Research Article

Proximate, Minerals and Fatty Acids Compositions in Different Muscles of Wild and Cultured *Osteobrama belangeri* (Valenciennes, 1844)

Ngangom Lucky Devi*, Chungkham Sarojnalini

Department of Zoology, Centre for Advanced Study in Life Sciences, Manipur University, Imphal, Manipur, INDIA.

Submission Date: 02-06-2022; Revision Date: 17-06-2022; Accepted Date: 25-07-2022.

ABSTRACT

Osteobrama belangeri is a medium carp that belongs to the family cyprinidae. Once abundantly found in Myanmar and India, the population of this fish in the wild especially in India has depleted significantly in the last four decades and has been declared "Near threatened" in the recent past. This article aims to quantify and compare the proximate composition, minerals and fatty acids in wild and cultured *Osteobrama belangeri*. Fatty acids are analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). Minerals analysis was carried out using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). Elements like Na, K, Fe, Cu, Zn and Se are found higher in the wild fish whereas Ca, Mg and Mn are found higher in the cultured fish. Palmitic acid, oleic acid and linoleic acid are the main fatty acids found in all the samples. The wild fish contains a relatively higher level of ω-3 and ω-6 polyunsaturated fatty acids, particularly docosahexaenoic acid, linoleic acid and arachidonic acid. The results also reflect a low total ω-3:ω-6 ratio in both wild and cultured fishes indicating a beneficial aspect for consumption. The results show that both cultured and wild species contain significant and comparable levels of valuable nutrients such as minerals (Na, K, Fe, Cu, Zn, Se Ca, Mg and Mn) and fatty acids especially oleic acid, linoleic acid, arachidonic acid and docosahexaenoic acid. Since the fish remains popular in India, it is suggested that the cultured fish be utilized for consumption while the wild fish be preserved.

Keywords: *Osteobrama belangeri*, Proximate composition, Fatty acids, Minerals analysis.

Correspondence:
Mrs. Ngangom Lucky Devi,
Department of Zoology, Centre for Advanced Study in Life Sciences, Manipur University, Imphal, Manipur, INDIA.

Email: luckyngangom@manipuruniv.ac.in

INTRODUCTION

Osteobrama belangeri (Valenciennes, 1844), which belongs to the order cypriniformes and family cyprinidae is a medium-sized carp that was once abundant in Myanmar and the Indian state of Manipur. *Osteobrama belangeri*, also regarded as the state fish is a highly esteemed fish among the people of Manipur where it is locally known as "*Pengba*". In the past, a sizeable population of fish used to be found in the Loktak Lake (Figure 1) of Manipur. The fish would habitually migrate upstream from the Chindwin-Irrawaddy River system of Myanmar to the Manipur River for breeding in the adjoining streams and lakes of Imphal valley especially the Loktak in the early monsoon.[1] The important stretches of the aforementioned rivers are shown in Figure 1. With the construction of the Ithai barrage (Figure 1) downstream of the Manipur River in 1983, the migratory route of the fish was blocked and led to the gradual decline of its indigenous population in the state. The introduction of invasive species and overexploitation further accelerated the disappearance of the fish from Manipur in the following years. Due to the dwindling population in the wild, the status of the fish had been assessed as "Extinct in wild",[2] "Endangered"[3] and "Near threatened".[4]

At present, wild *Osteobrama belangeri* is occasionally found and caught from the Lokchao river and sold in the Moreh market (Figure 1), a border town in Manipur adjoining Myanmar. The fish is also locally bred and cultured in some parts of Manipur. As reviewed by

SCAN QR CODE TO VIEW ONLINE

www.ajbls.com

DOI: 10.5530/ajbls.2022.11.78

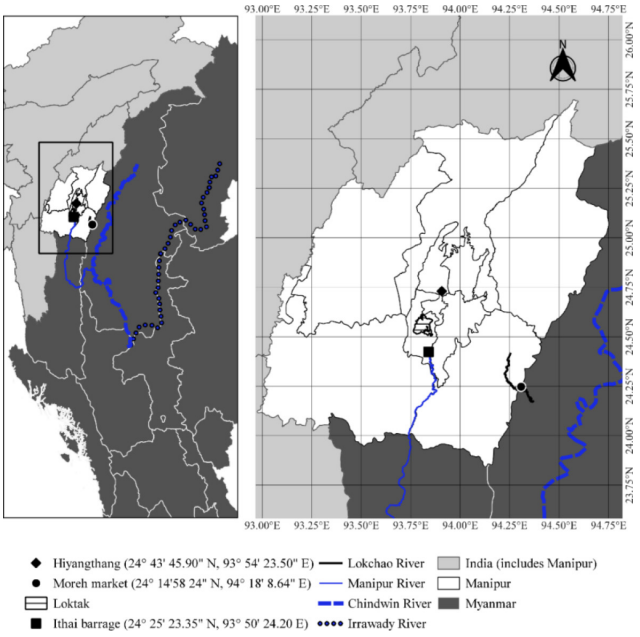

Figure 1: Map of the important sites and locations related to the current study. Prepared in QGIS® version 3.20.1.

