Bacterial Contaminants and Greenhouse Gas Emissions Associated with Nile Tilapia ponds Fertilized with Manure in Western Kenya

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Introduction

- In Kenya, fish farmers use of manure to enhance primary productivity in fish ponds (Mbugua, 2008)
- In Western Kenya, 60% of the fish farmers fertilize ponds using animal manure; however, presence of pathogens in farmed fish intended for human consumption has not been documented
- The extent to which pond manuring can contribute to greenhouse gas emission is not well articulated in fresh water culture systems, despite Kenya being a signatory to Kyoto Protocol
- The study aims to generate information on the baseline of GHG emissions in fish ponds, and the status of pathogens in the ponds
- This information will enable policy makers to come up with standard procedures for treatment of animal manure as organic fertilizer for fish ponds; hence improve productivity and reducing GHG emissions

Study Objectives

Overall objective

- To assess the bacterial contaminants and greenhouse gas emissions associated with Nile tilapia ponds fertilized with chicken manure in Kakamega, Western Kenya

Specific objectives

1. To evaluate the pathogenic bacterial in Nile tilapia fish ponds fertilized using organic and inorganic fertilizer.
2. To determine the growth of farmed Nile tilapia grown in fish ponds fertilized using organic and inorganic fertilizer.
3. To determine the levels of CH_4, CO_2 and N_2O in water for Nile tilapia ponds fertilized with organic and inorganic fertilizer

Materials and Methods

- Three fish farms each with 3, 300 m^2 Nile tilapia ponds were sampled for weight, bacterial counts and greenhouse gas concentrations in Kakamega County.

- In each of the farms, the three ponds consisted of unfertilized pond (UF), inorganic manure fertilized pond (IF), and Organic manure fertilized (OF).

- Static chambers were used to capture diffusive fluxes of CO_2, CH_4 and nitrous oxide at intervals of 0 minutes, 10 minutes, 20 minutes and 30 minutes using syringes and fed in 60 ml vials for chromatography

- Headspace gas concentration changes over time was plotted to produce a slope, and the slope was used to calculate flux (Butterbach-Bahl *et al*., 2011).

$$f = \frac{chamber\ vol(m^3) molweight(g/mol) slope(\frac{ppmv}{\min})}{chamber\ area(m^2) mole\ volume\ of\ gas(m3/mol)} 60$$

Materials and Methods contd.

- 30 fish per pond were collected using a sein net
- The fish was measured for length (using measuring board) and weight using Acculab VI-1200 (USA) scale
- Carbon and Nitrogen were analyzed using Eurovector EA 3000. Water quality parameters were measured insitu using Hydrolab MSIP-REM-HAH-QUANTA (USA)

Data analysis

- All data was analyzed using SPSS version 26 at $p = 0.05$
- One way ANOVA was used to compare the various treatment means, whereas Turkeys test was used to separate significant differences
- Pearson correlation was used to test for relationships between Greenhouse Gas (GHG) emission

Results and Discussions

Objective 1:

- The total plate counts had significant difference within the treatments (p=0.00), with the OF being most significant, while the total coliforms and *E.coli* were not significantly different (p= 0.232 and 0.244 respectively).

- Our results are in line with Rogers and Haines, 2005, that manure offer good environment for bacterial growth and survival. Highest *E.Coli* in OF agrees with Dritan and Bejo (2013), that the increase in *E.Coli*, was associated with input of manure.

Results and Discussions

	UF	IF	OF
LABED FARM	5.46	9.62	8.05
ILALA FARM	6.58	10.63	8.35
WALKER FARM	13.89	18.5	17.91

- There was significant difference on weight on the three different treatments in all the farms (p=0.025), with the inorganic fertilized ponds being most significant
- The mean weights in the fertilized ponds (OF and IF) were significantly higher than the unfertilized ponds
- Previous studies show higher weights to availability of primary productivity of planktons compared to unfertilized ponds

Results and Discussions

- The mean fluxes of CH_4 was highest in OF ponds (9.456 mg C /m^2/d) and the lowest flux of 3.96 mg C /m^2/d in UF pond
- Fluxes of CO_2 was highest in inorganic OF ponds (157.68 mg CO_2 /m^2/d) and the lowest flux of 104.64 mg CO_2 /m^2/d in UF pond
- Fluxes of N_2O was highest in OF ponds (12.34 µg N /m^2/hr) and the lowest flux of 2.188 µg N /m^2/d in UF pond. However, there was no significant differences in fluxes among the different treatments
- The high organic load in OF ponds paved way to heterotrophic respiration, where more CO_2 is made available. Our highest mean daily fluxes were lower than those recorded in tropical and sub tropical ponds of 115-453 mg CH4 /m2/d (Grinham et al.,2018) and1100 mg CO2 /m2/d in Australia(ollivier et al.,2018)

- The difference could be attributed to underestimations of fluxes from ebulitive pathways (Peacock et al 2019)

Conclusion and Recommendations

Conclusions

1. Pond manuring increases chances of pathogenic bacterial load in pond water and so in fish
2. Pond fertilization improves growth of Nile tilapia in fish ponds
3. Pond fertilization does not influence GHG fluxes in Nile tilapia ponds

Recommendations

1. A standard procedure be put in place for fish farmers to treat their manure before using it in ponds
2. Further data needs to be collected in different seasons to enable conclusion be made on average fluxes at different times of the year and different treatments

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