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Comparative study of body composition of four fish species in relation to pond depth

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ABSTRACT: Fish specimen of *Labeo rohita, Cirrhinus mrigala, Hypophthalmicthys molitrix* and *Catla catla* were sampled from three ponds of different depths (152 cm, 122 cm and 76 cm) to compare the body composition of these species in relation to pond depth. There was significant ($P < 0.001$) effect of pond depth on water, ash, organic, fat and protein contents (all % wet and dry body weight). It was observed that pond depth has significant effect ($P < 0.01$) on condition factor in pond B (122 cm depth) and no effect in pond A and C. Maximum mean values of body composition were observed in *Labeo rohita* in all the three ponds. Present study demonstrates that fish cultured in ponds of different depths have different values of protein which can help guide the farmers to select best pond depths to produce protein rich fish.

Key words: *Fish species, body composition, pond depth, water*

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INTRODUCTION

The main body constituents of the fish include water, lipid, ash and protein. Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis (Cui and Wootton 1988, Love 1980, Wootton 1990). The live weight of majority of fish usually consists of about 70-80% of water, 20-30% of protein and 2-12% of lipid (Love 1980). However, these values may vary considerably within and between species, and also with size, sexual condition, feeding, time of the year and physical activity. The distribution of these substances among the various organs and tissues of the body may also show considerable differences (Weatherley and Gill 1987). The term growth signifies change in magnitude. The variable undergoing change may be the length or other physical dimensions, including volume, weight, or mass either of an organism's whole body or its various tissues or it may relate to protein, lipids or other chemical constituent of the body. Growth may also relate to the change in the number of animals in population (Jhingran and Pullin 1985). Proximate body composition is the analysis of water, fat, protein and ash contents of fish (Love 1970). The percentage of water is good indicator of its relative contents of energy, proteins and lipids. The lower the percentage of water, greater the lipids and protein contents and higher the energy density of the fish (Dempson et al. 2004). It means determining the relative amount of water in the fish one can obtain relative estimates of the energy, fat and lipid contents (Jonsson and Jonsson, 1998, Salam *et al*. 1993, Salam and Davies 1994). The Catla, Rohu, and Mrigal are all fast growing and highly esteemed food fish of the continent. Fish has assumed great importance as a result of anti-cancerous effects, minimized risk of heart ailments and consequently prolongs life expectancy (Jhingran and Pullin 1985, Kulikove 1978). The fish can convert food in the body tissues more efficiently than any other form of animals. The reason for superior food conversion efficiency of fish is due to it assimilation of protein rich diet because of their lower dietary energy requirements. The present study was designed to compare the body compositions of four fishes species cultured at different pond depths. There is an increasing problem of water shortage in Pakistan under the current dry spell. It is very expensive to keep the level of water in aquaculture ponds. If some species are performing better in specific water table then farmers can be encouraged to culture those species in those ponds to get fish with desirable body contents. Fish species were collected from Abdullah Fish Farm, Muzaffargarh, Pakistan, during 2004.

Analyses of body composition was done at Institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan following shipping the specimens to lab.

MATERIALS AND METHODS

Four fish species were sampled from Abdullah Fish Farm, Muzaffargarh, Pakistan from three ponds with depths of 152 cm (Pond A), 122 cm (Pond B) and 76 cm (Pond C). The fish species collected included nine samples each of *Catla catla, Cirrhinus mrigala, Hypophthalmicthys molitrix,* and *Labeo rohita*. All these specimens were caught with the help of a cast net. These fishes were transported in plastic containers to the lab., where they were removed and killed with a blow on the head. After the fish became motionless they were blotted dry with a paper towel. All specimens were weighed on an electronic digital balance (Chyo, Japan). Total body length was measured using a Perspex measuring tray fitted with a sheet of millimeter ruler. All measurements were made from the tip of the maxilla to the longest caudal fin ray. Details of experimental procedures are provided elsewhere (Ali *et al.* 2005). Water content was determined by placing the whole fish in a pre-weighed aluminum foil tray for drying in an electric oven at 65-80 ^{o}C till constant weight. Ash content was estimated by burning 500 mg of sample in a pre-weighed heat resistant China clay crucible placed in a Muffle furnace for 7 hours at 500^{o}C and reweighed after cooling. Fat content was estimated by dry extraction following the method of Bligh and Dyer (1959), and Salam and Davies (1994). Powdered dry tissue (3 mg) was mixed into 10 ml solution of chloroform and methanol (in the ratio 1:2), and stirred with a glass rod. The resultant mixture was left over night and then centrifuged. After centrifugation, the clear supernatant was removed carefully into washed, dried and pre-weighed small bottles. These bottles were then put in an oven at 40 to 50^{o}C to evaporate the solvent leaving the lipid fraction. Total protein in dry mass was calculated by the difference method from the mass of other main

