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Nutritional Profile Comparison of Wild and *Tagal* Indigenous Mahseer (*Tor duoronensis*) from Borneo

(Perbandingan Profil Nutrisi Mahseer Asli Liar dan Tagal (*Tor duoronensis*) dari Borneo)

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ABSTRACT

Little is known about the nutritional status of mahseer (*Tor duoronensis*), a high-value indigenous freshwater species of Borneo. The present study evaluated the proximate, fatty acid, and amino acid compositions in carcasses of juvenile wild and conserved (*tagal* system) mahseer. The crude lipid content of the wild-caught fish was significantly higher ($P < 0.05$) than *tagal* fish. Mahseer from *tagal* system contained significantly higher ($P < 0.05$) fatty acid concentrations of C14:0, C15:0, C16:0, C16.1, C17:0, C18:0, C18:1 n9t, C20:0, C20:4n6, C20:5n3, and C22:6n3, and lower concentrations of C12:0, C18:1 n9c, C18:2 n6c, C18:3 n3, C20:1, and C21:0 fatty acids than wild mahseer. The percentages of total saturated fatty acids and n-3:n-6 ratio were higher in the *tagal* system than in wild mahseer. *Tor duoronensis* harvested from the *tagal* system showed higher total amino acid concentration (756.74 ± 225.21 ng g^{-1}) compared to wild fish (652.10 ± 249.50 ng g^{-1}). Among the amino acid recorded, cysteine content was high in both wild (147.12 ± 206.62 ng g^{-1}) and *tagal* fish (164.37 ± 229.39 ng g^{-1}). Nine essential amino acids (histidine, arginine, threonine, valine, methionine, lysine, isoleucine, and phenylalanine) that are important in fish's metabolic and physiological responses were present in both fish groups. This study indicates that the biochemical composition of *Tor duoronensis* was significantly influenced by their habitat, and these differences may be explained by the components of the fish's diet. The information generated from this study is beneficial for developing nutritionally balanced practical feed for this species.

Keywords: Body composition; feed development; Mahseer; *Tagal* system; *Tor duoronensis*

ABSTRAK

Setakat ini, sedikit yang diketahui mengenai status pemakanan ikan kelah (*Tor duoronensis*), yang merupakan salah satu spesies air tawar asli bernilai tinggi di Borneo. Kajian ini membandingkan komposisi proksimat, asid lemak dan asid amino ikan kelah juvenil yang liar dan ikan kelah juvenil yang dilindungi (sistem Tagal). Kandungan lemak mentah ikan liar adalah signifikan lebih tinggi ($P < 0.05$) daripada ikan Tagal. Ikan kelah daripada sistem Tagal mengandungi kepekatan asid lemak yang signifikan lebih tinggi ($P < 0.05$) bagi C14:0, C15:0, C16:0, C16.1, C17:0, C18:0, C18:1 n9t, C20:0, C20:4n6, C20:5n3 dan C22:6n3 dan kepekatan lebih rendah bagi C12:0, C18:1 n9c, C18:2 n6c, C18:3 n3, C20:1 dan C21:0 berbanding kelah liar. Peratusan asid lemak tepu keseluruhan dan n-3:n-6 adalah lebih tinggi bagi ikan kelah sistem tagal berbanding ikan kelah liar. *Tor duoronensis* yang ditangkap dari sistem Tagal menunjukkan kepekatan asid amino keseluruhan yang lebih tinggi (756.74 ± 225.21 ng g^{-1}) berbanding ikan liar (652.10 ± 249.50 ng g^{-1}). Bagi kandungan asid amino, didapati bahawa kandungan sisteina adalah tinggi dalam kedua-dua kelah liar (147.12 ± 206.62 ng g^{-1}) dan kelah Tagal (164.37 ± 229.39 ng g^{-1}). Sembilan asid amino penting (histidina, arginina, treonina, valina, metionina, lisina, isoleusina dan fenilalanina) yang penting dalam tindak balas metabolik dan fisiologi ikan ditemui dalam kedua-dua kumpulan ikan. Kajian ini menunjukkan bahawa komposisi biokimia *Tor duoronensis* dipengaruhi secara signifikan oleh habitat mereka dan perbezaan ini mungkin dapat dijelaskan oleh komponen diet ikan tersebut. Maklumat yang dihasilkan daripada kajian ini berguna untuk membangunkan makanan seimbang secara nutrisi untuk spesies ini.

