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Original Article

An investigation on protein and amino acid contents in scales and muscles of pomfret *Parastromateus niger* (Bloch, 1795) and *Pampus argenteus* (Eupharasen, 1788)

Uma investigação sobre o conteúdo de proteínas e aminoácidos em escamas e músculos de pomfret *Parastromateus niger* (Bloch, 1795) e *Pampus argenteus* (Eupharasen, 1788)

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Abstract

The present investigation was aimed to examine the percentage quantity of protein and amino acids in scales and muscles of *Pampus argenteus* and *Parastromateus niger* gathered from the local fish market of district Quetta of Balochistan. About 80 specimens of these two species, i.e., *Pampus argenteus* (N=40) and *Parastromateus niger* (N = 40), were collected from April 2017 to May 2018. In general, crude protein content was high in scales, that is, 71.03% in *Parastromateus niger* and 52.11% in *Pampus argenteus,* as well as in muscles of two Pomfret species of fishes i.e., 63.44% in *Pampus argenteus* and 60.99% in *Parastromateus niger* on a dry-weight basis, respectively. Likewise, the muscles and scales of *Parastromateus niger* reveal well compositions of amino acids that include proline was found to be high, and methionine was less than other amino acids, whereas threonine was found high in the scales of *Pampus argenteus*, but methionine was observed in lesser amount. However, the amino acids found in *Pampus argenteus* muscles also showed different compositions, such as lysine was found to be high, but histidine was less, respectively. In comparison, amino acids like tryptophan and cysteine were not detected in both scales and muscles of these Pomfret species of fishes. Thus, this study was based on analyzing the utilization of both Pomfret species of scales and meat whether they could have values as good supplements of both protein and certain kinds of essential amino acids in animal diets.

Keywords: Pomfret species, *Pampus argenteus*, *Parastromateus niger*, scales, muscles, crude protein, amino acids.

Resumo

A presente investigação teve como objetivo examinar a quantidade percentual de proteínas e aminoácidos em escamas e músculos de *Pampus argenteus* e *Parastromateus niger* coletados no mercado de peixes local do distrito de Quetta, no Baluchistão. Cerca de 80 exemplares dessas duas espécies, ou seja, *Pampus argenteus* (N=40) e *Parastromateus niger* (N=40), foram coletadas de abril de 2017 a maio de 2018. Em geral, o teor de proteína bruta foi alto em escamas, ou seja, 71,03% em *Parastromateus niger* e 52,11% em *Pampus argenteus*, bem como em músculos de duas espécies de peixes Pomfret, ou seja, 63,44% em *Pampus argenteus* e 60,99% em *Parastromateus niger* em base de peso seco, respectivamente. Da mesma forma, os músculos e escamas de *Parastromateus niger* revelam que as composições de aminoácidos que incluem prolina são altas, e a metionina é menor do que outros aminoácidos, enquanto a treonina foi encontrada alta nas escamas de *Pampus argenteus*, mas a metionina foi observada em quantidade menor. No entanto, os aminoácidos encontrados nos músculos de *Pampus argenteus* também apresentaram composições diferentes, como a lisina foi alta, mas a histidina foi menor, respectivamente. Em comparação, aminoácidos como triptofano e cisteína não foram detectados em ambas as escamas e músculos dessas espécies de peixes Pomfret. Assim, este estudo procurou analisar a utilização de ambas as espécies Pomfret de escamas e carne, e se eles poderiam ter valores como bons suplementos de proteína e certos tipos de aminoácidos essenciais em dietas de animais.

Palavras-chave: espécie Pomfret, *Pampus argenteus*, *Parastromateus niger*, escamas, músculos, proteína bruta, aminoácidos.

