
<td>NO₃- (mg/l)</td>
</tr>
<tr>
<td>PO₄³⁻ (mg/l)</td>
</tr>
<tr>
<td>Conductivity (μs/cm)</td>
</tr>
</tbody>
</table>

a, b, c, d; assigned values of the same letter on the same line do not differ significantly (p>0.05)
3.2 Density of zooplankton

The density of the zooplankton groups according to the doses of chicken manure illustrated in Fig 1 shows that the highest density was obtained in the treatment 1000 kg / ha. However, it was significantly (p<0.05) higher in copepods (nauplius + juvenile copepods + adult copepods), followed by rotifers irrespective of dose. The lowest value was recorded in the control treatment.

![Graph showing zooplankton density](image1)

**Fig 1:** Density of zooplankton groups as a function of the dose of dung

The bimonthly zooplankton cluster density shown in Fig 2 shows that, independently of the doses, the increased density of rotifers and cladocerans was accompanied by the decrease in copepods between 14 and 23 weeks. Furthermore, a concomitant increase was observed between the 4 to 8 week period of the test with higher value obtained at the 6th week in the 1000 kg / ha treatment. At the end of the test, the rotifers tendency was opposed to that of copepods and cladocerans with higher values in the 800 kg / ha treatment.

![Graph showing zooplankton density](image2)

**Fig 2:** Bimonthly change in density of zooplankton groups

3.3 Biomass of zooplankton

The biomass of the zooplankton groups according to the doses of chicken manure is illustrated in Fig 3. It appears that, independently of the groups, the biomass was significantly (p<0.05) higher in the treatment 1000 kg / ha. Thus, the biomass of the copepods (nauplius + juvenile copepods + adult copepods) was significantly higher, followed by that of the cladocerans regardless of the dose.

![Graph showing zooplankton biomass](image3)

**Fig 3:** Evolution of biomass of zooplankton groups

3.4 Correlations between physicochemical characteristics of water and density of zooplankton groups

The correlations between physicochemical characteristics of water and the density of zooplanktonic groups are summarized in Table 2. It appears that no significant correlation (p>0.05) was observed. Except temperature, all physicochemical characteristics of water were weakly and negatively correlated with rotifers and cladocerans density in the control treatment. Total phosphates and transparency were weakly and positively correlated with copepod density. Negative correlations were observed between the physicochemical characteristics of water and density of rotifers and copepods in the 800 kg / ha treatment. The reverse has been observed in the treatment 1000 kg / ha. Density of cladocerans was weakly and negatively correlated with transparency, conductivity and temperature respectively in 800 and 1000 kg / ha treatments.
Table 2: Correlations between Physicochemical Characteristics of Water and Zooplankton Density

<table>
<thead>
<tr>
<th>Density of zooplankton</th>
<th>Doses of the fertilizer</th>
<th>Conductivity</th>
<th>Temperature</th>
<th>pH</th>
<th>O2</th>
<th>NOx</th>
<th>NO2</th>
<th>PO4</th>
<th>Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotifers</td>
<td>Control</td>
<td>-0.233</td>
<td>+0.234</td>
<td>-0.236</td>
<td>-0.123</td>
<td>-0.182</td>
<td>-0.222</td>
<td>-0.171</td>
<td>-0.242</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>-0.314</td>
<td>-0.322</td>
<td>-0.265</td>
<td>+0.383</td>
<td>-0.387</td>
<td>-0.386</td>
<td>-0.383</td>
<td>+0.227</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>+0.179</td>
<td>+0.178</td>
<td>+0.165</td>
<td>-0.113</td>
<td>+0.143</td>
<td>+0.135</td>
<td>+0.092</td>
<td>+0.146</td>
</tr>
<tr>
<td>Cladocerans</td>
<td>Control</td>
<td>-0.209</td>
<td>+0.213</td>
<td>-0.218</td>
<td>-0.019</td>
<td>-0.113</td>
<td>-0.186</td>
<td>-0.318</td>
<td>-0.352</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>-0.160</td>
<td>-0.169</td>
<td>-0.112</td>
<td>+0.279</td>
<td>-0.274</td>
<td>-0.267</td>
<td>-0.249</td>
<td>+0.079</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>+0.166</td>
<td>+0.098</td>
<td>+0.001</td>
<td>-0.337</td>
<td>-0.082</td>
<td>-0.105</td>
<td>+0.346</td>
<td>-0.071</td>
</tr>
<tr>
<td>Copepods</td>
<td>Control</td>
<td>-0.211</td>
<td>+0.208</td>
<td>-0.205</td>
<td>-0.284</td>
<td>-0.261</td>
<td>-0.226</td>
<td>+0.152</td>
<td>+0.033</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>-0.092</td>
<td>-0.103</td>
<td>-0.035</td>
<td>+0.270</td>
<td>-0.258</td>
<td>-0.244</td>
<td>-0.214</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>+0.217</td>
<td>+0.244</td>
<td>+0.263</td>
<td>-0.039</td>
<td>+0.263</td>
<td>+0.260</td>
<td>+0.002</td>
<td>+0.264</td>
</tr>
</tbody>
</table>