Kata kunci: Kelah; komposisi badan; pembangunan makanan; sistem Tagal; *Tor duoronensis*

INTRODUCTION

Mahseer (*Tor douronensis*) or regionally known as pelian, is a freshwater species that is indigenous to the rivers in Sabah known to inhabit clear, swift-flowing waters with stony, pebbly, or rocky bottoms (Ingram et al. 2005). Wild mahseers are considered important to rural communities as a protein source, for recreational fishing, and for biodiversity reasons (Nguyen et al. 2006). Unfortunately, *Tor* species are considered under threat in the wild because of major river engineering projects, declining water quality and other anthropogenic impacts (Pinder et al. 2019). Given the threats to *Tor* species' wild populations and the growing demand for these species for sport and as a food fish, a joint initiative between local authorities and communities prompted the adoption of the *tagal* system through the concept of Community-Based Fishery Resources Management to protect and revive Sabah's dwindling freshwater fishery resources. Under this system, fishing is prohibited by the concerned communities for a certain pre-agreed period according to the zoning. Certain *tagal* systems are associated with tourism activities whereby visitors are allowed to enter the river. Under this system, the fish may occasionally be fed with generic commercial feeds by the visitors (Ingram et al. 2005; Wong, Etoh & Sujang 2009). In the wild, *Tor* species rely on natural food such as aquatic plants, insects, zooplankton, as well as fallen fruits and seeds from surrounding forest areas. The species adapts to seasonal and environmental changes by varying its diet based on food availability. This flexibility allows *Tor duoronensis* to thrive in fast-flowing, clear streams and rivers (Tan 1980).

Fish from different habitats can have different flesh qualities, which are assessed by their lipid content, the composition of amino acids and fatty acids, taste, color, and texture. Several biological factors such as fish species, size, sex, and age, and environmental factors such as the source of nutrients, season, and water salinity affect the composition of fish (Børrensen 1992). Some authors have reported the differences in the chemical composition of farmed and wild fish (Fallah, Siavash Saei-Dehkordi & Nematollahi 2011; Fuentes et al. 2010; González et al. 2006; Wang et al. 2012; Wang et al. 2014). One of the main factors influencing the properties of flesh composition among farmed and wild fish is the constituents of the fish diet (Alasalvar et al. 2002; Grigorakis 2007; Rasmussen 2001), which provides the aquaculture industry the ability to beneficially modify the quality of fish produced. Being aware of the compositional and nutritional variations between wild and cultivated fish is of great importance to the farming industry and consumers particularly when a new species is introduced by the aquaculture industry.

Despite the cultural and economic importance of this species in Sabah, there is very little technical knowledge available about the fish's body composition. Understanding the composition of fish body aids aquaculture by optimizing growth, enhancing feed efficiency, boosting health and immunity, meeting market demands, minimizing environmental impact, tailoring species-specific diets, and supporting reproductive success. This knowledge fosters sustainable, cost-effective, and eco-friendly practices, aligning production with consumer needs and environmental stewardship in aquaculture. The present study compares the proximate composition, fatty acid, and amino acid profiles between wild and *tagal* mahseer.

MATERIALS AND METHODS

SAMPLE COLLECTION AND PREPARATION

Sixty *Tor duoronensis* from the wild (Sungai Moroli, Ranau) and *tagal* system (Luanti *Tagal* System) used for this study were supplied by a local aquaculture farm in Ranau, Sabah. The Luanti *tagal* system is open for visitors and the fish may occasionally be fed by them using commercially formulated feeds. A total of 30 fishes (0.48 - 1.83 g and 3.54 - 5.31 cm) from each system were sampled and subjected to laboratory analysis.