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1. Introduction

The Arabian Sea of Pakistan is one of the most identical seas around the world and diverse fish fauna (≈1,000 species) due to nutrient-rich waters (Amir et al., 2022; Hassan et al., 2024). The fish industry has grown enormously to be an attractive center for scientific and public potential (Baker et al., 2013).Fish are the most abundant vertebrate group on the earth, consisting of 50% of the vertebrate species and chief sources of high-quality protein to consume one billion people globally (Rafique and Khan, 2012; Hassan et al., 2020; Khalid et al., 2021).Fisheries also play an essential role in generating income for many communities (Ghouri et al., 2020). So far, 34,000 fish species have been identified throughout the world (Di Pinto et al., 2015). Fish is a significant food source, as it contains a substantial amount of animal protein in our diet (Ahmad et al., 2021; Hassan et al., 2021a, b). Moreover, fish consumption has now been linked with human health benefits, as it contains essential amino acids and omega 3-fatty acids (Dhaneesh et al., 2012; Hussain et al., 2021). Pomfret species like *P. argenteus* belong to the family *Stromateidae,* commonly referred to as “silver pomfret”, which is mainly characterized by its silvery or whitish appearance flattened body having forked tail, long pectoral fins, and very few numbers of small-sized scales (Hassan et al., 2020). *P. argenteus* is abundantly found near the bottom of coastal areas of the Middle East and Southeast Asian countries. Though silver pomfret can grow up to 4 to 6 Kg (Hossain et al., 2011; Hassan et al., 2023), however, due to overfishing, some of its individuals could reach just below 1 Kg. The local name of *P. argenteus* local fish market of Pakistan is ‘pamphlet’. These fishes contain highly digestive flesh, which is rich in vitamin A, B, B_3, C, D, E, and K **(**Chung et al., 2008**),** as well as frequently used in the preparation of traditional medicines by the Chinese peoples. These species have great ability to promote the health of skin, therefore have eminent commercial value in contrast to other food fishes (Cruze et al., 2000). Whereas, *P. niger* is commonly called “Black Pomfret” and is belonging to the family *Carangidae* and inhabits the coral reefs of the Pacific Ocean (Nelson 2006; Froese and Pauly, 2013, 2014, 2016).

Fish scale can be considered the important structures that allow fish to exist normally in water (Shephard, 1994). Scales are made up of tremendous protein that provides protection and flexibility and aids in locomotion to fish (Ikoma et al., 2003; Torres et al., 2008; Kardong, 2015). Fish scale is also a valuable tool that provides key characters for the systematic classification of fish, as well as consider an indicator of environmental conditions around the fish in which it exists as reported by some researcher’s i.e., Chervinski (1984, 1986), Chang et al. (1999), Poulet et al. (2005) and Ibanez et al. (2007). So, many researchers have analyzed the level of protein and various amino acids in fish scales (Nagai et al., 2004; Duan et al., 2009; Pati et al., 2010; Zhang et al., 2011). Tiwari and Srivastava (1962), Saraswat and Ram (1970, 1972), and Saraswat (1976) had also analyzed the compositions of amino acids found in scales obtained from numerous fish species i.e., *Channa punctatus, Wallago attu, Cirrhinnus mrigala,* and *Labeo rohita* at various levels of their growth. Also, the collagen protein extracted from fish scales revealed that though alanine, glycine, proline, and glutamic acid were found in the highest amount; and among them, glycine was found to be high, whereas tryptophan was not seen (Nagai et al., 2004; Zhang et al., 2011). Nurul-Asyiraf (2011) had also examined the composition of collagen protein derived from scales. Fish scales are composed of mostly of keratin, the nutritional and commercial value of fish scales lies mainly in its high collagen content, enamel and protein rich mucus. The collagen and mucus together provide a very high proportion of proteins, especially lysine. Fish scales are also high in calcium phosphate, which serves as a source of calcium for strong bones and teeth (Wang et al., 2017). Collagen is also a vital component of connective tissue and supports joint injury recovery and diseases such as osteoporosis, promoted blood and lymphatic vessel formation, thus improving the potential for tissue repair, regeneration and skin elasticity and joint health. While researchers are investigating the wound healing potential of fish scale collagen. Fish scale-derived collagen would induce human umbilical vein endothelial cells to express 2.5 times more of a specific type of collagen responsible for blood vessel formation, as compared to endothelial cells cultured on bovine collagen. This suggests that fish scale-derived collagen has potential to be developed for use in biomedical applications (Chen et al., 2020). Whereas icthyolepidin is also another type of protein that is firstly reported in fish scales by Seshaiya et al. (1963) and observed that this protein was enriched in cystine and cysteine. In the past, very little work had been done on fish scales, but no information was presented on the protein and amino acid composition that occurs in these pomfret fish scales found on the Balochistan coast. Through, according to the previous studies, though fish scales were contained essential (EAA) as well as non-essential (NAA) amino acids, the total amount of non-essential amino acids (NAA) was consistently found higher than essential amino acids (EAA) as both chemical engineering and pharmaceutical researchers had already been suggested the utilization of fish scales in fertilizers, fisheries byproducts, and extractions of various organic and inorganic components by local farmers and industries, but still not met with success (Silva et al., 2019; Rudovica et al., 2021).

