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Research Application Summary

Effect of formulated and supplementary feeds on water quality parameters in concrete ponds stocked with *Oreochromis shiranus* fresh water fish

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Abstract

A study on the effect of formulated and supplementary feeds on water quality parameters of fresh water fish (*Oreochromis shiranus*) culture was conducted at Lilongwe University of Agriculture and Natural Resources Fish Farm for three months. The experiment had four treatments (commercial feed A (31% CP) + chicken manure (T1), maize bran (9.82% CP) + chicken manure (T2), only chicken manure (20% CP) (T3) and commercial feed B (22.64% CP) + chicken manure (T4)) replicated three times. Water quality parameters such as dissolved oxygen, temperature, conductivity and pH were measured twice a day on a eight hour time step using multi-probe water checker. Phosphorus was determined once every three weeks in the laboratory using ascorbic acid method. Total ammonia nitrogen was also determined to calculate unionized ammonia. Statistical analysis was performed using SPSS version 20. The pH ranged from 7.1 – 9.0 in the morning (6.00 am) and 8.2 - 9.4 in the afternoon (2.00 pm). Temperature, dissolved oxygen, conductivity, unionized ammonia and phosphorus ranged from 25.13±0.29 ^{0}C to 25.24±0.33 ^{0}C, 6.59±0.29 mg/L to 6.31±0.34 mg/L, 310 ±0.01µSe/cm to 320 ±0.01µSe/cm , 0.01 ±0.01mg/L to 0.02±0.01 mg/L and 0.38±0.12 mg/L to 0.57±0.08mg/L, respectively among the treatments. The results indicated that all water quality parameters were within recommended range for *O. shiranus.* The study found that the formulated and supplementary feeds did not affect dissolved oxygen, temperature, conductivity, unionized ammonia, and pH. However, phosphorus levels were a little bit higher, due to aging of ponds and additional phosphorus released from the chicken manure. The study suggested that using formulated and supplementary feeds in the pond within recommended range during culture of *O. shiranus* is ideal for having water quality parameters within acceptable range.

Key words: Chicken manure, dissolved oxygen, fish production, pH, phosphorus

Résumé

Une étude a été menée sur l'effet des aliments formulés et suppléments sur les paramètres de qualité des étangs des poissons d'eau douce (Oreochromis shiranus) à la ferme piscicole de l'Université Lilongwe d'Agriculture et des Ressources Naturelles, pendant trois mois. L'expérience comportait quatre traitements (aliment commercial A (31% PC) + fumier de volailles (T1), son de maïs (9,82% PC) + fumier de volaille (T2), fumier de volailles uniquement (20% PC) (T3) et aliment commercial B (22,64% PC) + fumier de volaille (T4)) répété trois fois. Les paramètres de qualité de l'eau tels que l'oxygène dissous, la

température, la conductivité et le pH ont été mesurés deux fois par jour sur une période de huit heures. Le phosphore a été déterminé toutes les trois semaines au laboratoire en utilisant la méthode à l'acide ascorbique. L'azote ammoniacal total a également été déterminé pour le calcul de l'ammoniac sous forme ionisée. L'analyse statistique a été réalisée à l'aide de SPSS 20. Le pH variait de 7,1 à 9,0 le matin (6 heures) et de 8,2 à 9,4 heures dans l'après-midi (14 heures). La température, l'oxygène dissous, la conductivité, l'ammoniac et le phosphore ont varié de 25,13 ± 0,29 C à 25,24 ± 0,33 C, 6,59 ± 0,29 mg / L à 6,31 ± 0,34 mg / L, 310 ± 0,01 µSe / cm à 320 ± 0,01 µSe / cm, 0,01 ± 0,01 mg / L à 0,02 ± 0,01 mg / L et 0,38 ± 0,12 mg / L à 0,57 ± 0,08 mg / L, respectivement. Les résultats ont indiqué que tous les paramètres de qualité de l'eau se situaient dans la fourchette recommandée pour O. shiranus. L'étude a révélé que les aliments formulés et supplémentaires n'affectaient pas l'oxygène dissous, la température, la conductivité, l'ammoniaque et le pH. Cependant, les concentrations de phosphore étaient un peu plus élevées, en raison du vieillissement des étangs et du phosphore supplémentaire rejeté par le fumier de poulet. L'étude suggère l'utilisation d'aliments formulés et supplémentaires dans l'étang dans les limites recommandées pendant la culture de O. Shiranus pour des paramètres de qualité de l'eau dans des limites acceptables.