PROXIMATE COMPOSITION

Proximate analysis was conducted in the Biotechnology laboratory at Borneo Marine Research Institute (BMRI), UMS. Fish samples were analysed according to standard methods of AOAC (1997). The moisture content was determined after the sample was oven dried at 105 °C for 24 h; ash content was determined by incinerating the sample in a muffle furnace at 550 °C for 6 h and weighing the residue; crude protein was determined using Kjeltec-Protein Analyzer (Kjeltec™ 2300, Foss, Sweden) after acid digestion; crude lipid was determined using Soxtec-Lipid Analyzer (Soxtec™ 2043, Foss, Sweden) with petroleum ether (40-60 °C boiling) as solvent.

FATTY ACID ANALYSIS

The crude lipid extracts were obtained using chloroform:methanol (1:1, v/v) as described in Bligh and Dyer (1959). Transmethylation of the extract into fatty acid methyl esters (FAME) was conducted using sodium hydroxide in methanol (NaOH-methanol) and hydrogen chloride in methanol (HCl-methanol). The fatty acid methyl esters were subjected to a gas chromatograph (Shimadzu GC-2010, Shimadzu Corporation, Kyoto, Japan). The esters were separated using a capillary column (60 m × 0.25 mm ID; BPX70 column, SGE Australia Pty. Ltd., Ringwood, Vic., Australia) and identification pf chromatograph peaks were carried out by comparing retention times with FAME standards (Supelco™ 37 Component FAME mix, Supelco Inc., Bellefonte, USA).

AMINO ACID ANALYSIS

Prior to amino acid analysis, fish samples were homogenized and freeze-dried. Amino acid content was analysed using the AccQ.Tag method in a certified laboratory at Unipeq UKM as described by Johar, Dzulfakar and Kofli (2018). The fish sample was hydrolysed with 6N HCl at 110 °C for 24 h to release the amino acids from and profiled using high-performance liquid chromatography (HPLC) system equipped with a fluorescent detector (FID).

STATISTICAL ANALYSIS

Independent sample t-tests were used to compare whole-body proximate and fatty acid composition between wild-caught fish and fish harvested from the *tagal* system. Homogeneity of variances was tested with Levene's test. The significance level was set at $P < 0.05$. All statistical analysis was carried out using SPSS v.27.0 for windows.

RESULTS AND DISCUSSION

PROXIMATE COMPOSITION

The proximate composition of wild and *tagal Tor duoronensi*s is depicted in Table 1. The whole body of crude lipid of wild mahseer was significantly higher (5.86%) than the *tagal* fish (3.30%). However, moisture, ash, and crude protein contents did not differ significantly (P > 0.05) between wild (79.96%, 2.77%, 14.30%) and *tagal* mahseer (80.36%, 2.66%, 13.04%).

In contrast to wild fish, which typically consume natural foods, fish in the *tagal* system are occasionally fed commercial feed. Recent studies indicate that the body composition of fish directly depends on the habitat in which they are found and the types of food they have access to. Generally, cultured fish shows a higher amount of lipid compared to their wild counterparts (Fallah, Siavash Saei-Dehkordi & Nematollahi 2011; González et al. 2006; Sharma et al. 2010; Wang et al. 2014). The present study showed a different trend whereby wild mahseer has higher lipid content, similar to a study reported by Ashraf et al. (2011) in wild *Ctenopharyngodon idella*. Pelleted feeds that are occasionally used in the *tagal* system typically consist of readily available commercial feeds, such as tilapia feed, which contains only about 5% lipid. Apart from that, they have to compete for the limited natural food available in the *tagal* system. Meanwhile, wild Tor species are known to feed on fallen riverine fruit, algae, and insect larvae which are rich in crude lipid that may contribute to the high content of lipids in fish flesh.