The fish muscle usually forms the major portion of the fish body as well as a most preferred portion for human consumption because of its delicious flavor and well-compositions of amino acids in its protein content, which is suitable for human diets as described by Pirestani et al. (2009), Mohamed et al. (2010), and Flowra et al. (2013). FAO (2009) reported that the fish business is now upholding the economy of Pakistan because it aids in earning 196 million Pakistani Rupees due to the exports of various fish species and fisheries byproducts. Fish flesh is now abundantly used in preparing fish meals for animal diets (Meyer and Fracalossi, 2005; Petricorena, 2015). Usydus et al. (2009) analyzed the chemical composition of 18 fish products and proved a higher quantity of protein and essential amino acids that might be safely used by local populations as well as the fish sellers along the coastline of Poland. Zhao et al. (2010) had also reported that the protein content of *Pampus punctatissimus* found along the China Coast contained an excellent composition of amino acids found in order; glutamic acid>lysine>leucine>aspartic acid. Hossain et al. (2011) had observed the amino acid requirements in the diets of silver pomfret, *P. argenteus* by analyzing the compositions of amino acids in the whole body and eggs. Jai-Ganesh et al. (2011) investigated the composition of amino acids in the protein content of black pomfret, *P. niger*. Namulawa et al. (2012) evaluated the essential amino acid composition in the muscles of Nile perch. Shokrollahi et al. (2012) were observed that muscles of silver pomfret found in the Persian Gulf were rich in protein and most noticeable amino acids, e.g., leucine, lysine, aspartic acid, glutamic acid, and valine. Xu et al. (2012) analyzed the flesh constituents in silver pomfret and concluded that its crude protein content as high as other species belongs to the genus *Pampus*.The relationship between the amount of protein and various amino acids found in the different parts of the body of both male and female individuals of *Pelteobagrus fulvidraco*. Pawar and Sonawane (2013) and Sarma et al. (2013) studies show that the composition of amino acids in fish muscles is most considerable to determine its nutritional benefits in human diets. Mohanty et al. (2014) had chosen the concentrations of protein and amino acids in fishes found in variable environments and observed the highest amount of glutamic acid and glycine in freshwater cat and carp fishes; while the highest amount of aspartic acid and lysine in fishes found in a cold marine environment, and also analyzed the principal amount of histidine in small native fish species. Masood et al. (2015a, b) had studied protein and amino acid constituents in scales of blue tilapia, *Oreochromis aureus* and carp species, *Labeo rohita*, and found higher concentrations of proline and glycine, while methionine, cysteine, and tryptophan were absent in scales of these two species. Our present study, based on examining crude protein and amino acid composition in both scales and muscles of black and silver pomfret fishes, was conducted for the first time on Pakistan Coast.