Shearer,[5] factors such as temperature, and salinity influence the proximate composition of fish. Further, freshwater fishes are generally rich in linoleic acid and linolenic acid whereas marine fishes are rich in docosahexaenoic acid and eicosapentaenoic acid.[6] Thus, the nutrient compositions in the wild and cultured fish could vary. Several researchers have shown the variation in the content of nutrients among some other species of fish collected from the wild and cultured habitats. Grigorakis *et al.*[7] reported the lipid content in cultured sea bream to be significantly higher than that in the wild fish. In addition, the cultured fish contained higher levels of monounsaturated fatty acids. Alasalvar *et al.*[8] compared the content of lipid and minerals in wild and cultured seabream (*Pagellus bogaraveo*) and found that the cultured fish contained higher levels of saturated fatty acids (SAFAs) and unsaturated fatty acids such as monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) and lower levels of total ω-3/ω-6 ratios. Minerals such as Cu, Fe, Mn, Se and Zn were higher in the cultured fish whereas Ca and Mg were higher in the wild fish. Similar other types of studies include.[9–11] Some researchers have also shown variation in the composition of the nutrients according to the different types of muscles in the same fish. Álvarez *et al.*[12] compared the content of lipid and minerals in the different muscles from ventral, dorsal and tail portions of wild and cultured seabream (*Pagellus bogaraveo*) and found that higher SAFAs, MUFAs and PUFAs were present in the dorsal muscles for both wild and cultured fish. So far, no researcher has compared the composition of the nutrients in wild and cultured *Osteobrama belangeri*. The objective of this study is to carry out a rigorous nutrient analysis in wild and cultured *Osteobrama belangeri* that includes the composition of proximate components, minerals and fatty acids. The nutrient profile is compared among the dorsal, ventral and whole muscles of the wild and cultured fish.

MATERIALS AND METHODS

Sampling

A total of 12 wild *Osteobrama belangeri* were bought from the market at Moreh and the cultured samples were bought from the local fish farm at Hiyangthang, Manipur. For both wild and cultured fish, sampling was carried out in the winter season between December and January for two consecutive years. The sampling sites are shown in Figure 1. Typical photographs of the fishes are shown in Figure 2. On average, the wild samples were about 1.5 times longer and 4.6 times heavier than the cultured samples. To make up for this significant variation, a pool of five samples of the cultured fish was considered per sample of the wild fish. Bogard *et al.*[13] used a similar procedure. The fishes were brought to the laboratory by stored in ice baths where they were washed to remove the adhering blood and excessive mucus. The fishes were then beheaded, gutted and the edible muscles from the dorsal (region A) and ventral (region B) portions indicated in Figure 2, were divided. The entirety of both A and B combined were considered as the whole muscles.

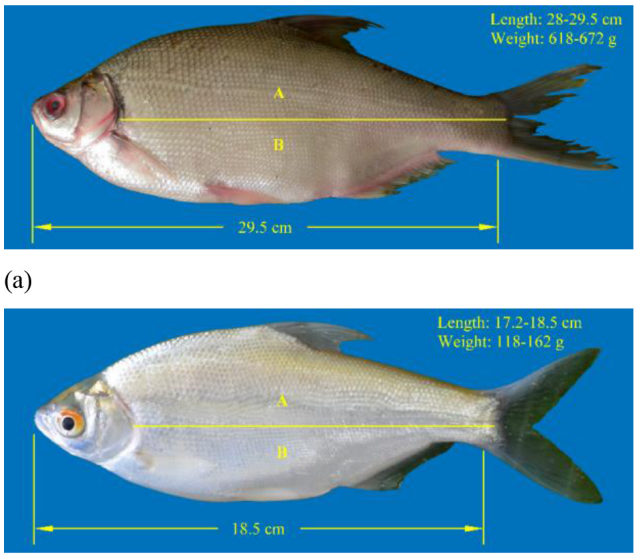

Figure 2: Photographs of the external morphology of (a) wild and (b) cultured *Osteobrama belangeri*.

