INFLUENCE OF FEED INGREDIENTS ON WATER QUALITY PARAMETERS IN AN INTENSIVE POLYCULTURE OF CARPS

[1]AASIA KARIM,* AND [2]MOHAMMAD SHOAIB

[1]Department of Zoology, Federal Urdu University of Arts, Science and Technology, Karachi, Pakistan.
[2]Department of Zoology, University of Karachi, Pakistan.
Corresponding author E-mail:aasiakarim@gmail.com

خلاصہ

پروتین ماخذ حیاتی اور نباتی اجزاء سے پانی کے مختلف طبعی و کیمیاء خواص مر اثرانداز ہونی والی تبدیلیوں کے مشاہدے کے لیے Carps مچھلیوں(*Cirhinus mrigala* اور *Lebeo rohita, catla catla*) کے فارم میں ایک تحقیق کا اجراء کیا گیا جس میں پروٹین کے چار مختلف حیاتی و نباتی اجزاء کو استعمال کرتے ہوئے چار ازمائش خوراکیں یعنی (*APCM*) Corn gluten meal (CGM),All parts chiken meal اور مرتب Soy bean meal (SBM) کی گئیں۔ نتائج سے یہ بات اخذ کی گئی ہے کہ اجزاء کی خاصیت اور مقدار آبی ماحول پر واضح طور پر اثرانداز ہونے کے ساتھ ساتھ ماحولیاتی عوامل میں کم و بیش تبدیلیوں کا باعث بھی بنتی ہے۔

Abstract

A study was conducted to observe changes in physio-chemical water quality due to the influence of four different animal and plant based protein ingredients in re-circulating water system through an intensive polyculture of Indian major carps *(Catla catla, Labeo rohita* and *Cirhinus mrigala).* Four experimental diets were formulated by using animal and plant based protein ingredients i.e. fish meal (FM), all parts chicken meal (APCM), corn gluten (CGM) and soybean meal (SBM). It was observed that nature and quantity of major ingredients definitely have impact on ecological conditions of water and may more or less alter the physic-chemical parameters.

Introduction

In aquaculture, water quality is one of the most critical issues to obtain maximum yield of healthy cultured animals. In intensive re-circulating culturing systems water quality may be influenced by many factors which include type of cultured species, its growing stage, stocking density, weather conditions, type of feed, type of rearing pond, turnover rate and quality of utilized water (Ziemann *et al.*, 1992). Most of the time, this concern co-relates to the amount and quality of waste discharge. Uneaten feed and excreta usually constitute almost entire aquaculture waste and are considered as the major sources of aquaculture waste. Water quality deterioration mostly occurs due to the nutrient leaching of excessive or low quality feed. An aquatic environment can be protected by the appropriate removal of organic and inorganic nutrients effluent during the discharge of water, (Lockwood, 1997; Lucien-Brun, 1997; Preston *et al*., 1997) or by gravitational or mechanical methods, if the waste is in the form of particulate matter (Chen *et al*., 1994).

It has been revealed that the characteristics of pellet are greatly affected by the ingredients used in the formulation of feed (Van Rooy, 1986; Wilson, 1994). To formulate least cost diets, a huge variety of feedstuffs are being integrated at varying levels nowadays. This may change the physical properties of diet; though the estimated dietary requirements are present. In general, the choice of ingredients for the formulation of diet has been attributed to alterations in pellet quality and on physico-chemical parameters of water.

The current study was conducted to characterize changes in various physio-chemical water quality factors by the influence of four different animal and plant based protein ingredients in re-circulating water system through an intensive polyculture of Indian major carps *(Catla catla, Labeo rohita* and *Cirhinus mrigala).*

Materials and Methods

Experimental design

Four experimental diets were formulated by using animal and plant based protein ingredients i.e. fish meal (FM), all parts chicken meal (APCM), corn gluten (CGM) and soybean meal (SBM). Each ingredient was added with various other additives and inclusions to compose a balanced fish diet (Table 1). Powdered ingredients were mixed thoroughly with canola oil. The dough, after passing through a pellet feed maker, was dried out at room temperature.

Table 1: Percentages of ingredients and proximate values per 100 g of diet.

