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Research Article

Relative Weight Relationship to Proximate Body Composition of Wild *Rita rita* (Hamilton, 1822)

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Authors' Contributions
SMAN supervised and guided the planning of the research work. ST executed the research experiments. TA help in writing the research article. HN help in data analysis. AG help in conduction of research experiments. AL help in results interpretation.

Keywords
Wild, Carnivorous fish, Nutrient composition, Meat, Liver

Abstract | Proximate composition of meat and internal organs composition of freshwater fish *Rita rita* was measured in this study. Three variant weight scales including ≤350g (W_1), 351-550g (W_2) and 551-750g (W_3) were selected. Among the weight groups, W_1 revealed maximum values of percent moisture compared to the W_2 and W_3. Fish of the W_3 weight group showed higher levels of crude protein and lipid percentage compared with W_1 and W_2. Highest ash (percentage) was measured in the gills of the weight group W_3 as compared to W_1 and W_2. Generally, total carbohydrates are determined by the difference of the entire proximate body composition indices, and in this study, it was found that the liver contains maximum carbohydrates (percentage) relative to other sections of the body examined. Weight group W_3 was found to have higher nutrients significantly ($p<0.05$) as compared to W_1 and W_2. Further, it is found that although the gills, liver, and gut of fish are not eaten directly by humans, but they have significant nutrient contents. The inferences of the present study would be helpful for the fish consumers in selection the best weight category and animal feed formulators.

Novelty Statement | The present study inferences will be helpful in the selection of appropriately sized fish for human consumption. Further, fish visceral organs (not consumed by humans) can be used in the formulation of nutritionally balanced diets for fish, poultry and livestock.

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Introduction

Fish is an essential component of food for consumers worldwide due to its quality nutrient profile which is imperative for proper body functioning, growth and reproduction (Ahmed *et al.*, 2015; Saoud *et al.*, 2008). *Rita rita* (Hamilton, 1822) is a fresh and brackish water carnivorous, bottom dwelling and sluggish fish species that belongs to family Bagridae and found abundantly in India, Pakistan, Bangladesh, Afghanistan, Nepal, and Mayanmar (Tripathi, 1996; Rafique and Najam-Ul-Huda, 2012). Its food mainly consists of insects, crustaceans, mollusks and small fishes (Yashpal *et al.*, 2006).

Measuring the moisture percentage in a fish is a good indicator of its relative energy contents i.e. proteins and

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fats. The lower the percentage of water, the greater the energy contents of the fish (Dempson *et al.*, 2004). To measure the water, protein, fats and ash contents of fish is known as a proximate body composition that illustrates the nutritional quality of food (Kamal *et al.*, 2007). In addition to nutritional consistency, the proximate body composition is also calculated to assess information on the health status and physiological conditions of the fish (Dempson *et al.*, 2004). Kandemir and Polat (2007) proposed that liver and muscle are two organs involved in the lipid storage. Fish liver is an excellent source of long-chain polyunsaturated fatty acids especially omega 3 family i.e. eicosapentaenoic acid and docosahexaenoic acid that minimize the risk of cardiovascular disorders. Discarding the fish liver and gut means all the nutritional properties are lost (Nathan, 2011).

Information regarding the fish proximate body composition is necessary for consumers, feed formulators and researchers for nutritional values, processing and seasonal variations, respectively (Murray and Burt, 2001; Azam *et al.*, 2004). Weatherley and Gill (1987) suggested that the various values of fish proximate body composition could be compared between varied sizes and condition factors of that fish species. Knowledge of the proximate body composition of fish is necessary for various applications of processes, species characteristics, raw material quality and providing an understanding of the sexual stage (Kamal *et al.*, 2007). Head, scales, fins, skin, gills, liver and gut are usually discarded in fish processing (Ahmed *et al.*, 2015) although these parts contain a good percentage of nutrients in terms of protein and fats that can be used in fishmeal (Celik *et al.*, 2005; Thammapat *et al.*, 2010). Liver tissues are involved in the storage of lipids and carbohydrates (Kandemir and Polat, 2007).