Proximate Analysis

For the proximate analysis moisture was estimated following the hot air oven method.[14] Total lipid was extracted using the procedure of Singh *et al.*[15] Ash content was determined following the method in AOAC (2019).[14] Determination of total nitrogen content was carried out by the modified micro Kjeidahl's method and multiplied by 6.25 to estimate the crude protein.

Mineral Analysis

The sample was prepared following the method in AOAC (2019).[14] One gram of fish was taken in a digestion vessel and added with 8 mL of concentrated HNO_3 (Trace Metal™ Grade, Fisher Scientific) and 2 mL of H_2O_2 (Optima, Fisher Scientific). The mixture was then kept in a microwave digestion chamber for 40 mins for digestion. After digestion, the sample was made up to 100 mL with Milli Q water in a volumetric flask and filtered through a membrane (0.45 µm). The filtrate was analyzed by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) equipment iCAP 6300 Duo (make Thermo Fisher Scientific, Cambridge, England) with axial-radial dual configuration operating iTEVA software (ver 2.8.0.97). The standard solution used for calibration was CertiPUR, Merck based on Yttrium as the internal standard.

Fatty Acid Analysis

Total lipid was extracted and purified following the method in Singh *et al.*[15] using chloroform-methanol (2:1, v/v) solvent method. Fatty acid methyl esters (FAMEs) were prepared using the technique in Metcalfe *et al.*[16] The solvents and chemicals were of analytical grade. The FAMEs were analyzed in Gas Chromatography-Mass Spectrometry (GC-MS) equipment QP2010 Plus with Thermal Desorption System TDS-20 (make Shimadzu) equipped with Flame Ionization Detector (FID). The column was Rxi-5Sil MS with dimensions 30 m×0.25 mm ID and 0.25 μm thick film. The injector and ion source was maintained at 260°C and 230°C, respectively. The injection volume was 2 μL and the operating split ratio was 10:1. Initially, the oven temperature was set at 140°C. After holding for 5 min, the temperature was linearly increased by a rate of 4°C·min^{-1} till 280°C, which was held again for 2 min resulting in a total run time of 42 mins. The carrier gas was helium maintained at a flow rate of 1.21 mL·min^{-1}. Fatty acids were identified by mass spectra and by comparing their mass spectra with data available in the NIST 14 library. The data were shown as a percentage of the total area of peaks obtained from the GC-MS.

Statistical analysis

For each experimental sample, three trial experiments were performed for repeatability. One-way ANOVA was performed by considering all the conditions as one factor. Subsequently, a two-way ANOVA was performed to study the independent effect of the factors *viz.*, habitat (F_H), muscle type (F_M) and their interaction (F_H: F_M) on the resulting nutrient concentrations.

The ANOVA qualitatively indicates significant factors. To quantify the level of significance of the factors, a post hoc analysis based on Tukey's test ($p<0.05$) was carried out. Statistical package SPSS ver. 25 was used. The data were presented as mean±standard deviation (SD) corrected up to two decimal places.

RESULTS AND DISCUSSION

Proximate Composition

The result of the proximate analysis is shown in Table 1. Focusing first on protein, the content ranges from 15.76-18.56% with the highest and lowest recorded in the whole muscle of the wild fish and dorsal muscle of the cultured fish. The variation of the content is significantly influenced by the muscle ($p\leq0.001$), habitat ($p\leq0.001$) and their interaction ($p\leq0.05$) as indicated by the two-way ANOVA. This is also complemented by

Table 1: Proximate composition in dorsal, ventral and whole muscles of wild and cultured *Osteobrama belangeri*.

Proximate composition	Dorsal		Ventral		Whole		Factorial ANOVA		
	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	F_M	F_H	F_M: F_H
Moisture	74.56±0.40^{cd}	75.05±0.25^{d}	65.08±0.45^{a}	65.53±0.22^{a}	73.06±0.27^{b}	73.85±0.63^{bc}	***	**	ns
Total lipid	5.82±0.13^{b}	5.25±0.11^{a}	14.38±0.17^{e}	14.13±0.29e	8.27±0.23^{d}	7.25±0.16^{c}	***	***	*
Protein	16.72±0.19^{b}	15.76±0.18^{a}	18.28±0.13^{cd}	18.02±0.23^{c}	18.56±0.24^{d}	18.12±0.11^{cd}	***	***	*
Ash	3.13±0.12^{ab}	4.66±0.20^{c}	2.60±0.24^{a}	2.86±0.28^{ab}	3.12±0.16^{ab}	3.23±0.14^{b}	***	***	***