	Diet			
	FM	**APCM**	**CGM**	**SBM**
Ingredients (%)				
Fish meal	25	-	9.13	8.69
All parts chicken meal	-	25	-	-
Corn gluten meal	1.16	1.74	25	-
Rice polish	63.83	63.24	55.85	56.29
Soybean meal	-	-	-	25
Starch	5	5	5	5
Canola oil	4.5	4.5	4.5	4.5
Vitamins and mineral mixture	0.5	0.5	0.5	0.5
Proximate composition (%)				
Crude protein	24.99	24.98	24.98	24.98
Crude fat	15.19	16.85	13.51	14.26
Crude fiber	2.56	2.95	3.29	3.74
Ash	13.7	12.02	9.83	10.61
Nitrogen –free extract	42.99	42.63	47.82	45.82
DE (K cal/Kg)	3109.9	3231.2	3018.5	3037.6
GE (K cal/Kg)	4520.4	4655.9	4565.3	4552.3

*FM = Fish meal, APCM = All parts chicken meal, CGM = Corn gluten meal, SBM = Soybean meal

Fingerlings of *Catla catla, Labeo rohita* and *Cirhinus mrigala* were stocked in rectangular concrete raceways (22′×50′) with the ratio of 33:33:34, respectively (Wahab *et al*., 2002) and fed manually at 3% body weight twice daily for the duration of one year.

Physico - chemical parameters

Water temperature, pH, dissolved oxygen, total dissolved solids, total suspended solids, total alkalinity, total hardness and ammonia were observed biweekly and their monthly mean values were subjected to analysis. The temperature and dissolved oxygen were evaluated by Dissolved oxygen meter (HI-9146) by fixing the temperature factor at 0˚C unit. The pH was measured by the microprocessor pH meter (HANNA-HI-8520) after setting its range at pH point. Total dissolved solids were determined by TDS meter (HANNA-HI-98302).
Total alkalinity and total hardness were determined by MERCK chemical test kits for testing water and waste waters. In present research work concentrations of ammonia in raceways were determined by following the method of John *et al.*, (2004).

Statistical analysis of experimental data

The obtained data was subjected to statistical analysis by using Minitab release 16. The comparison of mean values for various parameters was carried out by using one-way analysis of variance. Pearson coefficient of correlation was also performed to find out relationships among growth variables.

Results

In the present research trial, significant differences were observed among all water quality parameters (temperature, pH, dissolved oxygen, total solids, total dissolved solids, total alkalinity, total hardness and ammonia) by the Fisher's least-significant-difference (LSD) at $P \leq 0.05$ test except temperature, total alkalinity and ammonia (Table 2). All formulated diets confirmed the influence of feed ingredient by showing significant relationships among water quality variables by one-way analysis of variance. pH, total solids, total dissolved solids and total hardness were significantly affected by different formulated diets in the raceways although ammonia was not affected greatly in raceways (Table 2).

Mean, maximum and minimum values of all these parameters are illustrated in Figure 1. The mean range of temperature for all diets was noted between 21.1 to 21.7℃. Mean values of pH, dissolved oxygen, total solids, total dissolved solids, total alkalinity, total hardness and ammonia were within 7.9 - 8.4, 5.5 - 6.7 mg/L, 1100.2 - 1398.4 mg/L, 981.4 - 1302.9 mg/L, 393.6 – 419.5 mg/L, 166.1 – 256.2 mg/L and 0.05 - 0.08 mg/L, respectively.

Table 2: Mean values of various Physico-chemical parameters of water treated with different formulated diets.

	Temp (˚C)	pH	DO (mg/L)	TS (mg/L)	TDS (mg/L)	T Alk (mg/L)	T. Hd (mg/L)	Ammonia (mg/L)
FM±SE	21.6±2.30a	8.2±0.04ab	6.5±0.35ab	1398.4±20.7a	1302.9±15.7a	393.6±9.87a	168.1±5.15b	0.06±0.01a
APCM±SE	21.1±2.37a	8.1±0.05bc	6.7 ±0.27a	1396.2±22.6a	1287.5±19.0a	419.5±14.8a	167.3±4.26b	0.05±0.01a
CGM ±SE	21.4 ±2.12a	7.9 ±0.14c	6.0±0.54ab	1100.2±23.1b	981.4 ±27.2c	402.5±9.70a	166.1±6.56b	0.06±0.02a
SBM±SE	21.7 ±2.01a	8.4 ±0.08a	5.5 ±0.20b	1147.5±32.1b	1122.7±27.1b	407.5±7.08a	256.2±9.85a	0.08±0.00a
P-Value	0.997	0.008**	0.109	0.000**	0.000**	0.393	0.000**	0.464

*Temp = Water Temperature (°C), DO = Dissolved oxygen (mg/L), TS = Total solids (mg/L), TDS = Total dissolved solids (mg/L), T. Alk = Total alkalinity (mg/L), T.Hd = Total hardness (mg/L).
Values are means ± SE (n = 12).
Means in a column followed by different letter were significantly different from each other at $p < 0.05$ by the Fisher's least-significant-difference (LSD) test.
** = Significant;

Strong correlations were observed by Pearson coefficient of correlation among physico-chemical parameters of water (Table 3). Total solids were greatly affected by total dissolved solids while they both altered dissolved oxygen of water. Total hardness and pH were significantly correlated by amount of total solids and total dissolved solids respectively. A significant correlation of ammonia was also observed with temp, pH and dissolved oxygen.