Mots clés: Fumier de voilaille, oxygène dissous, production de poisson, pH, phosphore

Background

Fish is the cheapest source of protein in the tropical regions of Africa especially in sub-Saharan Africa where it provides nutrition to millions of poor households. Tilapia is an important food fish in many tropical areas of Africa (Corpei, 2001). They are considered suitable for culture, due to their high tolerance to adverse environmental conditions, their relatively fast growth and resistance to disease. *Oreochromis shiranus* is a widely cultured species by over 90% of farmers in Malawi owing to its ease in reproduction and survival in poor water quality conditions relative to other tilapias (Maluwa, 2005).

According to Bhatnagar and Devi. (2013), optimum fish production is dependent on the physical, chemical and biological qualities of water. Hence, successful pond management requires an understanding of water quality. Water quality parameters such as temperature, dissolved oxygen, pH, unionized ammonia, phosphorus and conductivity are the most important factors for fish health and growth in the culture system. When the temperature is too low or too high the feeding behavior of the fish will be disturbed and perhaps growth will be affected. If the water temperature shifts too high from the optimum the organs of the fish are affected. The oxygen that is dissolved in water either through diffusion from air or aeration as well as through photosynthesis is called dissolved oxygen (DO). Oxygen level can be reduced by many factors such as water temperature, amount of fertilizer and feed applied and pollutants (Bhatnagar and Devi, 2013).

Fish use more oxygen when their metabolism rate increases. Tilapias have the capacity to survive in very low levels of dissolved oxygen. Although they can survive in such conditions, DO above 1mg/L is recommended for good health and growth (Pompa and Masser, 1999). pH is the most important factor for normal physiological functions of fish organs. According

to Saha *et al.* (2002) when pH level increased, ammonia excretion increased. Conductivity is an index of the total ionic content of water. It can be used as indicator of primary production and thus fish production. Ammonia (NH_3) can be calculated by multiplying total ammonia nitrogen concentration (in mg/L) by the observed temperature and pH of the water sample. It has the capacity to kill fish at high concentration. High level of total phosphorus increases the algal bloom of the pond water. The algal bloom affects the level of dissolved oxygen by inhibiting most of the phytoplankton from photosynthesis. The objective of this study was to determine the effect of formulated and supplementary diets on water quality parameters (temperature, dissolved oxygen, pH, conductivity, unionized ammonia and phosphorus) in concrete ponds stocked with *Oreochromis Shiranus* in Malawi.

Study description

The study was conducted at Lilongwe University of Agriculture and Natural Resources (LUANAR) fish farm, under the Department of Aquaculture and Fisheries Science in Lilongwe, Malawi, for a period of three months from 17 December 2014 to 17 March 2015. Twelve concrete ponds of $20m^2$ each were used for the experiment. The experiment had four treatments (commercial feed A (31% CP) + chicken manure (T1), maize bran (9.82% CP) + chicken manure (T2), only chicken manure (20% CP) (T3) and commercial feed B (22.64% CP) + chicken manure (T4)) replicated three times. Chicken manure were applied using broadcasting method two weeks before stocking and there after every week at the rate of 500 kg ha^{-1} to boost the primary production (Kang'ombe, 2006). Dissolved oxygen, pH, temperature, phosphorus, conductivity and total ammonia nitrogen were measured throughout the experiment. Water temperature, dissolved oxygen, conductivity and pH were measured twice a day in the morning at 6.00 AM and in the afternoon 2.00 PM by using multi-probe water checker (Model YSI Pro20). Phosphorus and total ammonia nitrogen were determined once per three weeks in the laboratory using ascorbic acid and phenate method respectively in accordance to (APHA, 2005). Unionized ammonia was also calculated by using multiplication factor and total ammonia determined. Data were analyzed using one way analysis of variance (ANOVA).