Note: Mean±SD followed by identical superscripts are not significantly different ($p\leq0.05$); significance codes for two-way ANOVA: ***: ($0\leq p\leq0.001$), **: ($0.001<p\leq0.01$), *: ($0.01<p\leq0.05$), ns: ($0.1<p\leq1$). ns: not significant.

the one-way ANOVA where the comparisons among conditions with large factorial significance have different superscripts. This variation could be due to endogenous factors like size, sex, lifecycle stage and exogenous factors like habitat, temperature, salinity and diet.[5] The protein content is the highest in the whole muscle of wild fish with a mean content of 18.56% and lowest in the dorsal muscle of the cultured fish with a mean content of 15.76%. The ventral muscle of the wild fish has a mean content of 18.28% comparable to that of the whole muscle of the wild fish. For all the muscles, the wild fish had a higher content than the cultured fish. The content range of protein is comparable to that (15-20%) reported by FAO (1991)[17] for fish tissue. The range is also similar to those found in other freshwater fishes such as *Cyprinus carpio* (16.69%), *Acipenser ruthenus* (17.54%), *Abramis brama* (17.57%), *Aspius aspius* (18.07%) and *Esox lucius* (18.43%) reported by Ljubojevic *et al.*[18] The similarities may be attributed to the factors such as the likeness of the freshwater habitat and the comparability of the size of these fishes that contribute to the level of protein.[5] Hence, *Osteobrama belangeri* can be considered a good source of quality protein.

The total lipid content ranges from 5.25% to 14.38% with the highest recorded in the ventral muscle of the wild fish and conforms to the range (15-18%) reported by FAO (1991)[17] in fish. The higher percentage of lipid contents observed in the ventral muscles of wild (14.38%) as well as cultured (14.13%) fish have been reported in similar studies. According to Rahnan *et al.*[19] fishes are classified into lean (fat < 5%), medium fat (fat: 5%–10%) and fatty fish (fat more than 10%). Thus, *Osteobrama belangeri* can be classified as a medium to fatty fish. For in fatty fishes, the ventral muscles usually contain higher lipids than the dorsal muscles because the lipids are stored in the subcutaneous tissue that includes the belly flap muscle of the ventral region.[20] The two-way ANOVA indicates a highly significant ($p \leq 0.001$) role of the muscle type or habitat on the variability of lipid.

The highest moisture content is recorded in the dorsal muscles of the cultured fish (75.05%). The variability of moisture is significantly influenced by the muscle type ($p \leq 0.001$) and habitat ($p \leq 0.01$) whereas that due to their interaction is insignificant. The content of moisture varies inversely with the lipid content whose content is significantly affected by both endogenous factors like size, sex, life cycle stage and exogenous factors such as diet, temperature and salinity.[5] Thus, the content of moisture is indirectly affected by habitat and the type of muscles. The highest content of ash is in the dorsal muscle of the cultured fish (4.66%) whereas the lowest is in the ventral muscle of the wild fish (2.60%). The cultured fish contained a higher level of ash in all the muscles, especially in the dorsal muscle where the difference is much more significant although the differences in the ventral and whole muscles are not significant. The results of this study are within the ranges found by Sarower-E-Mahfuj *et al.*[21] in *Labeo bata*. As indicated in Table 1, the content of ash is significantly ($p \leq 0.001$) influenced by the muscle type, habitat as well as their interaction.

Minerals composition

The mineral profiles of different muscles in wild and cultured *Osteobrama belangeri* are shown in Table 2. Among the main elements, P is the most abundant followed by K, Ca, Na and Mg. The trace elements obtained in the decreasing order are Fe, Zn, Cu, Se and Mn. Elements K, Ca, Na, Fe, Zn, Cu and Se are found higher in the wild fish whereas the Mg and Mn are found higher in the cultured fish in all the muscles. The two-way ANOVA indicates that the effect of the muscle type, habitat as well as their interactions have a very high significance ($p \leq 0.001$) on the contents of all the main and trace elements. The higher concentrations of most of the elements in the wild fish could be due to the difference in the food habits of the wild and cultured fish where the wild fish have access to a more extensive variety of foods. Nevertheless, the content of these elements in the cultured fish can be improved by the adoption of better aquaculture techniques and the enriched quality of the feeds. The ranges obtained from the current study also fare with those typical in freshwater fishes as reported in the study by Bogard *et al.*[13] who carried out extensive nutrient profiles including analysis of minerals.

Fatty Acids Composition

The fatty acid profiles of wild and cultured *Osteobrama belangeri* comprise SAFAs, MUFAs and PUFAs. Thirty-four fatty acids are identified in the wild fish whereas twenty-eight fatty acids are identified in the cultured fish.