To compare the benefits offered by *R. rita* for consumer health and due to its popularity in the market, the present study was conducted. A little is known about the proximate body composition of meat and internal organs of *R. rita* in local and international literature. Keeping in view the above information present study was planned to measure the proximate composition of *R. rita.*

Materials and Methods

Fish sampling and measurements

A total of twenty-one individuals of *R. rita* of three different weight categories (≤350g, 351-550g and 551-750g) were captured from Trimmo Headworks-Pakistan. Morphometric indices including length, width and wet weight of each fish sample were measured at the sampling site. All the captured fish samples were transported to laboratory by placing them in ice boxes for proximate analysis.

Fish samples preparation and proximate analysis

From the ventral side of the sampled fish longitudinal cut was given and internal organs including liver, gut and gills along with meat were collected for proximate analysis by following the methods described in AOAC (2000).

Data analysis

Data were analysed by using SPSS 11.5 software. To resolve differences among means, Duncan's multiple range (DMR) tests were used. Among groups i.e. W_1, W_2 and W_3, a value of $p \leq 0.05$ was used to indicate significant difference (Ali and Kiumars, 2010).

Results and Discussion

The present study was conducted with an objective to measure the proximate body composition of wild *Rita rita* captured from Trimmu Headworks-Pakistan and compare the values of measured proximate composition with different weight i.e. ≤350g, 351-550g and 551-750g of *R. rita*. To measure the statistical difference between different sizes proximate body composition values, $P<0.05$ was used.

Comparative proximate composition of meat taken from different weight categories of R. rita

In the present study, various parameters of proximate composition i.e. moisture, crude protein, crude fat, ash and carbohydrates were measured from meat of wild captured *R. rita* and compared these measured values of proximate composition with different weight categories of *R. rita*. In meat, higher moisture contents (74.52±0.250) were measured in the smallest weight containing *R. rita* compared to larger fish. When energy i.e. protein and fat contents were compared with different weight categories, it was noted that larger weight containing fish i.e., W_3 showed higher percentage of protein (24.21±0.382) and fats (3.3±0.112) compared to smaller weight containing fish. The results of ash proportion showed gradual increase in ash percentage as the weight and size of fish increased. Carbohydrates percentage showed fluctuation because they do not measure directly as other parameters of proximate composition and only deduct from 100 by sum of all other parameter's values. Significant difference ($P<0.05$) were measured when compared all the proximate composition parameters between different weight categories within same species (Table 1).

Comparative proximate composition of gills taken from different weight categories of R. rita

Highest water contents (67.84±0.194) were measured in the gills of wild *R. rita* in weight category W_1 compared to other higher weight containing fish i.e. W_2 (66.36±0.292) and W_3 (64.23±0.199). Protein percentage in the gills were measured in the range between 17.93±0.255 to 19.54±0.218 in all the three weight categories. Results

about protein percentage further showed that W_3 weight category is best because of protein percentage because of higher (19.54±0.218) protein percentage. Similarly, W_3 weight category fish also showed maximum (3.79±0.244) percentage of fats compared to W_1 and W_2. W_3 weight containing fish showed maximum percentage of ash in gills (12.32±0.099) compared to opponent and less weight containing fish (Table 2). Significant ($P<0.05$) difference was noted when gills composition was compared between different weight categories of fish (Table 2).

Table 1: Comparison of meat proximate composition (%) in *R. rita* between different weight categories.

Parameters	Weight categories		
	W_1	W_2	W_3
Moisture	74.52±0.250a	70.23±0.208b	68.13±0.208c
Crude protein	19.79±0.232c	21.82±0.123b	24.21±0.382a
Crude fat	2.34±0.277c	2.89±0.138b	3.3±0.112a
Ash	2.41±0.124b	2.72±0.108a	2.97±0.128a
Carbohydrates	0.94±0.02b	2.34±0.095a	1.31±0.03b

Data are presented as mean±SD; within a row same letters are not significantly different ($p\leq0.05$)

Table 2: Comparison of gills proximate composition (%) in *R. rita* between different weight categories.