Results

The physio-chemical parameters of water did not differ significantly ($p \geq 0.05$) among the treatments (Table 2). The pH ranged from 7.1 – 9.0 in the morning (6.00 am) and 8.2 - 9.4 in the afternoon (2.00 pm) as shown in (Table 1). The mean water temperature ranged from 25.13 ^{0}C to 25.24 ^{0}C among treatments. The mean dissolved oxygen ranged from 6.31 mg L^{-1} to 6.59 mg L^{-1} (Table 2) among treatments. Conductivity of the pond water ranged from 310 µSe/cm to 320 µSe/cm as (Table 2). Unionized ammonia ranged from 0.01 mg L^{-1} up to 0.02 mg L^{-1} among the treatments. Besides, the total phosphorus ranged from 0.38 mg L^{-1} up to 0.57 mg L^{-1} (Table 2) among the treatments for the entire experiment.

Table 1. Range of pH measured in ponds treated by different feeds and chicken manure

		pH (Range)			
Date	Time	T1 (Commercial feed A)	T2 (Maize bran)	T3 (Chicken manure)	T4 (Commercial feed B)
Dec 14	6.00 AM	7.8-8.2	7.5-8.5	7.5-8.5	7.4-7.6
	2.00 PM	7.1- 8.9	7.4-8.3	8.2-8.7	7.9-8.9
Dec 28	6.00AM	8.5-8.6	8.4-8.7	8.3-8.7	8.4-8.7
	2.00 PM	8.6-8.9	8.7-8.8	8.5-8.9	8.6-8.9
Jan 11	6.00 AM	8.9-9.1	9.0-9.0	8.9-9.1	9.0-9.0
	2.00 PM	9.1-9.4	9.1-9.2	9.1-9.3	9.0-9.3
Jan 25	6.00 AM	8.6-9.0	8.4-8.9	8.7-9.0	8.3-8.7
	2.00 PM	9.2-9.4	8.9-9.3	8.9-9.4	8.5-9.4
Feb 08	6.00 AM	8.9-9.1	8.9-9.2	9.0-9.2	9.0-9.2
	2.00 PM	8.8-9.1	9.2-9.4	8.3-8.4	8.2-8.4
Mar 22	6.00 AM	8.7-8.9	9.0-9.3	9.0-9.4	9.0-9.3
	2.00 PM	8.4-9.4	8.3-9.0	8.5-9.4	8.4-9.4
Mar 08	6.00 AM	8.4-8.6	8.4-8.6	8.5-8.6	8.6-8.7
	2.00 PM	8.2-9.0	8.1-9.4	8.3-9.1	8.4-9.2

Table 2. Mean (±SE) of water quality parameters measured in ponds treated with different feeds and chicken manure

Parameters	Treatments			
	T1(Commercial feed A)	T2 (Maize bran)	T3 (Chicken manure)	T4 (Commercial feed B)
Temperature (^{0}C)	25.24±0.33	25.17±0.31	25.13±0.29	25.20±0.28
DO (mg/L)	6.31±0.34	6.42±0.29	6.59±0.29	6.46±0.33
Conductivity (µSe/cm)	320±0.01	310±0.01	310±0.01	320±0.01
Unionized ammonia (mg/L)	0.02 ±0.01	0.01 ±0.00	0.01±0.01	0.02 ±0.01
Phosphorus mg/L	0.56±0.23	0.49±0.15	0.38±0.12	0.57±0.08