SAFAs Content

Referring to Table 3, palmitic acid is the most significantly found SAFA where the content in the cultured fish (dorsal: 23.85%, ventral: 24.65%, whole: 24.08%) is slightly higher than that in the wild fish (dorsal: 21.71%, ventral: 21.68%, whole: 21.04%). These are comparable to that reported by Swapna *et al.*[22] in some Indian freshwater fishes. Stearic acid is the next abundant SAFA where the content is slightly higher in cultured fish (dorsal: 9.62%, ventral: 8.72%, whole: 9.45%) than the wild fish (dorsal: 7.86%, ventral: 7.78% and whole:

Table 2: Mineral elements in dorsal, ventral and whole muscles of wild and cultured *Osteobrama belangeri*.

Elements	Dorsal		Ventral		Whole		Factorial ANOVA		
	Wild (mg·100 g^{-1})	Cultured (mg·100 g^{-1})	Wild (mg·100 g^{-1})	Cultured (mg·100 g^{-1})	Wild (mg·100 g^{-1})	Cultured (mg·100 g^{-1})	F_M	F_H	F_M: F_H
Main									
Na	108.65±0.29^{e}	79.93±1.58^{c}	118.45±1.21^{f}	72.25±0.27^{a}	91.24±0.04^{d}	76.48±0.52^{b}	***	***	***
Mg	71.04±0.79^{e}	80.23±0.58^{f}	56.68±0.55^{b}	58.46±0.50^{c}	54.12±0.10^{a}	63.01±0.09^{d}	***	***	***
P	698.35±1.60^{d}	720.07±1.94^{e}	637.52±1.72^{c}	589.85±1.39^{b}	578.03±0.41^{a}	669.63±0.50^{f}	***	***	***
K	681.87±1.33^{f}	643.27±1.69^{e}	524.94±1.71^{d}	411.38±1.80^{a}	512.34±0.33^{c}	500.05±0.18^{b}	***	***	***
Ca	157.98±1.28^{a}	157.04±2.61^{a}	220.67±0.82^{d}	212.25±0.57^{c}	224.65±1.06^{e}	169.71±0.13^{b}	***	***	***
Trace									
Mn	0.08±0.00^{a}	0.12±0.00^{c}	0.10±0.00^{b}	0.17±0.00^{d}	0.08±0.00^{b}	0.19±0.00^{e}	***	***	***
Fe	3.99±0.05^{e}	2.49±0.05^{b}	3.79±0.04^{d}	2.14±0.02^{a}	3.27±0.05^{c}	2.07±0.05^{a}	***	***	***
Cu	0.25±0.00^{f}	0.15±0.00^{c}	0.20±0.00^{e}	0.09±0.00^{a}	0.16±0.00^{d}	0.13±0.00^{b}	***	***	***
Zn	2.86±0.03^{e}	2.34±0.05^{c}	2.62±0.02^{d}	1.55±0.03^{a}	2.24±0.03^{c}	2.13±0.07^{b}	***	***	***
Se	0.20±0.00^{d}	0.16±0.00^{b}	0.20±0.00^{d}	0.15±0.00^{a}	0.17±0.00^{c}	0.15±0.00^{a}	***	***	***

Note: Mean±SD followed by identical superscripts are not significantly different (p≤0.05); significance codes for two-way ANOVA: ***: (0≤p≤0.001).

Table 3: SAFAs and MUFAs content in dorsal, ventral and whole muscles of wild and cultured *Osteobrama belangeri*.

