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Comparative study of proximate composition and mineral contents in *Ctenopharyngoden idella* and *Rita rita* collected from River Chenab

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Abstract

Riverine system can provide healthy Catfish and Grass carps in term of mineral and nutrients as compared to the fish cultured in the hatcheries. The current study was carried out to find out the chemical composition and mineral contents in *Ctenopharyngodon idella* (grass carp) and *Rita rita* (catfish). The main objectives were to find the effect of feeding habitat on the fish growth, to determine the nutrients and minerals composition in the fish body. The samples of fish carcass were analyzed by standard methods (AOAC, 1995). The maximum percentage of protein, fat, moisture and ash in *Ctenopharyngodon idella* were 44.431±10.746, 19.64±0.104, 0.713±0.058 and 9.486±12.834 respectively while in *Rita rita were* 37.125±8.918, 22.63±0.052, 0.425±0.4960 and 6.312±8.628 respectively. The maximum percentage of Ca, K, Mn, Na, Cr, Zn in *Ctenopharyngodon idella* were 18.804±4.514, 0.856±0.049, 0.963±0.027, 0.835±0.048, 756±0.136, 8.575±2.008 while in *Rita rita were* 0.135±0.015, 9.091±12.782 0.135±0.015, 9.091±12.782, 2.224±2.982, 8.210±11.402 respectively. The duration of the sample collection was 6 months on fortnightly bases. The fish samples were collected from head Marla River Chenab, district Sialkot, Pakistan and local fish hatchery Sialkot. Data was subjected to one-way analysis of variance (ANOVA). The Co-Stat computer software (Version 6.303, PMB 320, Monterey, CA, 93940 USA) was used for statistical analysis. The present study showed important information and significant difference ($P<0.05$) between the studied fish species regarding proximate composition and mineral contents.

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Introduction

Fish meat contains higher proportion of protein, vitamin, minerals, healthy fats and carbohydrates in minor quantity which makes it good and fit diet and easily digested by human body. Proximate composition determination involves analysis of moisture, crude protein, lipid and ash contents. Mineral composition analysis involves the determination of contents such as potassium (K), sodium (Na), calcium (Ca), manganese (Mn), and zinc (Zn). However, nutrients are required for the proper functioning of body. Fats are essential sources of energy and protein is very important for the muscles. But these nutrients are lower in normal feedstuff or available at higher cost. Fish is very important food especially in developing countries due to its high protein percentage, low fat and nutritional values of poly unsaturated fatty acids (PUFA). PUFA are not only important for protection of the membranes of cells but also important for the formation of prostaglandins in body. These fats absorb vitamins A, D, E and K from food and also adjust cholesterol metabolism in the body (Jabeen and Chaudhry, 2011). Fish is widely consumed by all classes of people as it is available at low cost in every region of world (Andrew, 2001; 2005; Abolude and Abdullahi, 2005). Fish meat contains low lipids and high water as compared to beef or chicken (Nestel, 2000). It is most acceptable because of its high palatability, low cholesterol and digestible flesh (Eyo, 2001). Fish contains most of the minerals, which are necessary for human balanced diet (Dempson *et al.,* 2004). Fish is more beneficial for human body because it has essential amino acids which are good for human body (Buchtora *et al.*, 2010). Generally, composition of live fish weight, whole fish is 70-80% water, 20-30% protein and 2-12% lipid (Da and Sahu, 2000). The proximate analysis of fishes is essential for estimation of its nutritional values (Hei and Sarojnalini, 2012).

The grass carp (Chinese carp) is one of the largest members of the family Cyprinidae and member of the genus *Ctenopharyngodon* (Shireman and Smith, 1983; Chilton and Muoneke, 1992). The common names are grass carp and white amur, but it is known by many other common names worldwide where it has been introduced (listed in Shireman and Smith, 1983; Beck 1996). Grass carp feeds on weeds and grasses and has short intestine. Young one of grass carp feeds on zooplankton (Santhanam *et al.*, 1990). This species is identified by a wide scale less head, terminal mouth with simple lips no barbells and very short snout. The fish body is compressed with a rounded belly (Shireman and Smith 1983; Page and Burr 1991; Opuszynski and Shireman, 1995). This species generally gets weights of 30-50 kg (Chilton and Muoneke, 1992) and can reach lengths bigger than 1 m (Fraser, 1978, Pauley, 1978, Page and Burr, 1991, Nico and fuller, 2001).