No significant difference was observed in moisture, ash, and crude protein contents between the wild and *tagal* mahseer. A similar result has also been reported for the wild and farmed rohu *Labeo rohita* (Sharma et al. 2010), rainbow trout *Oncorhynchus mykiss* (Fallah, Siavash Saei-Dehkordi & Nematollahi 2011), longsnout catfish *Leiocassis longirostris* (Wang et al. 2012), and Ussuri catfish *Pseudobagrus ussuriensis* (Wang et al. 2014). The variations in the nutritional value of fish are influenced by several factors such as environmental conditions (temperature and salinity), the type and the availability of food, and feeding practices (Wang et al. 2014).

WHOLE BODY FATTY ACID COMPOSITION

The whole-body fatty acid composition of mahseer is listed in Table 2. Total saturated fatty acids (SFA) in the whole body of the *tagal* mahseer was significantly higher (P < 0.05) compared to the wild mahseer. However, *tagal* fish had significantly (P < 0.05) lower total monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) compared to wild fish. Palmitic acid (C16:0) and stearic acid (C18:0) were the primary and secondary SFAs in mahseer, whereby *tagal* mahseer is significantly higher ($P < 0.05$) than that of the wild mahseer. With regard to MUFAs, oleic acid (C18:1 n9c) as the major MUFAs in all groups was higher ($P < 0.05$) in wild fish than in *tagal* fish, followed by palmitoleic acid (C16:1), which was higher ($P < 0.05$) in *tagal* fish than in wild fish. Total n-3 PUFA contained in the whole body of *tagal* mahseer is higher ($P < 0.05$) compared to wild mahseer; however, the opposite for total n-6 PUFA. Linoleic acid (C18:2 n6c) was the primary n-6 PUFAs, showing a higher level ($P < 0.05$) in wild fish than in *tagal* fish. The next n-6 PUFAs is arachidonic acid (C20:4n6), presenting a lower level ($P < 0.05$) in wild fish than in *tagal* fish. Whole body EPA (C20:5N3) and DHA (C22:6n3) levels were higher ($P < 0.05$) in *tagal* mahseer: 1.88% and 6.75%, respectively, compared to wild mahseer: 1.65% and 2.94%, respectively. The ratio of n-3:n-6 PUFAs is highest ($P < 0.05$) in the *tagal* mahseer compared to the wild mahseer.

In aquaculture, the formulated diet provides farmed fish with the proper nutrient required for optimum growth, better production, and yield of body composition, in particular, the protein and lipid content (Islam & Tanaka 2004). A desirable nutritional value in fish can be achieved through its feeding, which is evident as general improvement of feeding strategy results in improvement of fish growth (Ashraf et al. 2011). The present study showed the whole body of the *tagal* mahseer contained higher levels of total saturated fatty acid (SFA). However, total monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) were higher in the wild mahseer. Sharma et al. (2010) reported similar findings whereby farmed rohu (*Labeo rohita*) contained higher levels of total SFA than the wild. Findings by Mnari et al. (2007) also showed that farmed sea bream (*Sparus aurata*) contains higher levels of SFA than its wild counterpart, but the latter contained higher levels of monounsaturated fatty acids (MUFA). Major SFAs identified in both wild and *tagal* mahseer were palmitic acid (C16:0) and stearic acid (C18:0); as for MUFA, major fatty acids identified were palmitoleic acid (C16:1) and oleic acid (C18:1 n9c). A similar outcome has also been reported in sea bream *Sparus aurata* (Grigorakis et al. 2002), seabass *Dicentrarchus labrax* (Alasalvar et al. 2002), and rohu *Labeo rohita* (Sharma et al. 2010) originated from the wild and aquaculture system. In both wild and *tagal* mahseer, palmitic acid (C16:0) was found to be the most abundant fatty acid; whereby it is significantly higher ($P < 0.05$) in *tagal* mahseer than in the wild ones.