Fatty acid	Dorsal		Ventral		Whole		Factorial ANOVA		
	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	F_M	F_H	F_M: F_H
Lauric acid	0.06±0.01^{a}	nd	0.11±0.01^{b}	nd	0.14±0.01^{c}	nd	***	***	***
Tridecylic acid	1.30±0.18^{c}	0.48±0.03^{a}	1.00±0.06^{b}	0.49±0.06^{a}	1.10±0.04^{bc}	0.48±0.05^{a}	*	***	*
Myristic acid	1.90±0.14^{b}	1.63±0.07^{a}	1.74±0.03^{ab}	1.55±0.07^{a}	1.93±0.08^{b}	1.60±0.08^{a}	*	***	ns
Pentadecylic acid	0.57±0.06^{a}	1.30±0.13^{b}	0.64±0.11^{a}	1.52±0.06^{bc}	0.63±0.06^{a}	1.74±0.28^{c}	*	***	ns
Palmitic acid	21.71±0.12^{a}	23.85±0.64^{b}	21.68±0.50^{a}	24.65±0.55^{b}	21.04±0.58^{a}	24.08±0.65^{b}	ns	***	ns
Margaric acid	0.52±0.03^{a}	1.18±0.15^{b}	0.61±0.14^{a}	0.98±0.09^{b}	0.68±0.01^{a}	1.02±0.02^{b}	ns	***	*
Stearic acid	7.86±0.15^{a}	9.62±0.52^{b}	7.78±0.82^{a}	8.72±0.14^{ab}	7.79±0.46^{a}	9.45±0.84^{b}	ns	***	ns
Nonadecylic acid	0.13±0.04^{a}	nd	0.41±0.05^{c}	nd	0.23±0.04^{b}	nd	***	***	***
Arachidic acid	0.51±0.02^{ab}	0.41±0.03^{a}	0.53±0.06^{ab}	0.43±0.04^{ab}	0.59±0.13^{b}	0.42±0.03^{ab}	ns	**	ns
Behenic acid	0.72±0.08^{c}	0.46±0.03^{b}	0.80±0.05^{c}	0.23±0.05^{a}	0.74±0.06^{c}	0.27±0.04^{a}	*	***	**
Lignoceric acid	0.17±0.02^{a}	0.57±0.08^{c}	0.17±0.04^{a}	0.23±0.01^{ab}	0.28±0.07^{ab}	0.32±0.04^{b}	***	***	***
SAFAs	**35.45±0.71^{a}**	**39.50±0.57^{b}**	**35.47±0.31^{a}**	**38.80±0.75^{b}**	**35.15±0.38^{a}**	**39.38±0.87^{b}**	**ns**	***	**ns**
Palmitoleic acid	2.37±0.42^{ab}	1.64±0.32^{a}	2.77±0.04^{b}	1.98±0.22^{a}	2.78±0.31^{b}	1.91±0.16^{a}	•	***	ns
Palmitelaidic	0.97±0.09^{b}	0.58±0.03^{a}	0.89±0.10^{b}	0.57±0.09^{a}	0.85±0.08^{b}	0.55±0.02^{a}	ns	***	ns
Oleic acid	26.86±0.46^{a}	34.81±0.88^{b}	26.26±0.90^{a}	34.83±0.55^{b}	26.31±0.38^{a}	34.93±0.79^{b}	ns	***	ns
Elaidic acid	0.16±0.02^{a}	0.37±0.07^{b}	0.15±0.01^{a}	0.35±0.05^{b}	0.14±0.02^{a}	0.39±0.05^{b}	ns	***	ns
Vaccenic acid	nd	0.62±0.05^{b}	nd	0.42±0.02^{a}	nd	0.68±0.06^{b}	***	***	***
Nonadecenoic acid	nd	0.62±0.10^{a}	nd	0.64±0.12^{a}	nd	0.63±0.20^{a}	ns	***	ns
Eicosenoic acid	1.53±0.44^{b}	0.46±0.06^{a}	1.46±0.11^{b}	0.19±0.01^{a}	1.96±0.18^{b}	0.10±0.01^{a}	ns	***	*
Erucic acid	0.24±0.06^{a}	1.18±0.17^{b}	0.23±0.04^{a}	2.01±0.16^{c}	0.16±0.05^{a}	1.28±0.12^{b}	***	***	***
MUFAs	**32.13±0.53^{a}**	**40.28±0.48^{b}**	**31.76±0.50^{a}**	**40.99±0.91^{b}**	**32.20±0.97^{a}**	**40.47±0.72^{b}**	**ns**	***	**ns**

Note: Entries followed by identical superscripts are not significantly different (p≤0.05); ***: (0≤p≤0.001), **: (0.001<p≤0.01), *: (0.01<p≤0.05), • : (0.05<p≤0.1), ns: (0.1<p≤1); nd: not detected; ns: not significant.

7.79%). The results match those of Mnari *et al.*[23] with reported concentrations of stearic acid in dorsal and ventral muscles of wild gilthead sea bream as 7.56% and 7.42%, respectively. For both the SAFAs, the two-way factorial ANOVA indicated that the content of the fatty acid was significantly ($p < 0.001$) affected only by the variation in the habitat. The role of the interaction between habitat and muscle is also insignificant.