Discussion

The efficient use of feeds at a limited rate, along with fertilizer and natural feeds does not adversely affect water quality (Diana *et al.* 1996) which concurs with the present finding. In this study pH ranged from 7.1 – 9.0 in the morning (6.00 am) and 8.2 - 9.4 in the afternoon (2.00 pm) and was within the recommended range for good fish growth. Santhosh and Singh (2007) found that pH range between 6.7 to 9.5 were within acceptable range for fish growth.Temperature is the degree of hotness or coldness in the body of a living organism either in water or on land (Lucinda and Martin, 1999). As fish is a cold blooded animal, its body temperature changes according to that of environment affecting its metabolism and physiology. Higher temperature decreased solubility of oxygen and also increased level of ammonia in water. It also increased demand of oxygen by increasing the rate of bio-chemical activity of the micro biota plant respiratory rate (Bhatnagar and Devi, 2013). The

temperature level in this experiment ranged from 25.13 ^{0}C to 25.24 ^{0}C and was within the recommended range of good tilapia growth. According to Delince (1992), 30 ^{0}C -35 ^{0}C is tolerable to fish. Lucinda and Martin (1999) found that temperature range 21 ^{0}C to 26 ^{0}C is ideal for fish growth.

In aquatic environments it is difficult to obtain sufficient DO due to low solubility of oxygen in water and decrease in solubility of oxygen by factors such as temperature, salinity, high concentration of plankton and submerged plants. The principal source of oxygen in water is atmospheric air and photosynthetic planktons (Bhatnagar and Devi, 2013). In this study, the amount of DO ranged from 6.59 mg L^{-1} to 6.31mg L^{-1} and was within the recommended range for good fish production (Bhatnagar and Singh, 2010). DO level >5ppm is essential to support good fish production. DO level of 5mg L^{-1} is adequate in fish ponds (Bhatnagar and Devi, 2013).

Conductivity can be used as an indicator of primary production and thus fish production. Conductivity of water depends on its ionic concentration (Ca^{2+}, Mg^{2+}, HCO^3, CO^{3-}, NO^{3-} and PO), temperature and on variations of dissolved solids. Stone and Thomforde (2004) recommended the desirable range 100 - 2,000 μSe/cm^{-1} and acceptable range 30 -5,000 μSe/cm^{-1} for pond fish culture. Conductivity of the pond water for the present study ranged from 310 μSe/cm^{-1} to 320 μSe/cm^{-1} and was within the recommended range of good fish growth.

Ammonia (NH_3) level depend on the temperature of the pond's water and its pH (Bantnager and Singh, 2010). For example at a higher temperature and pH, a greater level of ammonium ions are converted into ammonia gas this causes an increase in toxic ammonia levels within the aquaculture pond (Bansal *et al.,* 2007). The levels of ammonia (NH_3) were low because some ammonia were used up by algae and other aquatic plants as a nitrogen source for protein synthesis. Ammonia level for this study ranged from 0.01 mg L^{-1} up to 0.02 mg L^{-1} among all the treatments. Bantnager and Singh (2010) recommended ammonia of <0.2 mg L^{-1} as suitable for pond aquaculture. Therefore, the level of ammonia in this study was within the recommended range of pond aquaculture.

High level of total phosphorus increases the algal bloom of the pond water. The algal bloom affects the level of DO by inhibiting most of the phytoplankton from photosynthesis. With higher algae concentration, more CO is removed from the system and hence pH levels will rise (Bansal *et al.,* 2007). According to Bansal *et al.* (2007) 0.05 - 0.07 ppm is optimum and productive; 1.0 ppm is good for plankton production. Concentration of phosphorus for the present study ranged from 0.38 mg L^{-1} up to 0.57mg L^{-1s} among the treatments and higher because of the phosphorus released by chicken manure but within desirable range of plankton production.

Conclusion

As can be noted from above, all water quality parameters were not affected by the different types of feeds used during culture period and were within acceptable ranges for normal

physiological function of fish organs and therefore fish growth.

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