The presence of higher levels of palmitic acid in the body of the *tagal* mahseer may be attributed to the use of palmitic acid-rich oil such as palm oil in diets or from natural food available in the *tagal* system (Mnari et al. 2007). Results showed that the *tagal* mahseer contained

TABLE 1. Comparison of nutrient components (% wet weight basis) between wild and *tagal* mahseer

Nutrients	Wild	*Tagal* system	*p*
Moisture	76.96 ± 0.71	80.36 ± 0.83	0.06
Ash	2.77 ± 0.11	2.66 ± 0.06	2.44
Lipid	5.86 ± 0.30	3.30 ± 0.14	<0.01
Protein	14.30 ± 0.58	13.04 ± 0.56	0.55

Data are expressed as mean ± SD (n = 10); $P < 0.05$ is significant; $P > 0.05$ is nonsignificant

TABLE 2. Fatty acid composition (% of total fatty acids) of mahseer whole body harvested from different sources

	Fatty acids	Source		Significant difference
		Wild	*Tagal* system	
Lauric acid	C12:0	1.41 ± 0.01	0.66 ± 0.00	s
Myristic acid	C14:0	3.41 ± 0.00	3.51 ± 0.01	s
Myristoleic acid	C14:1	0.53 ± 0.01	0.64 ± 0.02	ns
Pentadecylic acid	C15:0	0.41 ± 0.02	0.49 ± 0.01	s
Palmitic acid	C16:0	30.72 ± 0.05	32.94 ± 0.13	s
Palmitoleic acid	C16:1	6.15 ± 0.01	8.31 ± 0.03	s
Margaric acid	C17:0	0.86 ± 0.00	1.11 ± 0.03	s
Stearic acid	C18:0	8.82 ± 0.02	11.13 ± 0.05	s
Elaidic acid	C18:1 n9t	0.15 ± 0.00	0.17 ± 0.00	s
Oleic acid	C18:1 n9c	25.98 ± 0.11	22.33 ± 0.09	s
Linoleic acid	C18:2 n6c	9.05 ± 0.02	3.96 ± 0.00	s
Gama linolenic acid (GLA)	C18:3 n6	0.15 ± 0.01	-	ns
Alpha linolenic acid (ALA)	C18:3 n3	3.88 ± 0.03	1.17 ± 0.04	s
Arachidic acid	C20:0	0.33 ± 0.01	0.43 ± 0.01	s
Paullinic acid	C20:1	0.41 ± 0.00	0.36 ± 0.00	s
Heneicosylic acid	C21:0	0.17 ± 0.01	0.11 ± 0.00	s
Dihomo-gama-Linolenic	C20:3n6	0.30 ± 0.02	0.29 ± 0.00	ns
Arachidonic acid	C20:4n6	1.52 ± 0.02	2.63 ± 0.02	s
Behenic acid	C22:0	0.19 ± 0.01	0.27 ±0.00	ns
Erucic acid	C22:1n9	0.11 ± 0.01	-	ns
Eicosapentaenoic Acid (EPA)	C20:5n3	1.65 ± 0.03	1.88 ± 0.07	s
Docosahexaenoic acid (DHA)	C22:6n3	2.94 ± 0.06	6.75 ± 0.07	s
Total Saturates	Total SFA	46.31 ± 0.03	50.64 ± 0.13	s
Total Monoenes	Total MUFA	33.33 ± 0.09	31.81 ± 0.13	s
	Total PUFA	19.50 ± 0.08	16.66 ±0.19	s
Total Omega 3 PUFA	Total n-3	8.47 ± 0.05	9.79 ± 0.17	s
Total Omega 6 PUFA	Total n-6	11.02 ± 0.03	6.87 ± 0.02	s
	n-3/n-6	0.77 ± 0.00	1.42 ± 0.02	s