MUFAs Content

As shown in Table 3, MUFAs such as palmitoleic, palmitelaidic, oleic, elaidic, eicosenoic and erucic acids are present in both wild and cultured fish, whereas vaccenic and nonadecanoic acid is exclusively found only in the wild fish although negligibly. Oleic acid is the predominant MUFA whose concentration in the cultured fish (dorsal: 34.81%, ventral: 34.83%, whole: 34.93%) is significantly higher than that in the wild fish (dorsal: 26.86%, ventral: 26.26%, whole: 26.31%). This variation is reflected by the two-way ANOVA where the variability of the total MUFA is significant only due to the habitat. The results from the present study are similar to those in studies.[18,24] Oleic acid regulates blood pressure and lowers the risk of cardiovascular disease.[25] Palmitoleic acid is the second most abundant MUFA ranging from 1.64% to 2.78% with significant differences among the dorsal, ventral and whole muscles. Rahnan *et al.*[19] reported a similar range (1.50-2.98%) in some Malaysian freshwater fishes. The content variation due to the habitat is highly significant ($p < 0.001$) whereas that due to the type of muscle is least significant ($p < 0.1$). The role of the interaction between habitat and muscle is also insignificant.

PUFAs content

Omega-3 and Omega-6 PUFAs although highly beneficial to human health but cannot be synthesized in the human body and must be obtained through food.[6] Referring to Table 4, linoleic acid (LA) is the most significant PUFA with a higher concentration in the wild fish (dorsal: 14.88%, ventral: 13.28%, whole: 13.95%) than in the cultured counterpart (dorsal: 8.73%, ventral: 9.15%, whole: 8.84%). These are similar to those found in the freshwater fishes *Cichla ocellaris*

Table 4: PUFAs content in dorsal, ventral and whole muscles of wild and cultured *Osteobrama belangeri*.

Fatty acid	Dorsal		Ventral		Whole		Factorial ANOVA		
	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	Wild (%)	Cultured (%)	F_M	F_H	F_M:F_H
Hexadecadienoic acid	0.19±0.08^{a}	0.58±0.05^{b}	0.60±0.04^{b}	0.92±0.08^{c}	0.56±0.14^{b}	0.64±0.03^{b}	***	***	*
Linoleic acid	14.88±0.85^{b}	8.73±0.38^{a}	13.28±0.22^{b}	9.15±0.50^{a}	13.95±0.55^{b}	8.84±0.87^{a}	ns	***	*
Linoelaidic acid	0.43±0.02^{a}	1.45±0.26^{b}	1.43±0.19^{b}	1.43±0.09^{b}	0.40±0.07^{a}	1.96±0.06^{c}	***	***	***
Alpha-linolenic acid	0.71±0.02^{b}	0.57±0.05^{a}	0.83±0.03^{c}	0.70±0.05^{b}	0.83±0.03^{c}	0.68±0.06^{b}	***	***	ns
Gamma-linolenic acid	0.52±0.14^{b}	0.50±0.06^{b}	0.17±0.01^{a}	0.82±0.06^{c}	0.57±0.04^{b}	0.89±0.09^{c}	***	***	***
Stearidonic acid	0.25±0.05^{a}	nd	0.19±0.03^{a}	nd	0.20±0.03^{a}	nd	ns	***	ns
Eicosadienoic acid	0.84±0.08^{c}	0.36±0.07^{a}	0.65±0.06^{b}	0.29±0.04^{a}	0.76±0.01^{bc}	0.36±0.04^{a}	**	***	ns
Eicosatrienoic acid	1.59±0.19^{a}	1.32±0.13^{a}	1.38±0.04^{a}	1.45±0.18^{a}	1.42±0.05^{a}	1.36±0.15^{a}	ns	ns	ns
Mead acid	0.42±0.07^{b}	nd	0.11±0.03^{a}	nd	0.38±0.05^{b}	nd	***	***	***
Arachidonic acid	5.14±0.17^{b}	2.88±0.21^{a}	6.83±0.72^{c}	2.07±0.20^{a}	5.39±0.20^{b}	2.29±0.23^{a}	*	***	***
Eicosapentaenoic acid	1.34±0.10^{c}	0.34±0.01^{a}	1.16±0.01^{b}	0.37±0.08^{a}	1.43±0.03^{c}	0.31±0.02^{a}	*	***	***
Heineicosapentaenoic acid	0.28±0.07^{a}	nd	0.32±0.08^{ab}	nd	0.47±0.13^{c}	nd	•	***	•
Adrenic acid	1.36±0.22^{a}	nd	1.13±0.12^{a}	nd	1.30±0.27^{a}	nd	ns	***	ns
Docosapentaenoic acid	1.13±0.09^{bc}	0.94±0.06^{bc}	1.42±0.50^{c}	0.65±0.05^{a}	1.38±0.13^{c}	0.63±0.07^{a}	ns	***	•
Docosahexaenoic acid	3.34±0.13^{cd}	2.55±0.36^{abc}	3.27±0.13^{bcd}	2.43±0.33^{ab}	3.61±0.43d	2.19±0.38^{a}	ns	***	ns
PUFAs	32.42±0.82^{b}	20.22±0.47^{a}	32.77±0.39^{b}	20.28±0.73^{a}	32.65±0.22^{b}	20.15±0.36^{a}	ns	***	ns
ω-3	5.92±0.23^{b}	3.46±0.08^{a}	5.77±0.22^{b}	3.50±0.10^{a}	6.54± 0.01^{c}	3.18± 0.04^{a}	*	***	***
ω-6	24.49±0.45^{b}	15.44±0.48^{a}	25.51±0.57^{b}	15.33±0.47^{a}	24.31± 0.38^{b}	15.61± 0.17^{a}	ns	***	*
ω-3:ω-6	0.24±0.03^{ab}	0.22±0.02^{a}	0.23±0.01^{ab}	0.23±0.02^{ab}	0.27± 0.00^{c}	0.20± 0.00^{a}	ns	**	**

