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Comparative Study on Body Composition of Two Chinese Carps, Common Carp (*Cyprinus carpio*) and Silver Carp (*Hypophthalmichthys molitrix*)

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Abstract: Fish is influencing almost every niche of human life. It is considered as one of the most important animals, on account of its widespread role economically, nutritionally and as a medicinal tool. Intensive research about different aspects of fish has been under its way all around the globe. The current study was conducted on two fish species *Cyprinus carpio* and *Hypophthalmichthys molitrix* available to consumer in fish market and hotels at Timergara, District Dir Lower Khyber Pakhtunkhwa Pakistan. This study was designed to evaluate the body composition of these two widely consumed Chinese carps. For common carp water content, protein (Dry), protein (Wet), Fat (Dry), Fat (Wet), Organic content (Dry), Organic content (Wet), Ash (Dry) and Ash (Wet) ranged (in percentages) from 65.09-67.1, 65.9-66.8, 24.7-25.4, 18.9-19.3, 7.69-8.45, 85.6-86.7, 28.97-29.56, 8.98-9.99 and 3.1-3.89 respectively, while for silver carp these constituents ranged from 74.87-76.8, 64.5-68.7, 24.89-26.5, 18.89-20.1, 7.89-8.9, 86.7-89.4, 27.6-29.7, 12.38-13.86 and 4.52-4.97 respectively. Results showed that these fish are having high nutritive values. The present study also revealed that there is a significant difference ($P<0.05$) between body composition of the studied fish species. Moreover, variations also exist between the specimens of the same species for all the constituents.

Key words: Dir Lower · Common Carp · Silver Carp · Body Composition · Proximate Analysis

INTRODUCTION

Fish is a stapled food item [1] due to its great importance both nutritionally and medically [2]. It is also a meat of choice as it is having good taste, high growth upholding values and is easily digestible [3]. Fish has gained high attention due to its effectiveness in cancer, heart ailment, wound healing and prolonging life expectancy [4-8]. Fish is influencing all spheres of human life. Nutritionally, it is one of the most important creatures. Fish diet supply vitamins such as A, D and E and other macro nutrients, protein, fats, principle minerals such as Sodium, Iron, Calcium, Phosphorus, Magnesium, Iodine and many other elements [9-11]. Fish meat is a rich source of protein [12], having several essential amino acids, traces of vitamin B complexes and fats [13-15]. Ullah and Ahmad [16] comprehensively reviewed medical and nutritional importance of fish.

Fish is capable of converting food in body tissues more proficiently as compare to all other animals. The reason for this higher food conversion adeptness is attributed to their lower dietary energy requirements, which is due to protein rich diet assimilation [17]. This makes the fish meat as a high value balanced diet. Fish is having almost all the important and necessary constituents required by humans. For evaluating body value of fish, its body compositional study is carried out through proximate analysis [18].

Body composition of any edible animal, including fish, is a key indicator of its biological and functional condition. Measuring body composition is the key factor for evaluating the physiological condition, but is a time consuming process [19]. Proximate analysis for quantifying body composition of a fish is done through gaging different ingredients such as protein, fat, water content, ash content, fibre and organic contents of that

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fish [20]. On account of the presence in negligible amount carbohydrate and non-protein compounds present are typically ignored [21].

Every component of the body works as a good indicator for specific contents [22]. Moisture content, water, indicates its energy contents relatively such as lipids and proteins. In other words water is in inverse proportion to these two, such as a lower percentage of water mean a greater amount of lipids as well as protein and vice versa [23, 24]. However, these are not fixed values, as these differ considerably interspecifically and intraspecifically. It also varies on the basis of age, size, physical activity, feeding season, reproductive status, fishing season and sexual condition [25-31]. Protein is the major and most important content of fish meat and lean to differ in a small amount in healthy fish [32].