Rita rita (Hamilton) is fresh water fish and is commonly called as catfish. It is locally known as "Khagga" in Pakistan. This fresh water species also found in streams, rivers, canals and ponds, occurs mostly in deep waters (Mirza, 1982). Young ones are greenish brown above and silvery brown on back of body. It is a bottom and column feeder, feeds on algae and upper plants as well as insects, crustaceans and rotifers. It is very slimy when captured (Rahman, 1989). It is used as food in many countries such as Pakistan, Afghanistan, India, Nepal, Bangladesh and Myanmar (Mirza, 2003). It is bottom-dwelling carnivorous fish and feed on mollusks, small fishes, crustaceans and insects as well as on decaying organic matters (Shrestha, 1990). The current research was aimed to evaluate the body composition and mineral contents of grass carps and a catfish due to their economical and nutritive worth, which will help to choose best fish in future as source of important nutrients and minerals.

Material and methods

Sampling area

Two fish species were collected from Marla head work of river Chenab, district Sialkot, Punjab, Pakistan.

Sampling procedure

A fish net was used to capture catfish and grass carps from Marla head work of river Chenab Sialkot Pakistan and local fish seed hatchery, Sialkot, Pakistan. These fishes were stored in thin plastic bags

containing dry ice and labeled them. Labeled bags were transported into research laboratory Department of Zoology, GC University, Faisalabad for further analysis.

Chemical analysis of fish carcass

The samples of fish carcass were observed using a motor and pestle and analyzed by standard methods (AOAC, 1995). Moisture was determined by oven-drying at 105°C for 12 h; crude protein (N × 6.25) by Micro Kjeldahl apparatus; crude fat by petroleum ether extraction method through Soxtec HT2 1045 system; crude fiber as loss on ignition of dried lipid-free residues after digestion with 1.25% H_2SO_4 and 1.25% NaOH; Ash, by ignition at 650°C for 12 h in electric furnace (Eyela-TMF 3100).

Mineral estimation

The fish samples were digested in a boiling nitric acid and perchloric acid mixture (2:1) according to AOAC, 1995. After appropriate dilution, minerals contents were estimated by using Atomic Absorption Spectrophotometer. The phosphorus was analyzed calorimetrically (UV/VIS spectrophotometer) at 350nm.

Proximate analysis

The analysis includes in this group, also known as Weende proximate analyses, are applied firstly to materials to be used in formulating a diet as a protein or energy source and to finish feedstuffs, as a control to check that they meet the specifications or requirements established during formulation. The analysis shows the moisture, crude protein (total nitrogen), crude fibre, crude lipids, ash and nitrogen-free extract content of the sample. A full description of these analysis can be found in Osborne & Voogt (1978), MAFF (1982) & AOAC (1984).

Moisture

In balancing the ration, it is essential to know the water content of each component; also, moisture in prepared feed must be monitored because levels over 8% favor the presence of insects, and over 14% there is the risk of contamination by fungi and bacteria (Cockerell *et al.*, 1971). The method is based on drying a sample in an oven and determining moisture content by the weight difference between dry and wet material. Weigh out approx. 5–10 g of previously ground sample. Place sample in drying oven at 105°C for at least 12 h. Let sample cool in dryer. Weigh again, taking care not to expose the sample to the atmosphere.