Table 1: Body constituents of four fish species sampled from pond A (152 cm. depth)

Body constituents	Catla catla	Cirrhinus mrigala	H. molitrix	Labeo rohita
Water	66.750 (0.340)	69.523 (0.351)	71.060 (0.394)	66.757 (0.369)
Ash (dry wt.)	16.667 (1.000)	18.193 (0.495)	16.667 (0.577)	9.664 (0.583)
Ash (wet wt.)	6.647 (0.335)	5.583 (0.175)	4.873 (0.167)	3.220 (0.190)
Organic contents (dry wt.)	80.007 (1.000)	81.507 (0.495)	83.333 (0.577)	90.337 (0.583)
Organic contents (wet wt.)	26.580 (0.310)	24.670 (0.150)	24.379 (0.172)	30.130 (0.191)
Fat (dry wt.)	20.663 (1.149)	27.323 (1.115)	24.000 (0.000)	15.990 (0.000)
Fat (wet wt.)	6.860 (0.381)	8.270 (0.346)	7.020 (0.000)	5.330 (0.000)
Proteins (dry wt.)	59.330 (1.528)	54.167 (1.258)	59.333 (0.577)	74.333 (0.577)
Proteins (wet wt.)	19.723 (0.150)	16.393 (0.383)	17.360 (0.173)	25.127 (0.508)
Condition factor	1.480 (0.306)	1.140 (0.145)	1.180 (0.155)	1.347 (0.362)

All the values are in percentage except for condition factor. Standard deviations are given in parenthesis

Table 2: ANOVA table showing the comparison of body constituents of four fish species sampled from pond A (152 cm. depth)

Body constituents	df	MS	F	P
Water	3,8	13.700	103.35	<0.001***
Ash (dry wt.)	3,8	62.594	130.51	<0.001***
Ash (wet wt.)	3,8	6.210	119.77	<0.001***
Organic contents (dry wt.)	3,8	62.594	130.51	<0.001***
Organic content (wet wt.)	3,8	21.015	545.87	<0.001***
Fat (dry wt.)	3,8	70.245	105.89	<0.001***
Fat (wet wt.)	3,8	4.3542	65.670	<0.001***
Proteins (dry wt.)	3,8	227.520	198.56	<0.001***
Proteins (wet wt.)	3,8	45.849	263.99	<0.001***
Condition factor	3,8	0.074	1.090	0.406 n.s

Significance level: *** P<0.001, N.S. = non-significant constituents like ash, lipid and water (Caulton and Bursell 1977; Dawson and Grimm 1980; Salam and Davies 1994; Dempson *et al.,* 2004). Carbohydrates do not form a major component of fish and thus are generally neglected due to their negligible amounts (Elliott 1976; Caulton and Bursell 1977; Salam and Davies 1994). Data were analyzed statistically using analysis of variance procedures, and means were compared with the LSD multiple mean comparison test at $P \leq 0.001$ unless otherwise stated.

RESULTS

Response of various fish species in pond A (152cm depth)

It was observed that depth of pond A (5 feet) had a highly significant ($P < 0.001$) effect on various body compositions (both dry and wet body weight) in fish of all four species, but there was no effect on condition factor (Table 2). Minimum water content was observed in *Catla catla* and *Labeo rohita* cultured in pond A, indicating maximum gain in body composition followed by *Cirrhinus mrigala* and *Hypophthalmicthys molitrix.* Ash and fat contents (dry and wet weight) were highest in *Cirrhinus mirigala* while maximum protein contents (dry and wet weight) were observed in *Labeo rohita* (Table 1). *Labeo rohita* and *Catla catla* showed overall better growth among the four species in 152 cm deep pond.