A lot of work is being carried out all around the world on body composition of different fish species such as rainbow trout [33], Tilapia [34-37], European Seabass [38], *Notopterus notopterus* [39], Atlantic salmon [24, 40, 41], northern pike [42], brown trout [43, 44], Kutum [45], herring fish [46], carps [47], *Corgenous artedi* [48], yellowtail [49], turbot [50], socheye salmon [51], lantern fish [52], *Clarias batrachus* [53], trunk fish [54], Trash fishes [55, 56], *Clarius garipenus* and *Synodontis schall* [57], *Labeo rohita* [58], bronze gudgeon [59], *Sarotherodon galileus* [60], *Clarias lazera* [61], *Symphysodon aequifasciata* [62], Gangetic Sillago [63] and *Scomberoides* fishes [64]. The present study was conducted to know about the body composition of two fish species, *Cyprinus carpio* and *Hypophthalmichthys molitrix*, available to consumer in local fish Market and hotels at Timergara District Dir Lower, Khyber Pakhtunkhwa Pakistan.

MATERIALS AND METHODS

Sampling Area: District Dir Lower is situated with Longitudes and Latitudes of 34°, 37' to 35°, 07' North and 71°, 31' to 72°, 14' East respectively, with approximate 2700 feet (820 meter) above mean sea level experiencing an annual rainfall of 1468.8mm and 253.7mm during December and March respectively [65]. District Dir Lower is bounded by District Dir Upper to the Northern Side, by Bajaur and Afghanistan to the Western side, by District Malakand to the Southern side and by District Swat to Eastern side [66]. Timergara is the main and most important city of District Dir Lower, home to many big markets, hotels, banks, schools, colleges, technical colleges, hospitals, a post graduate college and a university campus. Fish specimens were bought of fish market and hotels available to consumers at Timergara, District Dir Lower Khyber Pakhtunkhwa Pakistan. Three sets, consisting of three specimens each, were collected. One set of fishes was collected from the fish market while two sets were collected from two hotels situated in the study area. Figure 1 shows the study area, modified from Ullah *et al.* [67].

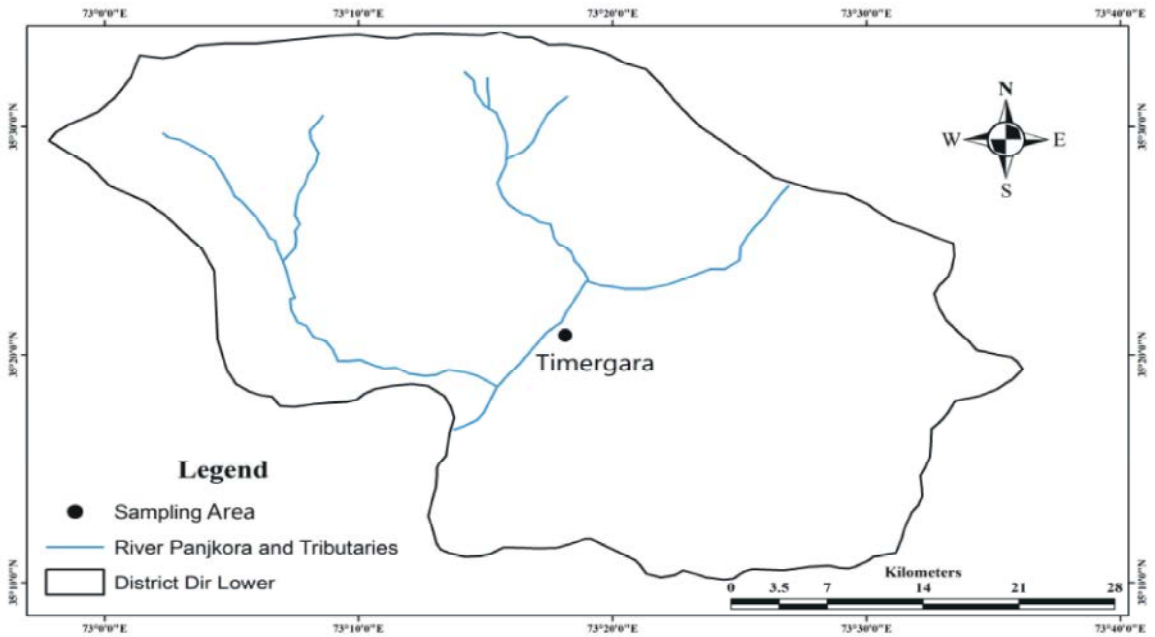

Fig. 1: Map showing the study area

Test Animals: The present study was conducted on two widely utilized edible Chinese carps, common carp (*Cyprinus carpio*) and silver carp (*Hypophthalmichthys molitrix*).