Crude protein

Because of its cost this is the most important dietary nutrient in a commercial operation; proper evaluation of it means that the quality of protein intake or of the feed being provided can be controlled. Analysis is by Kjeldahl's method, which evaluates the total nitrogen content of the sample after it has been digested in sulphuric acid with a mercury or selenium catalyst. To milligram precision, weigh out 1 g of sample and placed in the Kjeldahl flask; added 10g potassium sulphate, 0.7 g mercuric oxide and 20 ml concentrated sulphuric acid. Placed the flask tilted at an angle in the digester, bring to boiling point and retain until the solution is clear; continue to heat 30 minutes more. If foam is too abundant, added a little paraffin wax. Leave to cool, gradually adding approximately 90 ml distilled, de-ionized water. When cold add 25 ml sodium sulphate solution and stir. Added one glass bead and 80 ml of 40% sodium hydroxide solution, keeping the flask tilted. Two layers will form. Quickly connect the flask to the distillation unit, heat and collect 50 ml of distillate containing ammonia in 50 ml of indicator solution. At the end of distillation, remove the receptor flask, rinse the end of the condenser and titrate the solution.

Crude lipids

In this method, the fats are extracted from the sample with petroleum ether and evaluated as a percentage of the weight before the solvent is evaporated. Remove extraction flasks from the kiln without touching them with the fingers, cool in a dryer and weigh to within milligrams. Weigh 3 to 5 g of dry sample to within milligrams in an extraction thimble, handling it with tongs and place in the extraction unit. Connect the flask containing petroleum ether at 2/3 of total

volume to the extractor. Bring to boil and adjust heat to obtain about 10 refluxes per hour. The length of the extraction will depend on the quantity of lipids in the sample. Very fatty materials will take 6 hours. When finished, evaporate the ether by distillation or in a rot evaporator. Cool the flasks in a dryer and weigh them to within milligrams. The defatted sample can be used in determining crude fibre.

Ash

This method is used to determine ash content in carcass by calcination. Ash is considered as the total mineral or inorganic content of the sample. Placed 2.5 to 5 g of dry sample in a crucible previously calcined and brought to constant weight. Placed the crucible in a furnace and heat at 550°C for 12 hours; leave to cool and transfer to a dryer. Carefully weigh the crucible again with the ash.

Statistical analysis

Data of nutrient (crude protein, crude fat and apparent gross energy) and mineral composition was subjected to one-way analysis of variance (Steel *et al*., 1996). The differences among means was compared by Tukey's Honesty Significant Difference Test and was considered significant at $p<0.05$ (Snedecor and Cochran, 1991). The Co-Stat computer software (Version 6.303, PMB 320, Monterey, CA, 93940 USA) was used for statistical analysis.

Results

Analysis of carcass composition in Ctenopharyngodon idella

Apparent crude protein and fat (%)

The values 36.832±52.030 and 44.431±10.746 of protein in fish were observed in River I and River II and 73.623±0.041 was observed in hatchery respectively. The results indicated that the maximum value of crude protein (dry) was observed in river II and minimum in hatchery samples. The analysis of variance of crude protein in fish carcass indicated that Significantly ($p<0.05$) higher protein were present in grass carp than farmed one. The value of fat in *Ctenopharyngodon idella* fish was observed 9.872±13.813and11.842±2.787) in River I and River II and19.64±0.104in hatchery respectively. The results indicated that the maximum value of crude protein (dry) was observed in hatchery and minimum in river I. The analysis of variance indicated that significantly $p<0.05$) higher fat were present in grass carp than river samples.

Apparent moisture and ash (%)

The values of moisture were 0.385±0.462 and 0.424±0.054) in River I and River II while 0.713±0.058 in hatchery. The results indicate that the maximum value of moisture observed in hatchery and minimum in river II. Comparison of means indicate that moisture values in hatchery, river I and river II were significantly different ($p<0.05$) from each other. The values of ash 9.486±12.834 and 11.160±2.367 were observed in River I and River II and 18.561±0.410 was observed in hatchery respectively. Significantly ($p<0.05$) higher ash were present in grass carp than farmed.

