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Research Application Summary

The effect of formulated and supplementary feeds on water quality parameters in concrete ponds stocked with 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 Bunda Fish Farm for three months. The objective of this study was to determinethe effect of formulated and supplementary feeds on water quality parameters in concrete ponds stocked with *Oreochromis shiranus*. There were four different types of treatments replicated three times: commercial feed A (31% CP) (Treatment1), maize bran (9.82% CP) (Treatment 2), chicken manure (20% CP) (Treatment 3) and commercial feed B (22.64% CP) (Treatment 4). Water quality parameters such as dissolved oxygen, temperature, conductivity and pH were measured twice a day in the morning at 6.00 a.m. and in the afternoon at 2.00 p.m. on daily basis by using multi-probe water checker (Model YSI Pro20). Phosphorus content was determined once per three weeks in the laboratory using ascorbic acid method. Total ammonia nitrogen was also determined to calculate unionized ammonia. Statistical analysis was performed by using SPSS Version 20. The pH ranged from 7.1 - 9.0 in the morning (6.00 a.m.) and 8.2 - 9.4 in the afternoon (2.00 p.m.). Temperature, dissolved oxygen, conductivity, unionized ammonia and phosphorus ranged from 25.13°C to 25.24°C, 6.59 mg/L to 6.31 mg/L, 310 µSe/cm to 320 µSe/cm , 0.01 mg/L to 0.02 mg/L and 0.38 mg/L to 0.57 mg/L respectively among the treatments. The results indicated that all water quality parameters were within recommended range for culture of fresh water fish, *O. shiranus*. Further, the formulated and supplementary feeds did not affect the water quality parameters in concrete ponds stocked with *O.shiranus*.

Key words: Formulated and supplementary diets, *Oreochromis shiranus,* pH

Résumé

Une étude de l'effet des formules de compléments alimentaires sur les paramètres de qualité de l'eau piscicole du poisson frais (*Oreochromis shiranus*) a été conduite sur la ferme piscicole de Bunda pendant trois mois. L'objectif était de déterminer l'effet des formules de compléments alimentaires sur les paramètres de qualité de l'eau des étangs contenant *O. shiranus*. Quatre différents types de traitement étaient considérés et répétés trois fois :

aliment commercial A (31% CP) (traitement 1), son de maïs (9,82% CP) (Traitement 2), fumier de poulet (20% CP) (Taitement3), Aliment commercial B (22,64% CP) (Traitement 4). Les paramètres de qualité d'eau tels que l'oxygène dissout, la température, la conductivité, et le pH ont été mesurés deux fois par jour à 6:00 heures du matin et à 14:00 heures en utilisant un contrôleur multi-probes (Model YSI Pro20). La teneur en phosphore était mesurée au laboratoire une fois toutes les trois semaines en utilisant la méthode d'acide ascorbique. L'azote ammoniacal total a également été déterminé pour calculer l'ammoniac non-ionisé. L'analyse statistique a été faite en utilisant SPSS Version 20. Le pH varie de 7,1 à 9,0 dans la matinée et entre 8,2 et 9,4 dans l'après-midi. La température, l'oxygène dissout, la conductivité, l'ammoniac non-ionisé, et le phosphore varient respectivement de 25,13 à 25,24°C, 6,31 à 6,59 mg/l, 310 à 320 µSe/cm, 0,01 à 0,02 mg/l et 0,38mg/l à 0,57mg/l au sein des traitements. Ces résultats indiquent que tous les paramètres de qualité d'eau étaient dans les normes recommandées pour la l'eau du poisson *O shiranus*. De plus, les formules de compléments alimentaires n'ont pas influencé les paramètres de qualité d'eau dans les étangs.

Mots clés : régimes alimentaires à formules et compléments, *Oreochromis shiranus,* pH

Background and literature summary

According to Corpei (2001) tilapia is an important food fish in many tropical areas of Africa. 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 the ease with which it reproduces and survival in poor water quality conditions relative to other tilapias (Maluwa, 2005).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. Among the most commonly cultured fresh water species tilapias are the more tolerant to high unionized ammonia, temperature, phosphorus and low dissolved oxygen. When the temperature is too low or too high the feeding behavior of the fish will be disturbed and growth is affected. If the water temperature shifts too far from the optimum the organs of the fish is affected. The oxygen that is dissolved in water either through diffusion from air or aeration as well as through photosynthesis is called dissolved oxygen. Oxygen level can be reduced by many factors such as water temperature, amount of fertilizer, feed applied and pollutants. Fish use higher amount of oxygen when their metabolism rate increases. Tilapias have the capacity to survive under lower amount of dissolved oxygen. Although they can survive in such conditions, above 1mg/L of oxygen is recommended for good health and growth (Pompa and Masser, 1999). Importantly, pH is the most important factor for normal physiological functions of fish organs. According to Saha *et al.* (2002) when pH level increases,ammonia excretion also increases. 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 when its level increases. High amount of phosphorus increases the algal bloom of the pond water. This affects the level of dissolved oxygen by inhibiting

photosynthesis in most of the phytoplanktons. 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 *O. shiranus* in Malawi.