Parameters	Weight categories		
	W_1	W_2	W_3
Moisture	67.84±0.194a	66.36±0.292b	64.23±0.199c
Crude protein	17.93±0.255c	18.66±0.166b	19.54±0.218a
Crude fat	2.34±0.277c	3.01±0.271b	3.79±0.244a
Ash	10.91±0.245c	11.69±0.123b	12.32±0.099a
Carbohydrates	0.98±0.112a	0.28±0.179b	0.22±0.154b

Data are presented as mean±SD; within a row same letters are not significantly different ($p\leq0.05$).

Comparative proximate composition of liver taken from different weight categories of R. rita

Moisture contents in the liver of *R. rita* was measured 72.46±0.204, 71.21±0.284 and 68.93±0.243 in W_1, W_2 and W_3 weight categories, respectively. Maximum (%) protein was measured in *R. rita* belonging to weight category W_3 compared to W_1 and W_2. It was observed that maximum fat contents (6.94±0.137) were measured in liver of wild *R. rita* having higher weight (750g) compared to lower weight containing *R. rita*. Ash percentage in liver of studied fish were measured 1.08±0.209, 1.45±0.118 and 1.99±0.107 in W_1, W_2 and W_3 weight containing fish, respectively. Carbohydrates proportion were also recorded higher in liver of wild *R. rita* compared to other body parts studied in this work. Significant difference ($P<0.05$) were observed among all the proximate composition measured values in liver between different weight categories within same species (Table 3).

Table 3: Comparison of liver proximate composition (%) in *R. rita* between different weight categories.

Parameters	Weight categories		
	W_1	W_2	W_3
Moisture	72.46±0.204a	71.21±0.284b	68.93±0.243c
Crude protein	17.2±0.171c	18.21±0.199b	19.64±0.187a
Crude fat	5.93±0.208c	6.41±0.207b	6.94±0.137a
Ash	1.08±0.209b	1.45±0.118b	1.99±0.107a
Carbohydrates	3.33±0.177a	2.72±0.176b	2.5±0.154b

Data are presented as mean±SD; within a row same letters are not significantly different ($p\leq0.05$).

Comparative proximate composition of gut taken from different weight categories of R. rita

Maximum water contents (74.63±0.265) in gut were measured in W_1 weight category fish and minimum in W_3 (70.92±0.187). The proportion of gut crude protein measured in this study were recorded 16.92±0.199, 17.64±0.199 and 19.87±0.382 in W_1, W_2 and W_3 weight containing fish, respectively. Fats maximum proportion were measured 5.92±0.192 in gut of wild captured *R. rita* under W_3 weight category. Similarly, maximum (%) of ash were observed in W_3 weight holding fish compared to other weight containing fish (Table 4). When various values of gut proximate composition were compared between different weight containing fishes, significant ($P<0.05$) difference was observed as shown in Table 4.

Table 4: Comparison of gut proximate composition (%) in *R. rita* between different weight categories.

Parameters	Weight categories		
	W_1	W_2	W_3
Moisture	74.63±0.265a	72.21±0.203b	70.92±0.187b
Crude protein	16.92±0.199b	17.64±0.199b	19.87±0.382a
Crude fat	4.42±0.135c	5.23±0.153b	5.92±0.192a
Ash	1.45±0.233b	1.79±0.106a	1.96±0.172a
Carbohydrates	2.58±0.563b	3.13±0.246a	1.33±0.110c

Data are presented as mean±SD; within a row same letters are not significantly different ($p\leq0.05$).

Fish and fish products are beneficial for human health due to their nutritional properties that render them valuable foodstuffs. The present study was performed to examine the proximate body compositions of the freshwater carnivorous, bottom dwelling and sluggish fish species, *Rita rita* captured with the help of gillnets from Trimmu Headworks, Punjab, Pakistan.