2. Materials and Methods

About eighty samples of each fish pomfret species include forty individuals of *P. argenteus,* and forty of *P. niger* were gathered from local fish markets of District Quetta during the period from April 2017 to May 2018. In the laboratory, fish samples were stored in refrigerators for further analysis. Then the amount of crude protein in both muscles and scales from each species on a dry weight basis was determined by using a micro-Kjeldahl technique with the help of the method of Association of Official Analytical Chemists (AOAC, 2000), Huque et al. (2014) and Masood et al. (2015a, b). The composition of amino acids in scales and muscles was measured by the ion-exchange liquid chromatography method followed by the Association of Official Analytical Chemists (AOAC, 2005) and Masood et al. (2015a,b). Finally, the statistical analysis of data was tested by using MS Excel and SPSS (Hassan et al., 2021a) statistical software.

3. Results and Discussion

The total length (TL) and body weight (BW) of individuals of *P. niger* ranged from 17.0 to 19.0 cm and 293-304 in grams, while total length (TL) and body weight (BW) of *P. argenteus* was found in the range from 13.0-16.0 cm and weight 86.0-97.0 in grams, respectively. The overall results of the composition of amino acids in scales and muscles of *P. niger* and *P. argenteus* were presented in Tables 1-7, Figures 1-4, respectively.

3.1. Percentage composition of protein in scales and muscles of pomfret fishes

The fish scales are derivatives of mesodermal cells composed of three basic organic and inorganic constituents, i.e., collagen fibers, ichthylepidin, calcium, and magnesium carbonates (Brown and Wellings, 1969; Masood et al., 2021). The present results examined that the concentration of crude protein (CP) was higher in the scales (71.03%) and muscles (63.44%) samples of *P. argenteus* in contrast with crude protein contents found in *P. niger,* that is, 52.11% in scales and 60.99% muscles on a dry weight basis, respectively.

Likewise, the analysis of protein content in scales of Blue tilapia, *Oreochromis aureus* as observed by Masood et al. (2015a) was also found less in pomfret scales of our present study. Huque et al. (2014) had observed the 20% crude protein in raw muscles of Silver Pomfret Fish collected

Table 1. Showing the concentrations of amino acids in the scales of Black pomfret, *Parastromateus niger* collected from Quetta on dry weight basis (mg/Kg).

S. No.	Amino acid	Amino acid code	Amount (mg/Kg)
1.	Aspartic acid	Asp	0.121
2.	Threonine	**Thr**[a]	0.188
3.	Serine	Ser	0.127
4.	Glutamic acid	Glu	0.370
5.	Proline	Pro	**1.186***
6.	Glycine	Gly	0.105
7.	Alanine	Ala	0.334
8.	Valine	**Val**[a]	0.124
9.	Methionine	**Met**[a]	**0.052♠**
10.	Isoleucine	**Ile**[a]	0.141
11.	Leucine	**Leu**[a]	0.338
12.	Tyrosine	Tyr	0.182
13.	Phenyalanine	**Phe**[a]	0.094
14.	Histidine	**His**[a]	0.201
15.	Lysine	**Lys**[a]	0.626
16.	Arginine	Arg	0.250
17.	Tryptophan	**Trp**[a]	**ND**
18.	Cysteine	Cys	**ND**

Note: [a] shows Essential amino acid. * shows highest value. ♠ shows lowest value. ND = amino acid was not determined.

Table 2. showing the concentrations of amino acids in the scales of Silver pomfret, *Pampus argenteus* collected from Quetta on dry weight basis (mg/Kg).