Sample Analysis: For evaluating body composition of these fish species, standard procedure and protocol of AOAC [68] was adopted.

Statistical Analysis: All statistical analysis, Mean, Standard deviation, Pearson Correlation Coefficient and Percentages, was performed using Microsoft Excel 2013. Arc GIS 9.3 Platform was used for preparing the map of the study area. T-Paired (two-tailed) Test was employed to analyze the significance of the variance among the studied fish species using SPSS version 16.

RESULTS AND DISCUSSION

Results of T-paired (two-tailed) test showed that there was a significant difference ($P<0.05$) between the body composition of common carp and silver carp (Degree of freedom: 8; t-value: -1.872; significance: 0.098). There was a difference in proximate composition among the specimens of the fish species. For common carp water content, protein (Dry), protein (Wet), Fat (Dry), Fat (Wet), Organic content (Dry), Organic content (Wet), Ash (Dry) and Ash (Wet) ranged (in percentages) from 65.09-67.1, 65.9-66.8, 24.7-25.4, 18.9-19.3, 7.69-8.45, 85.6-86.7, 28.97-29.56, 8.98-9.99 and 3.1-3.89 respectively, while for silver carp these constituents ranged from 74.87-76.8, 64.5-68.7, 24.89-26.5, 18.89-20.1, 7.89-8.9, 86.7-89.4, 27.6-29.7, 12.38-13.86 and 4.52-4.97 respectively. Tables 1 and 2 are showing the results for proximate analysis of common carp and silver carp respectively. Table 3 is showing the comparative analysis of body composition of the studied fish species. Tables 4 and 5 are showing the correlation coefficient matrix of the studied body composition constituents of common carp and silver carp respectively.

For common carp the strongest correlations ($r > 0.5$, $p = 0.001$) with water was shown by protein dry (0.998), followed by ash dry (0.85) and protein wet (0.791) while for silver carp the strongest correlation with water included fats wet (0.857), followed by dry ash (0.812), wet protein (0.699) and dry protein (0.666). Figure 2 depicts water contents of both common and silver carp.

For common carp the strongest correlations ($r > 0.5$, $p = 0.001$) with protein dry was shown by ash dry (0.883), followed by protein wet (0.830) and fat wet (0.808) while for silver carp the strongest correlation with protein dry included protein wet (0.99), followed by organic content wet (0.997), fat dry (0.978), dry ash (0.976) and fat wet (0.955). Figure 3 shows protein (Dry) contents of both common and silver carp.