Apparent Na and K (%)

The values of Na in *Ctenopharyngodon idella* were observed 0.870±0.801% and 0.835±0.048%in River I and River II and 1.436±0.303% was observed in hatchery specimens. The results indicate that the maximum value of Na was observed in river I and river II and minimum in hatchery. Significantly ($p<0.05$) higher Na was present in river I and river II. The maximum value of K in *Ctenopharyngodon idella* was observed15.612±21.996 and18.804±4.514 was observed in River I and River II and 31.166±0.058% was observed in hatchery. The minimum value was observed in river 1. The maximum value was observed in river II. Significantly ($p<0.05$) higher K were present in river II and hatchery.

Apparent Ca and Mn (%)

The values of Ca in *Ctenopharyngodon idella* 0.453±0.570 and 0.511±0.083 was observed in River I and River II and 0.856±0.049 was observed in hatchery. The minimum value was observed in river II .The maximum value was observed in hatchery. Significantly ($p<0.05$) higher Ca was present in

hatchery and these values are different from river I and river II. The values of Mn in *Ctenopharyngodon idella* fish 0.495±0.661 and 0.5781±0.117 were observed in River I and River II and 0.963±0.027 was observed in hatchery. The results indicate significantly ($p<0.05$) higher Mn were present in hatchery as compared to river I and river II.

Apparent Cr and Zn (%)

The values of Cr in *Ctenopharyngodon idella* 0.660±0.853and 0.756±0.136 that was observed in River I and River II and 1.263±0.056 was observed in hatchery. The minimum value was observed in hatchery. The maximum value was observed in river II. The results indicate that the maximum value of Cr observed in river II and minimum in hatchery. The values of Zn in *Ctenopharyngodon idella* was observed 7.155±9.995 and 8.575±2.008 in River I and River II and 14.223±0.087 was observed in hatchery. The minimum value was observed in hatchery14.223±0.087.The maximum value was observed in River II (8.575±2.008).

Table 1. Carcass composition (%) and mineral analysis in *Ctenopharyngodon idella* and *Rita rita*.

Parameters	*Ctenopharyngodon idella*			*Rita rita*		
	River I	River II	Hatchery	River I	River II	Hatchery
Crude protein	36.832±52.030^{b}	44.431±10.746^{a}	73.623±0.041^{c}	30.819±43.431^{b}	37.125±8.918^{a}	61.53±0.108^{c}
Crude fat	9.872±13.813^{c}	11.842±2.787^{b}	19.64±0.104^{a}	11.341±15.964	13.652±3.268^{c}	22.63±0.052^{a}
moisture	0.385±0.462^{ab}	0.424±0.054^{b}	0.713±0.058^{a}	0.425±0.496^{a}	0.46±0.049^{a}	0.776±0.075^{a}
Ash	9.486±12.834^{b}	11.160±2.367^{a}	18.561±0.410^{c}	6.312±8.628^{a}	7.470±1.470^{b}	12.413±0.211^{a}
% of Na	0.870±0.801^{a}	0.835±0.048^{a}	1.436±0.0303^{b}	9.091±12.782^{a}	10.936±2.936^{c}	18.13±0.052^{b}
% of K	15.612±21.996^{c}	18.804±4.514^{a}	31.166±0.058^{b}	10.92±15.337^{a}	13.126±3.126^{c}	21.76±0.07^{b}
% of Ca	0.453±0.570^{b}	0.511±0.083^{c}	0.856±0.049^{a}	0.075±0.084^{a}	0.080±0.006^{a}	0.135±0.015^{b}
% of Mn	0.495±0.661^{c}	0.5781±0.117^{b}	0.963±0.027^{a}	0.014±0.012^{a}	0.013±0.001^{b}	0.023±0.006^{b}
% of Cr	0.660±9.995^{b}	0.756±0.136^{a}	1.263±0.056^{c}	2.224±2.982^{a}	2.603±0.535^{b}	4.333±0.115^{c}
% of Zn	7.155±9.995^{b}	8.575±2.008^{a}	14.223±0.087^{c}	8.210±11.402^{b}	9.806±2.256^{a}	16.273±0.148^{c}