A wealth of literature is available on body composition of various fish species i.e. *Esox lucius* (Salam and Davies, 1994), *Salmo gairdneri* (Grayton and Beamish, 1997), *Salmo trutta* (Jonsson and Jonsson, 1998), *Salmo salar* and *Salmo trutta* (Berg *et al.*, 2000), *Cirrhinus mrigala* (Mahboob *et al.*, 2003), *Salmo salar* (Dempson *et al.*, 2004),

Clarias gariepinus (Osibona *et al.*, 2006; Chukwu and Shaba, 2009), *Mystus bleekeri* (Naeem and Ishtiaq, 2011), *Cyprinus carpio, Labeo rohita* and *Oreochromis mossambicus* (Jabeen and Chaudary,2011), *Pangasianodon hypophthalmus* (Begum *et al.*, 2012), *Seriola dumerili* (Abdullah, 2012), *Cirrhinus mrigala* (Ahmed *et al.*, 2015) and *Labeo rohita* and *C. mrigala* by Sikandar *et al.* (2020). However, very little information is known about the body composition *Rita rita* (Abbas *et al.*, 2013).

For a fish, the proportion of water is a good indicator of its relative energy contents i.e. proteins and lipids. Significant differences ($p<0.05$) were observed in the present study for moisture contents in meat, gills, liver and gut among different weight containing *R. rita*. Highest moisture contents were measured in the smallest weight containing fish as compared to larger size fish meat, gills, liver and gastrointestinal tract. Related inferences were also reported by Hussain *et al.* (2011) in *Catla catla*, Semab (2011) in *Cyprinus carpio* and *Hypophthalmicthyes molitrix* and Ahmed *et al.* (2015) in *Cirrhinus mrigala*.

When energy i.e. protein and fats contents were compared with different weight categories, it was observed that larger weight containing fish i.e. W_3 showed higher percentage of protein and fats in all studied body parts in this study compared to smaller weight containing fish. Similar results were also described by Al-Asgah (1992) in *Oreochromis niloticus* and stated that the crude protein and fat contents had increasing trend with increase in weight and size of fish. Lesser the water (%), greater will be the protein and lipids proportion and higher the energy density of the fish (Dempson *et al.*, 2004). It is observed that protein and lipids (%) of *R. rita* increases as the increase in body weight of studied fish. The findings of present study are similar to the inferences of Ahmed *et al.* (2015) and Sikandar *et al.* (2020) who reported that energy contents i.e. protein and fats is directly proportional to increase in fish body weight.

In the liver and gut, higher lipids contents were measured in W_3 weight containing fish in this study as compared to other organs and according to the inferences of Thammapat *et al.* (2010) who reported higher proportion of lipids in the viscera of Asian catfish (*Pangasius bocourti*). Although viscera are not used as edible part of fish by man, yet it can be successfully utilized in the preparation of various feed and pharmaceutical products due to its higher protein contents as low/no cost.

The results of present study about ash proportion showed gradual increase in ash percentage as the weight and size of fish increased in all selected body organs of fish for proximate body composition. The ash (%) in fish increased significantly with increasing in length and weight of fish (Al-Asgah, 1992). The inferences of present study about ash (%) are according to the findings of Ali *et al.* (2005), Chukwu and Shaba (2009) and Jabeen and Chaudary (2011).

Carbohydrates percentage showed fluctuation because they do not measure directly as other parameters of proximate composition and only deduct from 100 by sum of all other parameter's values. In contrast to humans, fish consume lipids as energy source rather than carbohydrates which are generally ignored in proximate body composition analysis although they are chief part of human diet. Furthermore, as compared to larger fish, smaller sized fish showed more carbohydrates (%). The inferences about percent carbohydrates in different organs of *R. rita* in this study are similar to the findings reported by Saeed (2011) in *Cirhinus mrigala* and *Catla catla* and Ahmed *et al.* (2015) in *Cirrhinus mrigala* captured from wild source.

Conclusions and Recommendations

In conclusion, proximate body composition of *R. rita* differ with change in weight of fish. Larger weight containing fish showed higher nutrient values as compare to lesser weight containing fish. The results of the present study will be helpful in the selection of appropriately sized fish for human consumption. Also, fish visceral organs which are usually not consumed by humans, can be used in the formulation of nutritionally balanced diets for fish, poultry and livestock and in pharmaceutical products due to their nutrient contents. Further, fish as a whole has a lot of food potential and can therefore be expected to provide relief from malnutrition, especially in the developing country like Pakistan.