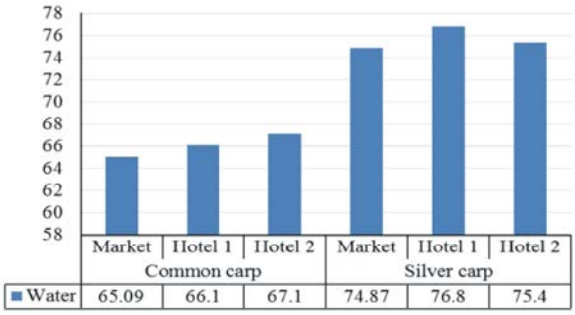

Fig. 2: Water contents of common carp and silver carp

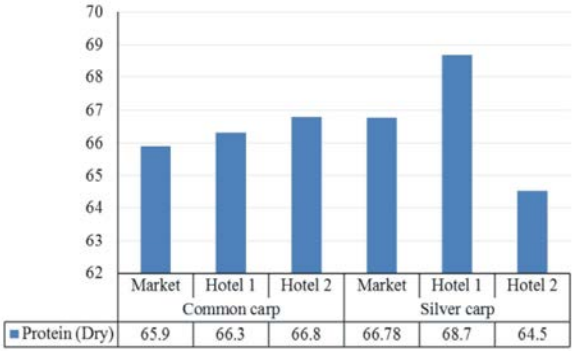

Fig. 3: Protein (Dry) of common carp and silver carp

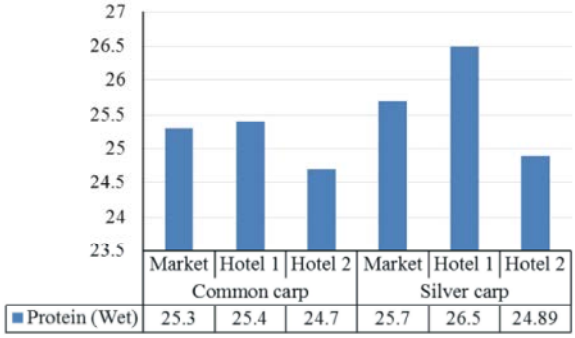

Fig. 4: Protein (Wet) of common carp and silver carp

For common carp the strongest correlations ($r > 0.5$, $p = 0.001$) with protein wet was shown by fat wet (0.999), followed by organic content wet (0.997), ash dry (0.995) and ash wet (0.893) while for silver carp the strongest correlation with protein wet included ash dry (0.985), followed by fat wet (0.968), fat dry (0.967) and ash wet (0.931). Protein wet showed perfect correlation (1.000) with organic content wet, showing strong association of both in silver carp. Figure 4 shows protein (Wet) contents of both common and silver carp.

Table 1: Body composition of Common carp, *Cyprinus carpio* All values are taken in percentages except standard deviation is footnote to the table 1. So place this statement below the table.

Body Composition	Fish Market	Hotel 1	Hotel 2	Mean	Standard Deviation
Water	65.090	66.100	67.100	66.097	1.005
Protein (Dry)	65.900	66.300	66.800	66.333	0.451
Protein (Wet)	25.300	25.400	24.700	25.133	0.379
Fat (Dry)	19.318	18.910	19.100	19.109	0.204
Fat (Wet)	8.313	8.450	7.690	8.151	0.405
Organic contents (Dry)	86.700	85.600	86.100	86.133	0.551
Organic contents (Wet)	29.100	28.970	29.560	29.210	0.310
Ash (Dry)	9.010	8.980	9.900	9.297	0.523
Ash (Wet)	3.560	3.130	3.890	3.527	0.381

Table 2: Body composition of Silver carp, *Hypophthalmichthys molitrix*

Body Composition	Fish Market	Hotel 1	Hotel 2	Mean	Standard Deviation
Water	74.870	76.800	75.400	75.690	0.997
Protein (Dry)	66.780	68.700	64.500	66.660	2.103
Protein (Wet)	25.700	26.500	24.890	25.697	0.805
Fat (Dry)	19.800	20.100	18.980	19.627	0.580
Fat (Wet)	8.170	8.900	7.890	8.320	0.521
Organic contents (Dry)	86.700	88.100	89.400	88.067	1.350
Organic contents (Wet)	28.700	27.600	29.700	28.667	1.050
Ash (Dry)	13.340	12.380	13.860	13.193	0.751
Ash (Wet)	4.590	4.520	4.970	4.693	0.242

All value are taken in percentages except standard deviation

Table 3: Body composition of Common Carp and Silver Carp

Body Composition	*Cyprinus carpio*	*Hypophthalmichthys molitrix*	Standard Deviation
Water	66.097	75.690	6.784
Protein (Dry)	66.333	66.660	0.231
Protein (Wet)	25.133	25.697	0.398
Fat (Dry)	19.109	19.627	0.366
Fat (Wet)	8.151	8.320	0.120
Organic contents (Dry)	86.133	88.067	1.367
Organic contents (Wet)	29.210	28.667	0.384
Ash (Dry)	9.297	13.193	2.755
Ash (Wet)	3.527	4.693	0.825

Values are taken in percentages except standard deviation

Table 4: Correlation coefficient matrix of the studied constituents of Common carp