S.No.	Amino acid	Amino acid code	Amount (mg/kg)
1.	Aspartic acid	Asp	0.325
2.	Threonine	**Thr[a]**	**0.685***
3.	Serine	Ser	0.045
4.	Glutamic acid	Glu	0.499
5.	Proline	Pro	0.159
6.	Glycine	Gly	0.031
7.	Alanine	Ala	0.101
8.	Valine	**Val[a]**	0.042
9.	Methionine	**Met[a]**	**0.003♠**
10.	Isoleucine	**Ile[a]**	0.004
11.	Leucine	**Leu[a]**	0.618
12.	Tyrosine	Tyr	0.056
13.	Phenyalanine	**Phe[a]**	0.036
14.	Histidine	**His[a]**	0.061
15.	Lysine	**Lys[a]**	0.100
16.	Arginine	Arg	0.215
17.	Tryptophan	**Trp[a]**	ND
18.	Cysteine	Cys	ND

Note: [a] shows Essential amino acid. * shows highest value. ♠ shows lowest value. ND= amino acid was not determined.

Table 3. showing the concentration of amino acids in the muscles of Black pomfret, *Parastromateus niger* collected from Quetta on dry weight basis (mg/Kg).

S.No.	Amino acid	Amino acid code	Amount (mg/kg)
1.	Aspartic acid	Asp	0.243
2.	Threonine	**Thr[a]**	0.376
3.	Serine	Ser	0.255
4.	Glutamic acid	Glu	0.739
5.	Proline	Pro	**2.373***
6.	Glycine	Gly	0.210
7.	Alanine	Ala	0.667
8.	Valine	**Val[a]**	0.249
9.	Methionine	**Met[a]**	**0.103♠**
10.	Isoleucine	**Ile[a]**	0.281
11.	Leucine	**Leu[a]**	0.676
12.	Tyrosine	Tyr	0.364
13.	Phenyalanine	**Phe[a]**	0.188
14.	Histidine	**His[a]**	0.403
15.	Lysine	**Lys[a]**	1.252
16.	Arginine	Arg	0.501
17.	Tryptophan	**Trp[a]**	**ND**
18.	Cysteine	Cys	**ND**

Note: [a] shows Essential amino acid. * shows highest value. ♠ shows lowest value. ND= amino acid was not determined.

Table 4. Showing the concentrations of amino acids in the muscle of Silver pomfret, *Pampus argenteus* collected from Quetta on dry weight basis (mg/Kg).

S.No.	Amino acid	Amino acid code	Amount (mg/kg)
1.	Aspartic acid	Asp	0.120
2.	Threonine	Thr[a]	0.519
3.	Serine	Ser	0.063
4.	Glutamic acid	Glu	0.291
5.	Proline	Pro	0.896
6.	Glycine	Gly	0.052
7.	Alanine	Ala	0.210
8.	Valine	Val[a]	0.116
9.	Methionine	Met[a]	0.746
10.	Isoleucine	Ile[a]	0.033
11.	Leucine	Leu[a]	0.145
12.	Tyrosine	Tyr	0.033
13.	Phenyalanine	Phe[a]	0.047
14.	Histidine	His[a]	**0.033♠**
15.	Lysine	Lys[a]	**2.708***
16.	Arginine	Arg	0.175
17.	Tryptophan	Trp[a]	ND
18.	Cysteine	Cys	ND

Note: [a] shows Essential amino acid. * shows highest value. ♠ shows lowest value. ND= amino acid was not determined.

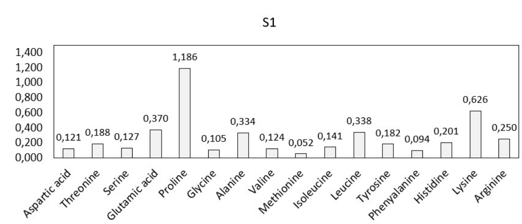

Figure 1. Showing the concentration of amino acids in the scales of Black pomfret, in mg/kg of crude protein.