Data are expressed as mean ± SD (n = 3)
SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, poly unsaturated fatty acids; ns, non-significant ($P > 0.05$); s, significant ($P < 0.05$)

more n-3 PUFA than wild mahseer, but its total n-6 PUFA content was lower, and the difference was statistically significant (*P < 0.05*). Similar findings were discovered for gilthead sea bream *Sparus aurata* (Mnari et al. 2007). The primary fatty acid found in both wild and *tagal* mahseer for the n-6 PUFA group was linoleic acid (C18:2 n6c) whereby wild mahseer is significantly higher (P < 0.05) compared to *tagal* mahseer. Linoleic acid (C18:2 n6c) concentrations were also reported higher in wild rohu than in cultured rohu (Sharma et al. 2010). It is well documented that dietary lipid source influences the fatty acid compositions of fish. Wild mahseer's natural diet consists of riverine fruits that contain high lipid content (Kamarudin et al. 2018). Kamarudin et al. (2012) reported that mahseer muscle and liver had higher levels of linoleic acid when they were fed meals with plant-based oil. Whole body EPA (C20:5N3) and DHA (C22:6n3) levels in *tagal* mahseer were found to be significantly higher than their wild counterpart. The elevated levels of EPA and DHA in *tagal* fish might be attributed to a dietary lipid supplement derived from fish meal and fish oil contained in the commercial feed given to the *tagal* mahseer. The n-3: n-6 ratios were significantly higher (P < 0.05) in *tagal* mahseer than in the wild mahseer. The differences in n-3 PUFA and n-6 PUFA were caused by variations in the fatty acids of each group (Mnari et al. 2007). High levels of n-3 PUFA caused an increase in n-3: n-6 ratios of *tagal* mahseer. This is probably due to the feed given in the *tagal* area, which contains an appreciable amount of n-3 PUFA. Kamarudin et al. (2012) also discovered a decrease in n-3 PUFA in the muscle and liver of mahseer when dietary fish oil is reduced in its diet. Higher levels of n-3 polyunsaturated fatty acids (PUFAs) offer significant health benefits, including improved cardiovascular health, enhanced brain function, better eye health, reduced arthritis symptoms, and stronger immune response. The *tagal* mahseer is typically found in remote, inland areas where access to marine fish is limited. This unique freshwater species presents an important nutritional resource for local communities, providing them with a sustainable source of protein and essential nutrients.

WHOLE BODY AMINO ACID COMPOSITION

The amino acid profile of *Tor duoronensis* from two different sources is depicted in Table 3. A total of eighteen amino acids were detected from the carcass of *T. duoronensis*. *Tagal* mahseer showed higher levels of aspartic acid (58.62 ng g^{-1}), serine (28.52 ng g^{-1}), glutamic acid (85.44 ng g^{-1}), histidine (16.63 ng g^{-1}), arginine (45.42 ng g^{-1}), threonine (28.86 ng g^{-1}), alanine (36.18 ng g^{-1}), cysteine (164.37 ng g^{-1}), tyrosine (21.34 ng g^{-1}), valine (28.73 ng g^{-1}), methionine (19.55 ng g^{-1}), lysine

TABLE 3. Amino acid concentrations (ng g^{-1} dry weight) in wild and *tagal* mahseer

Amino acids	Wild	*Tagal* system
Hydroxyproline	9.92 ± 1.82	8.66 ± 0.18
Aspartic acid	53.13 ± 7.84	58.62 ± 10.52
Serine	21.99 ± 4.06	28.52 ± 0.79
Glutamic acid	75.81 ± 7.50	85.44 ± 9.44
Glycine	39.66 ± 0.79	40.15 ± 3.20
Histidine	12.12 ± 2.38	16.63 ± 0.97
Arginine	32.99 ± 2.06	45.42 ± 10.82
Threonine	22.68 ± 2.08	28.86 ± 2.62
Alanine	34.81 ± 0.79	36.18 ± 1.67
Proline	26.43 ± 1.84	26.76 ± 0.72
Cysteine	147.12 ± 206.62	164.37 ± 229.39
Tyrosine	15.64 ± 3.52	21.34 ± 1.19
Valine	23.29 ± 0.06	28.73 ± 3.12
Methionine	14.76 ± 1.73	19.55 ± 1.87
Lysine	44.29 ± 0.80	48.46 ± 3.49
Isoleucine	29.75 ± 11.83	36.65 ± 10.95
Leucine	27.70 ± 8.51	35.53 ± 14.57
Phenylalanine	20.02 ± 2.41	26.88 ± 2.01
Total	652.10 ± 249.50	756.74 ± 225.21

Data are expressed as mean ± SD (n = 2)

(48.46 ng g^{-1}), isoleucine (36.65 ng g^{-1}), leucine (35.53 ng g^{-1}), and phenylalanine (26.88 ng g^{-1}) than wild mahseer. The total amino acid in *tagal* fish (756.74 ng g^{-1}) was also higher compared to wild fish (652.10 ng g^{-1}).