Table 3: Pearson correlation (r) among various Physico-chemical parameters of water enriched with different formulated diets.

	Temp (˚C)	pH	DO (mg/L)	TS (mg/L)	TDS (mg/L)	T. Alk (mg/L)	T. Hd (mg/L)
pH	-0.250 **(0.087)**						
DO (mg/l)	-0.183 **(0.213)**	-0.000 **(0.998)**					
TS (mg/l)	-0.017 **(0.908)**	0.124 **(0.399)**	0.448 **(0.001)****				
TDS (mg/l)	-0.044 **(0.765)**	0.330 **(0.022)****	0.363 **(0.011)****	0.853 **(0.000)****			
T. Alk (mg/l)	0.063 **(0.670)**	-0.071 **(0.634)**	-0.165 **(0.261)**	0.037 **(0.801)**	-0.013 **(0.933)**		
T. Hd (mg/l)	0.048 **(0.747)**	0.173 **(0.241)**	-0.191 **(0.193)**	-0.316 **(0.029)****	-0.133 **(0.369)**	0.103 **(0.485)**	
Ammonia (mg/l)	0.395 **(0.005)****	0.646 **(0.000)****	-0.177 **(0.229)**	-0.025 **(0.865)**	0.109 **(0.462)**	-0.095 **(0.522)**	0.033 **(0.825)**

*Pearson coefficient of correlation, the figures within parentheses denote p values ($p < 0.05$),
** = Significant;
Acronyms; Temp = Water Temperature (°C), DO = Dissolved oxygen (mg/L), TS = Total solids (mg/L), TDS = Total dissolved solids (mg/L), T. Alk = Total alkalinity (mg/L), T. Hd = Total hardness (mg/L).