Response of different fish species in pond B (122 cm depth)

It was observed that depth of pond B (122 cm) had a highly significant ($P < 0.001$) effect on all the body composition (both dry and wet body weight) and significant effect ($P < 0.01$) on condition factor in fish of all four species (Table 4). Minimum water content was observed in *Labeo rohita* cultured in pond B, indicating maximum gain in body composition followed by *Catla catla*, *Hypophthalmicthys molitrix* and *Cirrhinus mrigala.* Ash content (dry and wet weight) was maximum in *Catla catla* and minimum in *Labeo rohita.* Highest values organic and protein contents were observed in *Labeo rohita* while *Catla catla* showed minimum value of organic content and *Cirrhinus mirigala* showed the lowest protein content (dry and wet weight). *Labeo rohita* showed overall better growth among the four species in 122 cm deep pond (Table 3).

Response of different fish species in pond C (76 cm depth)

It was observed that depth of pond C (76 cm) had a highly significant ($P < 0.001$) effect on all the body composition (both dry and wet body weight) and no effect on condition factor in fish of all four species (Table 6). Minimum water content was observed in *Labeo rohita* cultured in pond C, indicating maximum gain in body composition followed by *Catla catla*, *Cirrhinus mrigala* and *Hypophthalmicthys molitrix.* Ash content (dry and wet weight) was maximum in *Catla catla* and minimum in *Labeo rohita.* Highest organic content (dry and wet weight) was observed in *Labeo rohita* and minimum in *Catla catla.* Organic and protein contents were maximum in *Labeo rohita* while these were minimum in *Catla catla* and *Hypophthalmicthys molitrix*. *Hypophthalmicthys molitrix* showed maximum and *Labeo rohita* minimum fats contents (dry and wet weight) (Table 5).

DISCUSSION AND CONCLUSION

Readily and easily measured growth is one of the more complex activities of organisms.

Table 3: Body constituents of four fish species sampled from pond B (122 cm. depth)

Body constituents	Catla catla	C. mrigala	H. molitrix	Labeo rohita
Water	65.637 (0.200)	73.150 (0.080)	69.190 (0.240)	63.553 (0.075)
Ash (dry wt.)	20.490 (0.500)	18.993 (1.005)	16.333 (0.577)	13.323 (0.577)
Ash (wet wt.)	7.020 (0.170)	5.097 (0.265)	5.033 (0.179)	4.583 (0.213)
Organic contents (dry wt.)	79.510 (0.500)	81.007 (1.005)	83.667 (0.577)	86.667 (0.577)
Organic contents (wet wt.)	27.250 (0.170)	21.740 (0.270)	25.777 (0.179)	31.580 (0.208)
Fat (dry wt.)	26.657 (3.055)	24.657 (1.155)	29.333 (2.309)	18.663 (2.315)
Fat (wet wt.)	8.450 (0.398)	6.620 (0.311)	9.040 (0.710)	6.797 (0.837)
Proteins (wet wt.)	54.833 (1.258)	56.333 (1.528)	54.327 (2.076)	68.000 (1.732)
Proteins (dry wt.)	18.797 (0.432)	15.120 (0.412)	16.737 (0.640)	24.777 (0.635)
Condition factor	2.220 (0.502)	0.993 (0.180)	1.197 (0.150)	1.227 (0.160)

All the values are in percentage except for condition factor. Standard deviations are given in parenthesis

Table 4: ANOVA table showing the comparison of body constituents of four fish species sampled from pond B (122 cm. depth)