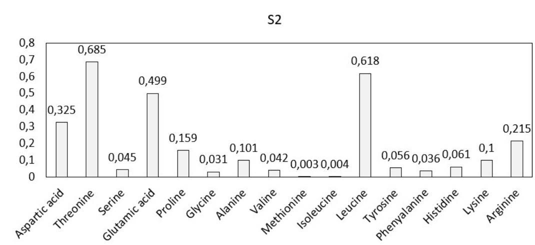

Figure 2. Showing the concentrations of amino acids in the scales of Silver pomfret in mg/kg of crude protein.

from the coastal area. These variations in the amount of protein of both muscles and scales obtained from various fish species might be due to variation in habitats,

Table 5. Showing the Correlations and covariance's between amino acid contents in the scale and muscle samples of Black pomfret, *Parastromateus niger* and Silver pomfret, *Pampus argenteus* collected from Quetta on dry matter basis (mg/Kg).

S.No.	*Parastromateus niger* mg/kg	*Pampus argenteus* mg/kg	Pearson Correlation (r)	p-value at 5%	Significance	Covariance's (C.V)
1.	S1 *vs.* S2		0.121	0.66	*	0.007[b]
2.	M1 *vs.* M2		0.532	0.03	**	0.201[b]

Where: S1=is the scale samples of *Parastromateus niger;* S2=is the scale samples of *Pampus argenteus;* M1=is the muscle samples of *Parastromateus niger;* M2=is the muscle samples of *Pampus argenteus.* Note: *shows insignificance relationships between amino acid content of two scale samples at 5% level (when P> 0.05). While ** shows highly significance relationship between amino acid content of two scale samples at 5% level (when P< 0.05). [a:] shows the highest value of covariance (C.V). [b:] shows the lowest value of covariance (C.V).

Table 6. One-Way ANOVA for analysis of variations between means of the amino acid compositions in the scales and muscles among black and silver pomfret fishes collected from Quetta.

Species	Symbol of Means	Mean ± sd	95% CI	ANOVA at significance level α = 0.05 (when P<0.05).					
				Source	**df**	**Adj SS**	**Adj MS**	**F-Value**	**p-value**
Parastromateus niger	S1	0.27±0.28	(0.15,0.41)	Factor	1	0.07	0.066	1.03	**0.31***
Pampus argenteus	S2	0.18±0.22	(0.06, 0.32)	Error	30	1.94	0.064		
				Total	31	2.01			
Parastromateus niger	M1	0.55±0.56	(0.23,0.87)	Factor	1	0.23	0.226	0.59	**0.45***
Pampus argenteus	M2	0.38±0.67	(0.07,0.70)	Error	30	11.6	0.385		
				Total	31	11.8			

Note: *shows insignificant variations when P>0.05. CI=Confidence Interval.

Table 7. Turkey Simultaneous Tests and 95% Confidence for Differences of Means of the scales and muscles among black and silver pomfret fishes.

Difference of samples	Difference of Means	SE of Difference	95% CI	T-test	P-value
S1-S2	-0.0912	0.090	(-0.275, 0.093)	-1.01	**0.319***
M1-M2	-0.168	0.219	(-0.616, 0.280)	-0.77	**0.449***

Note: *shows the p-value insignificant when P>0.05. Individual confidence level = 98.00%.

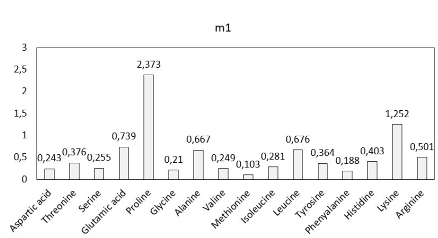

Figure 3. Showing the concentration of amino acids in the muscles of Black pomfret in mg/kg of crude protein.