	Water	Protein (D)	Protein (W)	Fat (D)	Fat (W)	O.C (D)	O.C (W)	Ash (D)	Ash (W)
Water	1.000								
Protein (D)	0.998	1.000							
Protein (W)	-0.791	-0.830	1.000						
Fat (D)	-0.536	-0.479	-0.093	1.000					
Fat (W)	-0.767	-0.808	0.999	-0.130	1.000				
O.C (D)	-0.547	-0.490	-0.080	1.000	-0.117	1.000			
O.C (W)	0.740	0.783	-0.997	0.171	-0.999	0.158	1.000		
Ash (D)	0.850	0.883	-0.995	-0.011	-0.990	-0.024	0.983	1.000	
Ash (W)	0.430	0.490	-0.893	0.531	-0.909	0.520	0.926	0.842	1.000

Bold r-Values >0.500 are significant at $P < 0.05$.

D=Dry, W=Wet, O.C=Organic contents

Table 5: Correlation coefficient matrix of the studied constituents of Silver carp

	Water	Protein (D)	Protein (W)	Fat (D)	Fat (W)	O.C (D)	O.C (W)	Ash (D)	Ash (W)
Water	1.000								
Protein (D)	0.666	1.000							
Protein (W)	0.699	0.999	1.000						
Fat (D)	0.494	0.978	0.967	1.000					
Fat (W)	0.857	0.955	0.968	0.871	1.000				
O.C (D)	0.494	-0.524	-0.485	-0.692	-0.248	1.000			
O.C (W)	-0.721	-0.997	-1.000	-0.958	-0.975	0.457	1.000		
Ash (D)	-0.812	-0.976	-0.985	-0.908	-0.997	0.326	0.990	1.000	
Ash (W)	-0.389	-0.946	-0.931	-0.993	-0.808	0.771	0.919	0.853	1.000

Bold r-Values >0.500 are significant at P < 0.05.

D=Dry, W=Wet, O.C=Organic contents

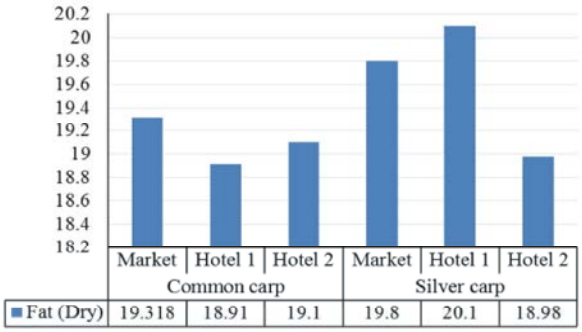

Fig. 5: Fat (Dry) of common carp and silver carp

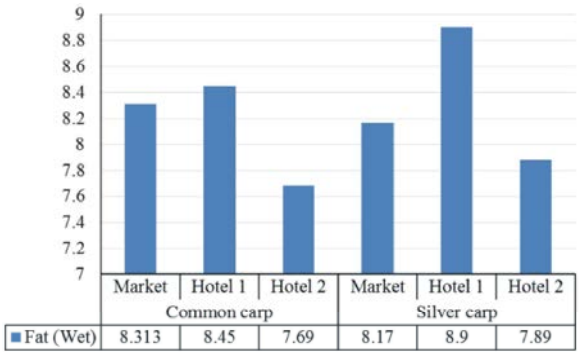

Fig. 6: Fat (Wet) of common carp and silver carp

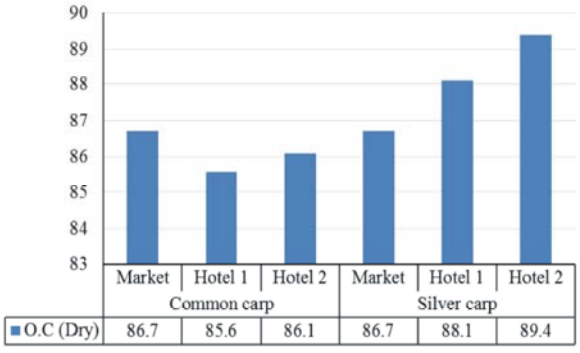

Fig. 7: Organic content (Dry) of common carp and silver carp

For common carp the strongest correlations (r > 0.5, p = 0.001) with fat dry was shown by ash wet (0.531), while for silver carp the strongest correlation with fat dry included fats wet (0.857), followed by ash wet (0.993), organic content wet (0.958), ash dry (0.908), fat wet (0.871) and organic content dry (0.692). Fat dry showed perfect correlation (1.000) with organic content dry, showing their strong association in body of common carp. Figure 5 shows fat (dry) content of common and silver carp.