Body Constituents	df	MS	F	P
Water	3,8	53.242	1940.17	<0.001***
Ash (dry wt.)	3,8	29.791	61.85	<0.001***
Ash (wet wt.)	3,8	3.109	70.34	<0.001***
Organic contents (dry wt.)	3,8	29.712	61.68	<0.001***
Organic contents (wet wt.)	3,8	49.519	1118.88	<0.001***
Fat (dry wt.)	3,8	61.670	11.55	<0.001***
Fat (wet wt.)	3,8	4.338	11.88	<0.001***
Proteins (dry wt.)	3,8	125.74	44.80	<0.001***
Proteins (wet wt.)	3,8	53.507	182.98	<0.001***
Condition factor	3,8	0.909	10.90	0.003**

Significance level: ** P<0.01, *** P<0.001

Table 5: Body constituents of four fish species sampled from pond C (76 cm. depth)

Body Constituents	Catla catla	Cirrhinus mrigala	H. molitrix	Labeo rohita
Water	72.137 (0.065)	70.750 (0.230)	72.960 (0.160)	66.873 (0.091)
Ash (dry wt.)	19.663 (0.583)	17.990 (0.100)	15.990 (0.090)	12.656 (0.577)
Ash (wet wt.)	5.477 (0.161)	5.260 (0.009)	4.3200 (0.010)	4.190 (0.190)
Organic contents (dry wt.)	80.333 (0.577)	82.010 (0.014)	84.000 (0.000)	87.343 (0.577)
Organic contents (wet wt.)	22.373 (0.162)	23.980 (0.001)	22.700 (0.001)	28.940 (0.191)
Fat (dry wt.)	19.993 (4.005)	23.990 (0.001)	26.657 (2.309)	17.327 (2.315)
Fat (wet wt.)	5.567 (1.115)	7.010 (0.001)	7.200 (0.623)	5.740 (0.762)
Proteins (dry wt.)	60.333 (4.041)	58.000 (0.001)	57.333 (2.309)	70.000(2.646)
Proteins (wet wt.)	16.803 (1.122)	16.960 (0.001)	15.493 (0.629)	23.193 (0.877)
Condition factor	1.733 (0.220)	1.060 (0.135)	1.300 (0.175)	1 .500 (0.488)

All the values are in percentage except for condition factor. Standard deviations are given in parenthesis

Table 6: ANOVA table showing the comparison of body constituents of four fish species sampled from pond C (76 cm. depth)

Body Constituents	df	MS	F	P
Water	3,8	21.816	959.29	<0.001***
Ash (dry wt.)	3,8	27.236	161.79	<0.001***
Ash (wet wt.)	3,8	1.271	81.46	<0.001***
Organic contents (dry wt.)	3,8	27.245	163.47	<0.001***
Organic contents (wet wt.)	3,8	27.747	1777.68	<0.001***
Fat (dry wt.)	3,8	51.510	7.71	<0.001***
Fat (wet wt.)	3,8	2.140	3.87	<0.001***
Proteins (dry wt.)	3,8	103.190	14.40	<0.001***
Proteins (wet wt.)	3,8	35.717	58.96	<0.001***
Condition factor	3,8	0.247	2.93	0.099 n.s

Significance level: *** P<0.001, N.S. = non-significant

It represents the net outcome of series of behavioral and physiological processes that begins with food intake (the consumption of an appetitive behavior) and terminates in deposition of animal substance (Brett *et al.,* 1969).

The analysis of four main tissue constituents that is protein, water, lipids and ash contents is some times described " approximate analysis" (Love 1970). Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis (Love 1970, 1980; Weatherly and Gill 1987). Lipids are regarded as one of the most important food reserve contributing to the condition and this has led to the use of fat indices as a measure of relationship b/w percent water and percent fat (Sinclair and Duncan 1972). Such estimates are used simply because the measurement of water is easy and rapid. These relationships have been shown to exist in various fish species and have been extensively used for predictive estimates (Brett *et al.* 1969; Iles and Wood 1965, Salam *et al.* 1993).