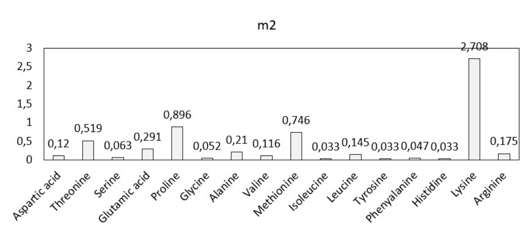

Figure 4. Showing the concentration of amino acids in the muscle of Silver pomfret in mg /kg of crude protein.

seasons, great diversity in feeding habits, and certain other physiological and environmental factors as observed by Saraswat (1976). Kaushik (1998) had found that crude protein (CP) content ranged from 57% to 71% on a dry weight basis in the whole-body composition of European seabass, gilthead seabream, and turbot fish. Solanki et al. (1976) had also detected the seasonal variant in the biochemical composition of silver pomfret, *P. argenteus*.

3.2. Amino acid composition in scales and muscles of pomfret fishes

Out of twenty types of amino acids, eighteen amino acids were examined in both scales and muscles of *P. niger* and *P. argenteus*, and both tryptophan and cysteine were not detected in the present study. Furthermore, the composition of amino acids found in scales and muscles of *P. niger* reveals the highest amount of proline and lysine, but methionine was found in less than other amino acids, as shown in Tables 1 and 2 and Figures 1 and 2, respectively. The obtained results of amino acids present in scales of *P. argenteus* revealed that its scales were enriched in amino acids in order of threonine>leucine>glutamic acid>aspartic acid and arginine methionine was reported in fish meager quantity, as presented in Table 2 and Figure 2, respectively. On the other hand, the muscle samples of *P. argenteus* revealed the different concentrations of amino acids were found in order of lysine> proline>methionine, but histidine was found less, as shown in Tables 4 and Figures 4, respectively. The lowest concentration of amino acids like methionine, tryptophan, and cysteine might be due to the slight acid treatment during the digestive samples, as reported by Zhao et al. (2010). As muscle samples of *P. argenteus* also shows high lysine content had observed much healthier than cereals based diets used for obtaining the lysine for growing children's in developing countries. Kim and Lall (2000), Gallinetti et al. (2013), and Wu (2010, 2013) have found amino acids as essential components, which can play a chief role in the regulation of metabolism for the health of each living organisms. Dhaneesh et al. (2012) had observed the essential amino acids i.e., leucine, lysine, and methionine in commercially important edible fish species of *Lakshadweep archipelago*, India. Kaushik (1998) had also studied the whole-body amino acid composition of European sea bass (*Dicentrarchus labrax*), gilthead sea bream (*Sparus aurata*), and turbot (*Psetta maxima*) observed no significant variations in amino acid contents with different body sizes. Our present results of amino acid compositions in scales and muscles of *P. niger* were following Masood et al. (2015b), who also described the higher concentration of proline in scales of *Labeo rohita,* and less quantity of methionine. Hossain et al. (2011) had also analyzed the high contents of essential amino acids (EAA) e.g., lysine, leucine, histidine, phenylalanine, methionine, and threonine, in the whole body of silver pomfret, *P. argenteus*. Li et al. (2009) proposed that proline is an essential amino acid that helps enhance fish growth; thence, the occurrence of large amounts of this kind of amino acid would be helpful for all physiological processes in fish. The presence of such large amounts of proline in fish scales may be due to its contributions to the synthesis of proteins like collagen, following Zhang et al. (2011).

Lysine is also an essential amino acid (EAA), which was found high in muscles of both *P. argenteus* and *P. niger,* and in scales of *P. niger,* which can play a vital role in the strengthening of the immune system and also help in the regulation of growth (Chen et al., 2003). Our present work was also in agreement with Zuraini et al. (2006), who also detected lysine as a prominent essential amino acid in *Tor putitora*. Threonine was another essential amino acid (EAA), which was also found in pronounced amounts in scales of *P. argenteus,* which was following Mohanty et al. (2014), who had also described the highest content of threonine in marine fish species, i.e., *Stolephorus waitei*. Threonine may also show a substantial role in the therapeutic process during coordination and nervous defects, therefore directed to all patients suffering from these disorders (Hyland, 2007). Besides, leucine was found in a noticeable amount in the scales of *P. argenteus* of the present study.