Conflict of interest

The authors have declared no conflict of interest.

References

Abbas, F., Hafeez-Ur-Rehman, M., Ashraf, M. and Iqbal, K.J., 2013. Body Composition of Feather Back *Notopterus notopterus* and *Rita rita* from Balloki Headworks-Pakistan. *J. Agri-Food Appl. Sci.*, **1**: 126-129.

Abdullah, O., 2012. Comparison of meat yield, flesh color, fatty acid, and mineral composition of wild and cultured Mediterranean amberjack (*Seriola dumerili*). *J. Fish. Sci.*, **6**: 164-175.

Ahmed, T., Naqvi, S.M.A., Abdullah, S., Abbas, K., Shah, S.Z.H. and Zia, M.A., 2015. Comparative proximate body composition of wild captured and farm cultured *Cirrhinus mrigala*. *Pak. J. Agric. Sci.*, **52**: 203-207.

Al-Asgah, N.A., 1992. Variation in carcass composition

of *Oreochromis niloticus* in relation to body weight and length. *Pak. J. Zool.*, **24**: 47-51.

Ali, A. and Kiumars, P., 2010. Chemical and proximate composition properties of fish species obtained from Iran. *World J. Fish. Mar. Sci.*, **2**: 237-239.

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. Comp. *Int. J. Environ. Sci. Technol.*, **2**: 229-232. https://doi.org/10.1007/BF03325880

AOAC, 2000. Official methods of analysis. 17th ed. Association of official analytical chemists. gaithersburg, MD, USA, pp. 2200.

Azam, K., Ali, M.Y., Asad-Uz-Zaman, M., Basher, M.Z. and Hossain, M.M., 2004. Biochemical assessment of selected fresh fish. *J. Biol. Sci.*, **4**: 9-10.

Begum, M., Akter, T. and Minar, M.H., 2012. Analysis of the proximate composition of domesticated stock of pangas (*Pangasianodon hypophthalmus*) in laboratory condition. *Environ. Sci. Nat. Resour.*, **5**: 69-74. https://doi.org/10.3329/jesnr.v5i1.11555

Berg, O.K., Thronaes, E. and Bremset, G., 2000. Seasonal changes in body composition in young riverine Atlantic salmon and brown trout. *J. Fish Biol.*, **52**: 1272-1288. https://doi.org/10.1111/j.1095-8649.1998.tb00971.x

Celik, M., Diler, A. and Kuchkgulmez, A., 2005. A comparison of the proximate body compositions and fatty acid profiles of zander (*Sander luciperca*) from two different regions and climate conditions. *Food Chem.*, **92**: 637-641. https://doi.org/10.1016/j.foodchem.2004.08.026

Chukwu, O. and Shaba, I.M., 2009. Effects of drying methods on proximate compositions of catfish (*Clarias gariepinus*). *World J. Agric. Sci.*, **5**: 114-116.

Dempson, J.B., Schwar, Z.C.J., Shears, M. and Furey, G., 2004. Comparative proximate composition of Atlantic salmon with emphasis on parr from fluvial and lacustrine habitats. *J. Fish Biol.*, **64**: 1257-1271. https://doi.org/10.1111/j.0022-1112.2004.00389.x

Grayton, B.D. and Beamish, F.W.H., 1997. Effects of feeding frequency on food intake growth and body composition of rainbow trout (*Salmo gairdneri*). *Aquaculture*, **11**: 159-172. https://doi.org/10.1016/0044-8486(77)90073-4

Hussain, B., Mahboob, S., Hassan, M., Liaqat, F., Sultana, T. and Tariq, H., 2011. Comparative analysis of proximate composition of head from wild and farmed *Catla catla*. *J. Ann. Pl. Sci.*, **21**: 207-210.