Based on the current studies, mahseer originating from the *tagal* system had a better amino acid profile and higher concentrations than their wild counterparts. Cysteine was the most abundant amino acid found in both samples. Hussain et al. (2016) found high levels of cysteine concentration in muscle tissues of fishes collected from a highly polluted river compared to farmed fish. The relationship between cysteine and metallothioneins can be used to understand the increase in cysteine caused by pollution and its biological effects on fish. Metallothioneins (MTs) are heat-stable cysteine-rich proteins that form meta-thiote bonds with metals. One of the major physiological roles of MT is the detoxification of certain trace metals (Goering & Klaassen 1984). Several isoforms and metals bind to these proteins in various fish organs (Vasak 2005). Such cysteine-rich proteins, which form a distinct set of protein frameworks and folds, are found in all living organisms and frequently play critical roles in various biological pathways as growth factors, hormones, ion channel modulators, and enzyme inhibitors. As a result of metal pollution, there may be an increased demand for cysteine to support the synthesis of MTs (Lavergne, Taft & Alewood 2012). Both Luanti *tagal* system and Sungai Moroli, where the fish samples were obtained, are still considered in good condition but may not be as pristine as they were many years ago. The growing number of visitors to the *tagal* system and Sungai Moroli may raise concerns about pollution, potentially increasing waste, and environmental degradation. Although this remains a hypothesis, it underscores the need for comprehensive investigation. Regular monitoring of water quality, including physical, chemical, and biological assessments, is essential to protect the aquatic ecosystem's health and support sustainable local aquaculture practices.

The current study shows that there are nine essential amino acids namely histidine, arginine, threonine, valine, methionine, lysine, isoleucine, leucine, and phenylalanine present in the carcass of wild and *tagal* fish. Mozanzadeh et al. (2018) reported that dietary essential amino acid supplementation affects fish performance and its nutritional value. Fish fed with protein-deficient diets are more likely to show negative effects on their metabolic and physiological responses compared to those fed with optimum protein diets. The body composition of fish species is correlated to their natural and artificial diet which is apparent especially when the fish are given restricted feed options (Ashraf et al. 2011). In the *tagal* system, fish are provided with external feed input (formulated freshwater fish feed) considering their limited access to wild-sourced food. Such information proves that the *tagal* mahseer is nutritionally superior to that of wild mahseer. The findings highlight the importance of formulating species-specific feeds that optimize growth and health. By incorporating the identified essential nutrients into feed formulations, aquaculture practices can enhance fish performance, improve feed efficiency, and promote sustainable farming operations.

CONCLUSIONS

The result obtained in this study provided scientific information and knowledge of the proximate composition, fatty acid, and amino acid profile of wild and *tagal Tor duoronensis*. Wild mahseers were found to have significantly higher body lipid content than their *tagal* counterparts, which could be attributed to the fish's diet constituents. The total SFAs, total n-3 PUFA, EPA, DHA, and the ratio of n-3:n-6 PUFAs of *tagal* mahseer were higher than that of wild mahseer. Mahseer raised in the *tagal* system also contains a higher concentration of amino acid than in the wild. Overall, *Tor duoronensis* have good nutritional components making them a high-potential candidate in the aquaculture industry. Further research is being conducted on the protein and lipid ratio in the feed development of juvenile mahseer to develop a practical feed for this species. This study highlights the nutritional potential of *Tor douronensis* in sustainable aquaculture. The *tagal* system exemplifies community-based management, promoting fish farming that alleviates pressure on wild populations. By fostering stewardship and sustainable practices, this approach supports both local livelihoods and ecological conservation, paving the way for a sustainable aquaculture future.

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