For common carp the strongest correlations (r > 0.5, p = 0.001) with fat wet was shown by organic content dry (0.999), followed by ash dry (0.990) and ash wet (0.909) while for silver carp the strongest correlation with fat wet included ash dry (0.997), followed by organic content dry (0.975) and ash wet (0.808). Figure 6 shows fat (wet) contents of both common and silver carp.

For common carp the strongest correlations (r > 0.5, p = 0.001) with organic content dry was shown by organic ash wet (0.520), while for silver carp the strongest correlation with organic content dry included ash wet (0.771). For common carp the strongest correlations (r > 0.5, p = 0.001) with organic content wet was shown by both ash dry (0.983) and ash wet (0.926), while for silver carp, again the strongest correlation with organic content wet included ash dry (0.990) and ash wet (0.919). For both common carp and silver carp ash dry and ash wet showed stronger correlations (r > 0.5, p = 0.001). Ash dry shown an association with ash wet (0.842) and (0.853) for common carp and silver carp respectively. Tables 4 and 5 are showing the Correlation coefficient matrix of the studied body composition constituents for common and silver carp. Figures 7-10 are showing organic content (dry), organic content (wet), ash (dry) and ash (wet) of both the species respectively while Figure 11 depicts the overall summary of the fish species in percentages.

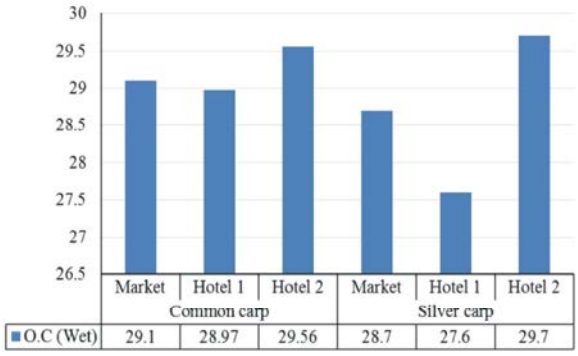

Fig. 8: Organic content (Wet) of common carp and silver carp

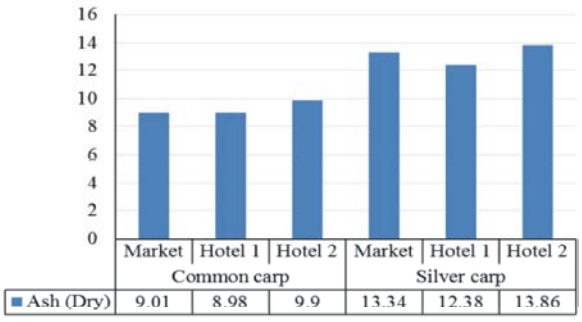

Fig. 9: Ash (Dry) of common carp and silver carp

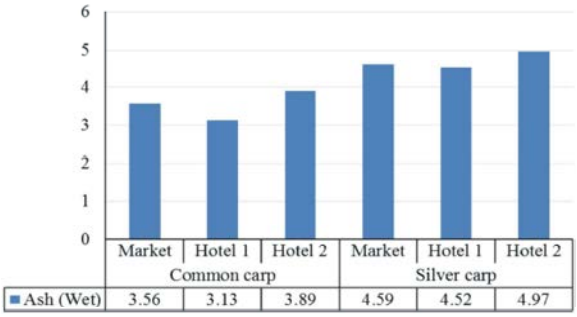

Fig. 10: Ash (Wet) of common carp and silver carp

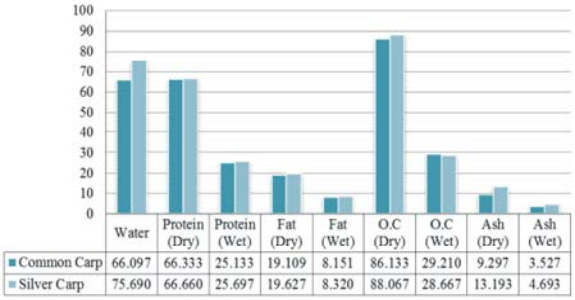

Fig. 11: Body composition of common carp and silver carp

The mean water contents in *Cyprinus carpio* were 66.097 ± 1.005, protein (dry) was 66.333 ± 0.451, protein (wet) was 25.133 ± 0.379, fat (dry) was 19.109 ± 0.204, fat (wet) was 8.151 ± 0.405, organic contents (dry) was 86.133 ± 0.551, organic contents (wet) was 29.210 ± 0.310, ash (dry) was 9.297 ± 0.523 and ash (wet) was 3.527 ± 0.381. The mean water contents in *Hypophthalmichthys molitrix* were 75.690 ± 0.997, protein (dry) was 66.660 ± 2.103, protein (wet) was 25.697 ± 0.805, fat (dry) was 19.627±0.580, fat (wet) was 8.320 ± 0.521, organic contents (dry) was 88.067 ± 1.350, organic contents (wet) was 88.067 ± 1.350, ash (dry) was 13.193 ± 0.751 and ash (wet) was 0.242 ± 0.242 (Table 3).

While carrying out proximate analysis of fish, four main constituents, water, protein, ash and lipid are described while the non-protein compounds and carbohydrates are usually ignored as these are present in a little amount [32, 69]. This study showed a high nutritive value of the fish species studied. On change in energy budgets, fish can exchange their body water [70]. The studies of Schmidt-Neilsen [71], Jobling [72] and Luo *et al*. [59] showed that same amount of reduction in body water is associated with lipid accumulation as protein by three fold. Although in our study, there is a significant difference between the body composition and nutritive value of the fish species studied, yet both species are good enough as for as nutritive worth is concern.