Copepods: (nauplii + juvenile copepods + adult copepods)

4. Discussion

Results on the physicochemical characteristics of water showed that dissolved oxygen, transparency, nitrates, nitrites, and phosphates were significantly affected by dung doses. Thus, the concentrations of nitrate ions and phosphates were higher in a fertilized pond. Our values were lower than 11.06 mg / l of nitrates and 12.56 mg / l of phosphate obtained on the production of zooplankton based on pig dungs in plastic buckets [3]. This would be related to the composition of the mineral elements of the droppings and also the high temperature of the water (31.28 °C against 20.50 °C in our ponds) which contributed to the better decomposition of the organic matter. In addition, the concentrations of nitrate and phosphates were higher than those recorded [20] in nursery tanks fertilized with chicken manure and cow dung. Such a difference would be due to the lack of fry in our ponds that feed on the organic matter in suspension responsible for the increase of the mineral elements after decomposition.

The waters of the fertilized ponds with the greatest amount of manure were remarkable for their low transparency. This trend is largely due to the distribution of seston elements in the water column, including plankton swarming.

Dissolved oxygen was significantly lower with the largest amount of the fertilizer. The tendency is dissimilar to the observation of Agadjihoué et al [5] and Akodogbo et al [3]. This is certainly due to the activity of bacteria that are more numerous in environments receiving organic matter. In fact, deoxygenation is the consequence of the oxidation of organic matter, carried out biologically or chemically [24]. The average temperature and pH in the fertilized ponds were in the favorable range of plankton development, respectively 20-30 °C; 6.5 - 7.5 [11, 14]. The results of the study revealed that the average temperature of water was around 20.5 °C with a minimum value of 19 °C and a maximum of 22 °C during the study.

The low temperature range observed is a feature of most tropical waters [25]. Thus, none significant difference observed among the treatment is similar to that obtained by several authors [1-3, 7].

The density and biomass of rotifers, cladocerans, and copepods was increased significantly with the dose. The same trend was observed by Akodogbo et al [3], but the biomass in dry weight of zooplankton (1.2 and 4.2 mg/L) obtained by Mitra et al. [20] in the fertilized pond in India is lower than those obtained in this study. This would be due to the richness of the medium in biogenic elements such as nitrates, nitrites, and phosphates as revealed by the positive correlations. Indeed, these biogenic elements are essential for the good development of phytoplankton, the main food source of zooplankton. Such a relationship has already been demonstrated and confirmed through several studies [21, 24, 31] who found a positive correlation between nutrient enrichment and phytoplankton biomass on the one hand, between phytoplankton biomass and zooplankton biomass somewhere else. The density copepod significantly (p<0.05) high observed is due to their opportunistic and predatory nature on rotifers and cladocerans. Indeed, the decrease of these last from the 10th week was accompanied by the progressive increase of the copepods. This observation corroborates that made by Agadjihoué et al [5] about the dynamics of zooplankton in the tanks. With regard to zooplankton group biomass, that of cladocerans in contrast to density was higher than those of rotifers. This result is similar to the observation of Agadjihoué et al [5] and would be due to the higher individual weight of cladocerans. Indeed, the dry weights of rotifers, copepods, and adults of copepods; nauplii of copepods and cladocerans are 0.18; 1.36; 0.08 and 1.32 μg [17, 22].

5. Conclusion

The present study has shown that the physicochemical characteristics of water have been significantly affected by the doses of chicken manure. In fact, the concentration of nitrates and phosphates were higher in the treatment 1000 kg / ha, against the opposite was observed with dissolved oxygen and transparency.

The dose of chicken manure was significantly influenced density and biomass of zooplankton, thus they were significantly (p<0.05) higher in the treatment 1000 kg / ha. The biomass of copepods, followed by cladocerans were significantly higher independently of the doses. In practice, 1000 kg / ha of chicken manure can be used for weekly fertilization.

6. Acknowledgement

We are grateful to Mr. Nvondo Narcisse, member of the Laboratory of Hydrobiology and Environment of the University of Yaoundé I for his role in the identification of species.

7. References


32. Zébazé TSH. Biodiversité et dynamique des populations du zooplancton (Ciliés, Rotifères, Cladocères et Copépodes) au lac municipal de Yaoundé (Cameroun). Thèse de 3ème cycle, Université de Yaoundé I (Cameroun). 2000, 175.