Analysis of carcass composition in Rita rita

Apparent crude protein and crude fat (%)

The values of protein in *Rita rita* 30.819±43.431 and 37.125±8.918 was observed in River I and River II and61.53±0.108 was observed in hatchery. The minimum value was observed in hatchery61.53±0.108.The maximum value was observed in river II (37.125±8.918). The results indicate that the maximum value of crude protein was observed in river II and minimum in hatchery. The values of fat in *Rita rita*11.341±15.964 and13.652±3.268 was observed in River I and River II and (22.63±0.052) was observed in hatchery. The minimum value was observed in River II (13.652±3.268). The maximum value was observed in hatchery (22.63±0.052).

Apparent moisture and ash (%)

The values of moisture in *Rita rita* were observed 0.425±0.496 and 0.46±0.049 in River I and River II and 0.776±0.075 in hatchery. The results indicate that the maximum value of Moisture was observed in River I River II and hatchery which were 0.425±0.4960, 0.46±0.049 and 0.425±0.4960.The values of ash in *Rita rita* 6.312±8.628 and 7.470±1.637 was observed in River I and River II and 12.413±0.211was observed in hatchery. The results indicate that the maximum value of ash was observed in hatchery and river I. and minimum in river II. Significantly ($p<0.05$) higher ash was present in hatchery than river.

Apparent Na and K (%)

The values of Na in *Rita rita* 9.091±12.782 and 10.936±2.609 was observed in River I and River II and (18.13±0.052) was observed in hatchery.

The minimum value was observed in River II (10.936±2.609). The maximum value was observed in River I (9.091±12.782). The results indicate that the

maximum value of Na observed in river I and minimum in river II. Significantly ($p<0.05$) higher Na was present in river catfish than farmed. The values of K in *Rita rita*10.92±15.337and13.126±3.126 was observed in River I and River II and (21.76±0.07) was observed in hatchery. The minimum value was observed in River II (13.126±3.126). The maximum value was observed in River I (10.92±15.337). Significantly ($p<0.05$) higher K was present in river catfish than farmed.

Apparent Ca and Mn (%)

The values of Ca in *Rita rita* 0.075±0.084 and 0.080±0.006 was observed in River I and River II and (0.135±0.015%) was observed in hatchery. The minimum value was observed in hatchery (0.135±0.015). The maximum value was observed in hatchery 0.135±0.015 and River II0.080±0.006. The results indicate that the maximum values of Ca were observed in river I and river II and minimum in hatchery. The values of Mn in *Rita rita* 0.014±0.012 and 0.013±0.001 was observed in River I and River II and (0.023±0.006) observed in hatchery. The minimum value was observed in hatchery and River II. The maximum value was observed in River I. The results indicate that the maximum value of Mn observed in river I and minimum in river II and hatchery.

Apparent Cr and Zn (%)

The maximum value of Cr in *Rita rita* 2.224±2.982 and 2.603±0.535 was observed in River I and River II and 4.333±0.115 was observed in hatchery. The minimum value was observed in hatchery4.333±0.115. The maximum value was observed in river I 2.224±2.982. Significantly ($p<0.05$) higher Cr were present in river catfish than farmed. The values of Zn in *Rita rita* 8.210±11.402and9.806±2.256 was observed in River I and River II and (16.273±0.148%) was observed in hatchery. The minimum value was observed in hatchery16.273±0.148. The maximum value was observed in River II 9.806±2.256. Significantly ($p<0.05$) higher Zn were present in river catfish than farmed.