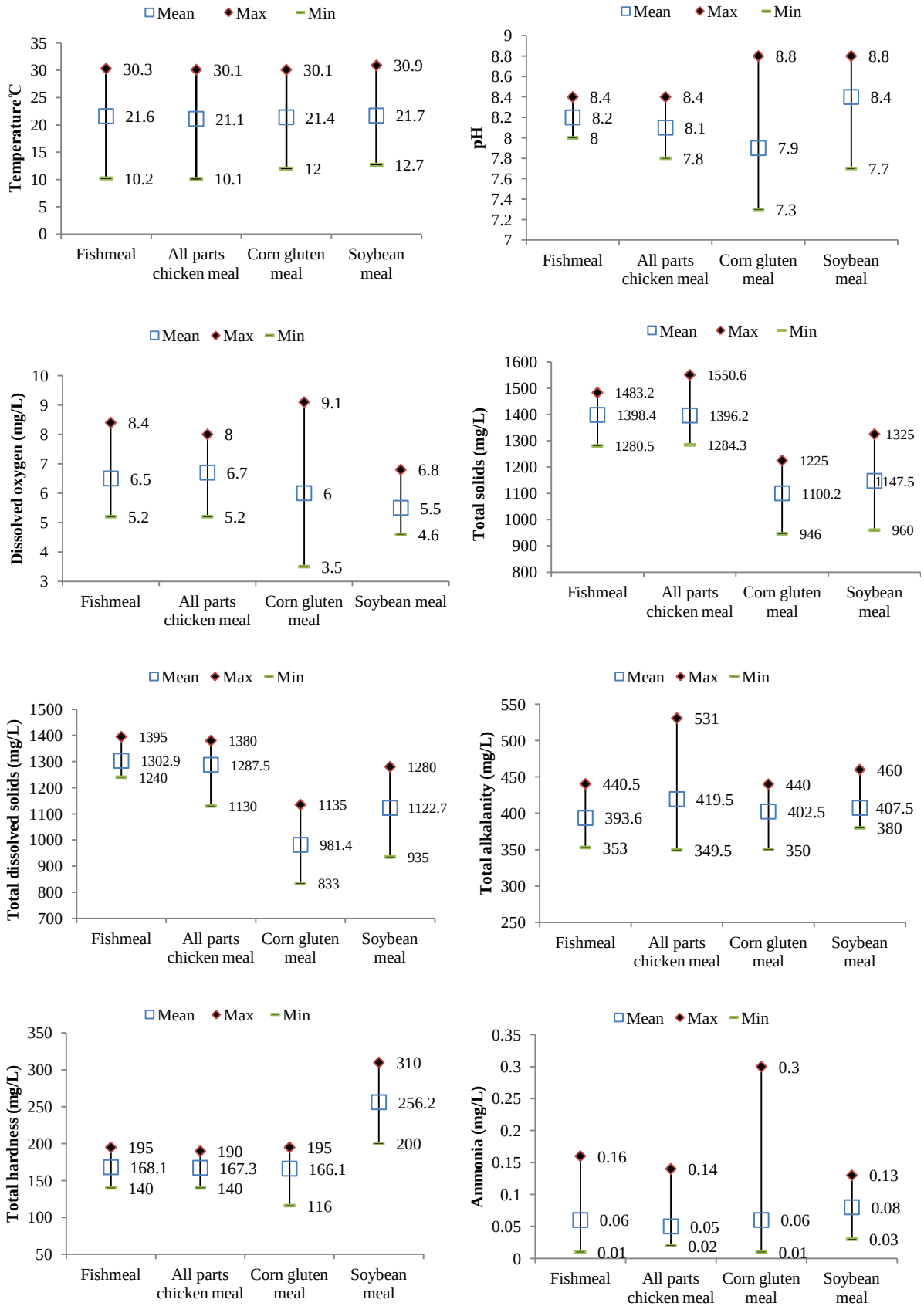

Fig.1. Mean, maximum and minimum values of various Physico-chemical parameters of water treated with different formulated diets.

Discussion

In intensive culturing system, nature of ingredients of supplementary feed and their inclusion level play a significant role to keep aquatic environment affable. The rate of change in water quality parameters is significant in determining whether the change is within the natural limit or not. Rate of change above the natural limit is injurious for fish. In order to regulate the water quality in carp ponds, assessment of physico-chemical parameters of water is a very useful tool. In general they reflect overall ecological condition and variations in the aquatic environment. The temperature, pH, oxygen, ammonia, nitrates, nitrites and chlorine are crucial in this connection (Bociec *et al.,* 2011).

Water quality monitoring in four different carp ponds, treated with four different formulated feed, (fish meal, all parts chicken meal, corn gluten and soybean meal) showed that most of the parameters i.e. temperature, pH, dissolved oxygen, total hardness and ammonia were within their optimal ranges recommended for carp rearing. Although temperature showed fluctuations in the whole experimental period, but the mean values of temperature remained between 21.1 to 21.7 ºC in all treated raceways, conducive for optimum growth of carps. Similarly, the DO remained above the minimum level (5.5 to 6.7 mg\L) in all treatments, to sustain excellent fish production. Cyprinids can thrive in water containing 6–8 mg\L (Banerjea, 1967) and show signs of suffocation, when the oxygen concentration falls to 1.5–2.0 mg\L. pH was desirable (7.9 to 8.4) for the growth of carps in all treatments. The optimal pH range for fish is from 7.5 to 8.5 (Boyd, 1998). Values above 10.8 and below 5.0 are fatal to cyprinids (especially carp). Extremely high or low pH values can cause damage to fish tissues, especially the gills and haemorrhages may occur in the gills and on the lower part of the body (Lloyd, 1992).

Concentration of ammonia is limited to <0.05 mg/L for fresh water fish culture (Lawson, 1995). During our study ammonia concentration was higher than the acceptable range. It was may be due to the correlation with temp, pH and dissolved oxygen. Higher values of temperature and pH increase ammonia concentration in water, while lower concentration of oxygen enhances the toxicity of ammonia. Ammonia toxicity lessens the oxygen carrying capacity of blood of fish (Lawson, 1995).

In the present study, variations in total alkalinity were within the desirable range for fish culture (5-500 mg/L Lawson, 1995), although TDS and TS were higher than the levels conducive (TS > 100 < 220 mg/L, TDS 2000 mg/L). Total solids were greatly affected by total dissolved solids while they both altered dissolved oxygen of water.

In the current research trial, the physical and chemical factors of water were strongly influenced by ingredient composition of feed. pH, total solids, total dissolved solids and total hardness were significantly affected by different formulated diets. Although temperature, dissolved oxygen, total alkalinity and ammonia were not affected greatly in raceways (Table 2).

The influence of dietary protein levels on pond water and feed utilization were also evaluated by Bechara *et al.,* (2005). Feed prepared from soybean meal, blood meal and bone meal with yellow maize were used, and given to fish (*Pacu piaracrtus mesoptamicus*). Higher levels of protein gave high values of alkalinity, electrical conductivity and nitrate in water. Similar interpretations were proposed by Dulic *et al.,* (2010). They used unprocessed cereals and some other ingredients to make three different types of feed and assessed their effects on water quality of intensive ponds of carps. The feed from uncooked cereals, however sets down more clumps at the bottom of the pond.

In conclusion, it can say that nature and quantity of major ingredients, definitely have great impact on ecological condition at one side and fecal matter excreted as a result of digestion may alter these parameters on other side, as there were statistically significant differences among treatments, but all these diets (FM, APCM, CGM and SBM) had the excellent quality of feed and can be fed to cultured carps without adverse effects on water quality and consequently on growth.

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