The information obtained on fats, protein and minerals contents and how they vary in relation to size and condition factor are important for the fish used as food by the consumers. It also facilitates the selection of most appropriate species having higher protein contents and optimum size and condition for human consummation. This information can helpful to the overall techniques and knowledge of aquaculture in country (Dempson *et. al*. 2004*)*. The body composition is used as indicator to assess the nutritional status and condition of fish. Based on the results of body composition, it was found that *Labeo rohita* performed better in pond of all depths indicating that growth of *Labeo rohita* is independent of pond depth. Significant differences among body composition were observed when various fish species were compared based on the pond depth. It was observed that body composition like ash, fat, organic and protein contents vary significantly in four fish species in relation to depth. It was also noted that fish of same species have different values of body composition in ponds of different depths (Tables 1, 3 and 5). Generally fish is considered as a rich source of protein. Present study demonstrates that fish cultured in ponds of different depths have different values of protein which can help guide the farmers to select best pond depths to produce protein rich fish.

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REFERENCES

Ali, M., Iqbal, F., Salam, A., Iram, S. and Athar, M., (2005). Comparative study of body composition of different fish species from brackish water pond. Int. J. Environ. Sci. Technol. Submitted.

*Brett, J. R., Shelbousne, J. E. and Shoop, C. T., (1969). Growth rate and body composition of fingerling socheye salmon Oncorhynchus mesha in relation to temperature and ration size. J. Fish Res. Board Can., **26**, 2364-2394.*

*Bligh, E. G. and Dyer, W. J., (1959). A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., **37**, 911-917.*

*Caulton, M. S. and Bursell, E., (1977). The relationship between condition and body composition in young Tilapia rendalli (Boulenger). J. Fish Boil., **11**, 143-150.*

*Cui, Y. and Wootton, R. J., (1988). Effects of ration, temperature and body size on the body composition, energy content and condition of Minnow (Phoxinus phoxinus). J. Fish Biol., **32**, 749-764.*

*Dawson, A. S. and Grimm, A. S., (1980). Quantitative seasonal changes in the protein, lipid and energy contents of carass, overies and liver of adult female (Pleuronectes platena L.). J. Fish Biol., **16**, 493.*

*Dempson, J. B., Schwar,z C. J., Shears, M. and Furey, G., (2004). Comparative proximate body composition of Atlantic salmon with emphasis on parr from fluvial and lacustrine habitats. J. Fish Biol., **64**, 1257-1271.*

*Elliot, J. M., (1976). Body composition of brown trout (Salmo trutta L.) in relation to temperature and ration size. J. Anim. Ecol., **45**, 273-289.*

*Iles, I. D. and Wood, R. J., (1965). The fat/water relationship in north sea herring, Clupea harengus and its possible significance. J. Marine Boil. Assoc., UK, **45**, 353-366.*

Jhingran, V. G. and Pullin, R. S. V., (1985). A hatchery manual for the common, Chinese and India major carps. Asian Development Bank, Manila, Philippines. 16-17.

*Jonsson, N. and Jonsson, B., (1998). Body composition and energy allocation in life history stages of brown trout. J. Fish Boil., **53**, 1313.*

Kulikove, D. I., (1978). Production of meal, oil and protein, vitamin preparation in the fishing industry. Amerind Publishing Co., New York, USA.

Love, R. M., (1970). The chemical biology of fishes. Academic Press, I, London, UK.

Love, R. M., (1980). The chemical biology of fishes. Academic Press, II, London, UK.

*Salam, A., Ali, M., Chatta, A. M. and Zaman, Q. U., (1993). Growth performance of cultured exotic Silver carp (Hypophthalmicthys molitrix) under semi- intensive farming: An ecological approach. Acta Sc., **3**, 89-100.*

*Salam, A. and Davies, P. M. C., (1994). Body composition of Northern Pike (Esox lucius L.) in relation to body size and condition factor. J. Fish Res., **19**, 193-204.*

*Sinclair, A. R. E. and Duncan, P., (1972). Indices of condition in tropical ruminants. East Africa. Wild J., **10**, 143-149.*

Weatherley, A. H. and Gill, H. S., (1987). The biology of fish growth. Academic Press, London, UK.

Wootton, R. J., (1990). Ecology of Teleost fishes. Chapman and Hall, London, UK.