Study description

The study was conducted at Lilongwe University of Agriculture and Natural Resources fish farm for a period of three months (December 2014 to 17 March 2015). Twelve concrete ponds each measuring 20 m^2 were used for the experiment. Four feed treatments were administered to the different ponds and included T1 (commercial feed A (31% CP) +chicken manure)), T2 (maize bran (9.82% CP) + chicken manure)), T3 (only chicken manure (20% CP)), T4 (commercial feed B (22.64% CP)+ chicken manure)). All these were replicated three times. Chicken manure was applied by broadcasting two weeks before stocking and thereafter every week at the rate of 500 kg/ ha 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 a.m. and in the afternoon at 2.00 p.m. using a 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 and thereafter converted into total ammonia. Data were analyzed using one way analysis of variance (ANOVA).

Results

The physico-chemical parameters of water did not differ significantly ($p>0.05$) among the treatments as shown in Table 1. 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 2). The mean water temperature ranged from 25.13°C to 25.24°C among treatments. The mean dissolved oxygen ranged from 6.31 mg/L to 6.59 mg/L (Table 1) among treatments. Conductivity of the pond water ranged from 310 µSe/cm to 320 µSe/cm as shown in Table 1. Unionized ammonia ranged from 0.01 mg/L up to 0.02 mg/L among the treatments. Besides, the total phosphorus ranged from 0.38 mg/L up to 0.57 mg/L (Table 1) among the treatments for the entire experiment.

Discussion

Combination of feeding with regular fertilization might lead to a higher natural pond productivity and sustain a larger plankton biomass. According to Diana *et al.* (1996) the efficient use of feeds at a limited rate, along with fertilizer and natural feeds does not adversely affect water quality which concurs with the present findings.

Water quality parameters within acceptable limits are important for fish growth. According to Santhosh and Singh (2007) the suitable pH range for fish culture is between 6.7 and 9.5. In this study pH ranged from 7.1 – 9.0 in the morning and 8.2 - 9.4 in the afternoon and was within the recommended range for good fish growth.

Table 1. 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 (°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

Table 2. Range of pH measured in ponds treated by different feeds and chicken manure

Date	pH (Range)				
	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

As fish is a cold blooded animal, its body temperature changes according to that of environment thus affecting its metabolism and physiology. Higher temperature decreased solubility of oxygen and also increased level of ammonia in water. It also increases demand of oxygen by increasing the rate of bio-chemical activity of the micro-biota, and plant respiratory rate (Bhatnagar and Devi, 2013). According to Delince (1992), 30°C -35°C is tolerable to fish while Lucinda and Martin (1999) puts the range at 21°C to 26°C. In this study, the temperature level ranged from 25.13°C to 25.24°C and was within the recommended range of good tilapia growth.

In an aquatic environment, 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 to 6.31mg/L and was within the recommended range for good fish production (Bhatnagar and Singh, 2010). In practice DO level >5ppm is essential to support good fish production, but a DO 5mg/L is adequate in fish ponds (Bhatnagar and Devi, 2013).

Conductivity can be used as 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 a desirable range of 100-2,000 µSe/cm and acceptable range of 30-5,000 µSe/cm for pond fish culture. Conductivity of the pond water for the present study ranged from 310 µSe/cm to 320 µSe/cm and was within the recommended range of good fish growth.

Ammonia level is dependant 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 thus increasing toxic ammonia levels in the pond (Bansal *et al.,*2007). Ammonia level for this study ranged from 0.01 mg/L up to 0.02 mg/L among all the treatments. Bantnager and Singh (2010) recommended ammonia (<0.2 mg/L) as suitable for pond aquaculture. Therefore, the level of ammonia in this study was within the recommended range for 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_2 is removed from the system and hence pH rises (Bansal *et al.,* 2007). According to Bansal *et al.* (2007) 0.05 - 0.07 ppm is optimum and productive; and 1.0 ppm is good for plankton production. Concentration of phosphorus for the present study ranged from 0.38 mg/L up to 0.57mg/L among the treatments and higher because of the phosphorus released by chicken manure but within desirable range of plankton production.

As can be noted from above, all the 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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