According to Sinclair and Duncan [73] lipids is the most pivotal reserve of food that contributes to the condition. This has led to employ fat indices to measure the association between percent fat and percent water. Water, on account of being rapid and easy to measure, this estimate is widely and commonly used. The relationship between these two ingredients has shown their existence in many species of fish, therefore it is widely used for estimates prediction [22, 44, 49]. According to Barros *et al*. [74] and Yildirim *et al.* [75] body fat contents are associated closely to gained weight and inversely linked with moisture content of the body. In this study both fish species were having variation between fat contents, which may be attributed to catchment and collection from different geographic locations [39].

Information regarding different fish contents such as protein, minerals and fats and how they vary in different fish species used is very important for the consumers. This information helps them to select the most suitable fish species because of having elevated protein contents. It also facilitates the consumer to select fish of optimum size and suitable for consumption. Moreover, this information is also helpful for knowledge and over all

systems and techniques of fisheries and aquaculture in a country [24]. In this study, common carp was having high organic content (wet) and organic content (dry) than silver carp while silver carp was richer in all other constituents than common carp. This may be due to the fact that the collected specimens of silver carp were bigger in size than common carp [76, 77].

Data about body composition is used as an indicator for assessing the condition and nutritional status of different fish species. The results showed that constituents like protein contents, fat, ash and organic contents differ in both the species. It was also noted that different specimens of the same species were also differing little and were having varying values of composition.

CONCLUSION

The present study showed that there is a significant difference ($P<0.05$) between the studied fish species, *Cyprinus carpio* and *Hypophthalmichthys molitrix*. Moreover, variations also exist between the specimens of the same species for all the constituents. The results provide up to date and important information about differences between the studied fish species regarding proximate composition. This information will help in taking necessary precautionary measures in the processing of these species from a production standpoint. It will also provide assistance for distinguishing the nutritional values and making selection based on this data from a consumer point of view.

Disclosure: None of the authors have any conflict of interest.

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