Jabeen, F. and Chaudary, A.S., 2011. Chemical compositions and fatty acid profiles of three freshwater fish species. *Food Chem.*, **125**: 991-996. https://doi.org/10.1016/j.foodchem.2010.09.103

Jonsson, N. and Jonsson, B., 1998. Body composition and energy allocation in life history stages of brown trout. *J. Fish Biol.*, **53**: 13-15. https://doi.org/10.1111/j.1095-8649.1998.tb00250.x

Kamal, D., Khan, A.N., Rahman, M.A. and Ahmad, F., 2007. Biochemical Composition of some small indigenous fresh water fishes from the river Mouri, Khulna, Bangladesh. *Pak. J. Biol. Sci.*, **10**: 1559-1561. https://doi.org/10.3923/pjbs.2007.1559.1561

Kandemir, S. and Polat, N., 2007. Seasonal variation of total lipid and total fatty acid in muscle and liver of rainbow trout (*Oncorhynchus mykiss*) reared in Derbent Dam Lake. *Turk. J. Fish. Aquat. Sci.*, **7**: 27-31.

Mahboob, S., Kanwal, S., Hassan, M., Hussain, A. and Nadeem, S., 2003. Fatty acid composition in Meat, liver and gonad from wild and farmed *Cirrhina mrigala*. *Aquact. Eur.*, **16**: 15-20.

Murray, J. and Burt, J.R., 2001. The Composition of Fish. Torry Advisory Note No. 38, Ministry of Technology. Tor. Res. Station, U.K., pp. 14.

Naeem, M. and Ishtiaq, A., 2011. Proximate composition of *Mystus bleekeri* in relation to body size and condition factor from Nala Daik, Sialkot, Pakistan. *Afr. J. Biotechnol.*, **10**: 10765-10763. https://doi.org/10.5897/AJB10.2339

Nathan, G., 2011. Fish liver may be source of essential fatty acids. *J. Food Composit. Anal.*, **24**: 217-222.

Osibona, A.O., Kusemiju, K., and Akande, G.R., 2006. Proximate composition and fatty acids profile of the African catfish, *Clarias gariepinus*. *Acta Satech J. Life Phys. Sci.*, **3**: 1-5.

Rafique, M. and Khan, N.U.H., 2012. Distribution and status of significant freshwater fishes of Pakistan. *Rec. Zool. Surv. Pak.*, **21**: 90-95.

Saeed, R., 2011. *Comparative proximate composition of meat and internal organs of both wild and farmed Cirrhinus mrigala and Catla catla*. M.Sc. thesis. Department of Zoology, Govt. Postgraduate College, Gojra.

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. https://doi.org/10.1016/0165-7836(94)90038-8

Saoud, I.P., Batal, M., Ghanawi, J. and Lebbos, N., 2008. Seasonal evaluation of nutritional benefits of two fish species in the eastern Mediterranean Sea. *Int. J. Food Sci. Technol.*, **43**: 538-542. https://doi.org/10.1111/j.1365-2621.2006.01491.x

Semab, M., 2011. *Comparative proximate composition of meat and internal organs from wild and farmed Cyprinus carpio and Hypophthalmicthyes molitrix*. M.Sc. thesis. Department of Zoology, Govt. Postgraduate College, Gojra.

Sikandar, M.A., Hassan, Z., Basit, A., Khan, R. and Ozdemir, F.A., 2020. Virtual analysis on proximate body composition of *Labeo rohita* and *Cirrhinus mrigala*. *Turk. J. Agric. Food Sci. Technol.*, **81**: 105-109

https://doi.org/10.24925/turjaf.v8i1.105-109.2812

Thammapat, P., Raviyan, P. and Siriamornpun, 2010. Proximate and fatty acids composition of the muscle and viscera of Asian cat fish *Pangasius bocourti*. *Food Chem*., **122**: 223-227. https://doi.org/10.1016/j.foodchem.2010.02.065

Tripathi, S.D., 1996. Present status of breeding and culture of catfishes in South Asia. *Aquact. Living Resour*., **9**: 219-228. https://doi.org/10.1051/alr:1996056

Weatherley, A.H. and Gill, H.S., 1987. The biology of fish growth. London, Academic Press, 443p.

Yashpal, M., Kumari, U., Mittal, S. and Mittal, A.K., 2006. Surface architecture of the mouth cavity of a carnivorous fish (*Rita rita*) Hamilton, 1822 Siluriformes, Bagridae. *Belgian J. Zool*., **136**: 155-162.