Such the highest amount of leucine was primarily observed in fishes that occur in marine habitats, which also aids in building protein that happens in their muscles (Mohanty et al., 2014). Dillon (2013) had also reported that such the highest amount of leucine could exhibit its capability to stop protein breakdown. The above observations associated with essential amino acids (EAA) in scales of pomfret fishes also emphasize the importance of current findings. The level of methionine also shows tremendous variation amongst the scales and muscles of black and silver pomfret fishes and described the highest content of methionine found in muscles of silver pomfret of this study, respectively. While in contrast, low levels of methionine in scales of black and silver pomfret fishes and the muscles of black pomfret. Such a high level of methionine in silver pomfret may illuminate the presence of its strong liver. This might be because Loest et al. (1997) stated that liver disorders could also be treated by using methionine to support the process of healing and in numerous health phenomena'. Wang et al. (2012) had also clarified the significant role of methionine in the methylation process of the fish body.

Among the non-essential amino acids (NEAA), the amount of glutamic acid was also high in scales of *P. argenteus*, which was following Sathivel et al. (2005), and Hou et al. (2011), who also detected a large amount of glutamic acid in salmon and mackerel fishes. Mohanty et al. (2014) also reported the high content of glutamic acid in catfish and common carp, because of its essential role in metabolism and helped in detoxification. Nevertheless, arginine was observed in less concentration except in scales of *P. argenteus* of the present study, which was in association with Mohanty et al. (2014), who also examined a significantly less quantity of arginine in marine fishes. Sarma et al. (2013) reported that fishes that live in cold waters were enriched in arginine because it helps in cell division.

Moreover, no prominent variations were observed among the amino acid compositions between the fishes found in both freshwaters and marine environments, following Saad and Alim (2015). Muyonga et al. (2004) had observed a small quantity of tyrosine, histidine, and tryptophan in fish, which also represents the occurrence of collagen. Though our present findings were more in harmony with several other workers who have done their work on analyzing fish's amino acid composition, some variations were observed, which might be because of usages of dissimilar fisheries derivatives that show their unique compositions with variable percentages for these constituents. Still, some substantial work is also essential to modernize the in-depth information associated with black and silver pomfret species found along the Pakistan coast.

Table (5) presenting the values of correlations coefficients (r-values) and covariance's (C.V) between the different compositions of amino acids found in scales and muscles of *P. niger* and *P. argenteus* on a dry weight basis (mg/Kg). Our present results showed insignificant relationships (P> 0.05), and a low value for Covariances; that is, C.V= 0.007[b] were observed among the amino acid compositions in the scales of two pomfret species. But the muscle samples of both pomfret species, in contrast, we're demonstrating the significant relationship (P<0.05) and low value of Covariance (C.V), that is 0.201[b]. Therefore, the composition of amino acids in scales amongst the two pomfret species was found identical, though different in their muscles. Tables 6 presented One-Way ANOVA at 5% significance were calculated to examine the deviations amongst the means of the amino acid composition found in scales and muscles of black and silver pomfrets of Balochistan coast. Present results also showed no significant variations (P>0.05) amongst the amino acid compositions in scales and muscles of the black and silver pomfret fishes.

4. Conclusions

Our present results concluded that both muscles and scales of black and silver pomfrets of the present study could also be used as raw materials in industries for food processing products, cosmetics, fertilizers, pharmaceutical supplements, and significant protein sources for a growing world. Furthermore, this work could be used as a valuable tool for the nutritional benefits of the *P. argenteus* and *P. niger*. Fisheries biologists, nutritionists, zoologists, industrialists, and many other ichthyologists could also utilize all these outcomes to make future researchers.

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