Discussion

The proximate composition determination involves the estimation of crude protein, crude fat, moisture and ash. The proximate mineral composition determination involves sodium (Na), potassium (K), Calcium (Ca), Maganese (Mn), Cromimum (Cr), Zine (Zn) evaluation. The proximate compositions from edible tissues were determined in triplicate and the results were tabulated. The findings are in accordance with the findings of FAO (2015) for freshwater fish. The relatively high to moderate percentage of crude protein may be attributed to the fact that these fishes are good source of protein but the differences observed among the selected species could be as a result of fish consumption or absorption capability and conversion potentials of essential nutrients from their diets or their local environment. Protein contents were decreased with increase in weight as large fish require low level of proteins and higher level of energy than small fish which is in agreement with the findings of Jimmy *et al.* (1973). Similar findings were revealed by Fawole *et al.* (2007), Jabeen and Chaudhry (2011) and Onyia *et al.* (2010). The differences in fat levels in the fish tissues could have been due to the impact of food (Oniya *et al.*, 2010). There was a positive relationship between increase in fat contents and the body weight of fish which is in agreement with the study of Naeem and Salam (2010).Farmed fish muscle showed higher ($p<0.01$) total lipid content thanits wild counterparts. They opined that the feed offered to farmed specimen had direct impact on its body fat increments. Earlier, Boujard *et al.* (2004) validate our findings that higher moisture and lower protein and fat contents is a characteristic feature of wild fish populations. Previous and current studies confirm that moisture and protein and lipids are inversely related to each other. The ash contents in *C. idella* and *R. rita* were recorded in good agreement with the previous studies (Kalita *et al.*, 2008; Naeem and Salam, 2010).

The ash content in the analyzed Chenab fishes is an indication of copious amount of mineral contents in fish which is in harmony with the findings of Oniya *et al.* (2010).

All the fish samples examined in this study contained appreciable concentrations of macro elements likes, sodium, potassium, manganese, calcium, Cromium and zinc, suggesting that these fishes could be used as good sources of minerals. Na, K, Mn, Ca, Cr and Zn are the essential minerals in human nutrition. The presence of appreciable concentration of Na, K and Mg recorded in this study suggests that Chenab fishes are good source of Na, K and Mn, Ca, Cr and Zn. The concentration of Na, K, Mn, Ca, Cr and Zn reported in this study was within the limits of FAO (2015) values for fish muscles. These findings were in harmony with the finding of Hei and Sarojnalini (2012).

The pattern of elemental concentration in the carcass Na>K>Ca>Mn>Cr>Zn is contrary to reports of some workers in some other environmental setting. For example, Sadiku and Oladimeji (1991) reported a decreasing order of K> Na>Mn>Ca in the carcass of *C. idella* and *R. rita* while Ako and Salihu (2004) reported lack of well-defined decreasing order of magnitude in major element evaluated on the same fish from another environment. Zinc is an essential element for mammal, fish and other organisms (Eisler, 1993). There is no FDA action level for zinc in fish tissue. Diets containing Zn between 80-90ppm however caused digestive problems and decreased serum cholesterol levels in human (Eisler, 1993). Fish with diets deficient in Zn can experience reduced growth and increased mortality. Variations in the concentration of minerals in fish muscles could be due to their concentration in the water bodies where they live (Window *et al.*, 1987; Ali *et al.*, 2001), the fish physiological state (Ako and Salihu, 2004) or the ability of the fish to absorb the elements from their diets and the water bodies. Microbiological activities in the aquatic environment, feeding habits and age of fish have also impact on elemental concentrations in fish. Even within a species of fish, mineral retention depends mainly on the feed and the feeding rate, interaction with the water environment. Window *et al.*, (1987) concluded that although anthropogenic activities might elevate the concentration of metals in the environment. The accumulation in the muscle tissue of fish might be regulated biochemically, to exclude toxic concentration.

Conclusion

The present study showed that there is a significant difference ($P<0.05$) between the studied fish species *Ctenopharyngodon idella* and *Rita rita*. Body composition and mineral analysis of *C. idella* and *R. rita* revealed that the mean concentrations values of protein, fat, moisture, ash and minerals (Na, K, Ca, Mn, Cr, Zn) in both fish species were significantly different ($P<0.05$) from each other. Moreover, variations also exist between the specimens of the same species for all the constituents. The variations could be due to certain factors such as their different habitats, availability of food, water quality etc. It is concluded that riverine system can provide healthy fishes in term of mineral and nutrients as compared to the fish cultured in hatcheries.

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