Note: Mean±SD followed by identical superscripts are not significantly different ($p \leq 0.05$); significance codes for two-way ANOVA: ***: ($0 \leq p \leq 0.001$), **: ($0.001 < p \leq 0.01$), *: ($0.01 < p \leq 0.05$), •: ($0.05 < p \leq 0.1$), ns: ($0.1 < p \leq 1$); nd: not detected; ns: not significant.

and *Prochilodus lineatus*.[26] Arachidonic acid (AA) is the second most abundant PUFA found in the analysis. The content in the wild fish (dorsal: 5.14%, ventral: 6.83%, whole: 5.39%) is higher than that in cultured fish (dorsal: 2.88%, ventral: 2.07%, whole: 2.29%). AA has beneficial healing properties by attaching to endothelial cells and accelerating blood clotting during wound healing.[27]

Docosahexaenoic acid (DHA), is also found in moderate amounts with content in the wild fish (dorsal: 3.34%, ventral: 3.27%, whole: 3.61%) exceeding that in the cultured fish (dorsal: 2.55%, ventral: 2.43%, whole: 2.19%). In most of the remaining PUFAs, the concentrations in the wild fish exceed those in the cultured counterparts. This variation is also indicated by the two-way ANOVA where the variation of the total PUFA is significantly affected only by the habitat ($p<0.001$). This could be due to the difference in the food habits of the fish raised in different habitats. Unlike cultured fish, wild fish have exposure to extensive sources of food. It is well known that PUFAs are derived from unicellular blue-green algae, phytoplankton and zooplankton through the aquatic food web. The level of accumulation in a particular species further depends on factors such as size, sex and the season.

Consumption of DHA has various physiological benefits in preventing cardiovascular diseases.[28] Intake of DHA and eicosapentaenoic acid (EPA) is critically important during fetal development until the biochemical development of the brain and retina after birth. DHA also plays a major role in cognitive functions.[28]

The total ω-3: ω-6 ratio also computed is also shown in Table 4. The total ω-3: ω-6 ratio (dorsal: 0.24, ventral: 0.23, whole: 0.27) in the wild fish was higher than that in the cultured fish (dorsal: 0.22, ventral: 0.23, whole: 0.20). The low total ω-3:ω-6 ratio is beneficial to health for consumption. The variations of ratios were significantly ($p<0.01$) affected by the type of habitat and the interaction with the type of muscle. The ratios are similar to the findings of Jabeen and Chaudhary[27] in some freshwater fishes.

CONCLUSION

From this study, it can be concluded that *Osteobrama belangeri* has a significant content of vital nutrients. Among minerals, elements such as Na, Mg, Ca, K, Fe, Cu, Zn, Mn and Se were present. The fish also contained significant levels of vital fatty acids. ω-3 and ω -6 fatty acids *viz*., LA, AA and DHA were present in high and moderate concentrations in the wild as well as the cultured fishes. The results suggest that *Osteobrama belangeri* can be cited as a good source of valuable fatty acids. To increase the population of the fish in the wild, awareness may be propagated to the locals who remain fond of the fish that the cultured variant of the fish is comparably just as nutritious as the wild fish and thus the cultured fishes are utilized for consumption while the wild is preserved and allowed to thrive.

ACKNOWLEDGEMENT

The authors would like to acknowledge the Guwahati Biotech Park (GBP), Assam, India for providing hands-on training for the preparation of Fatty acid methyl esters (FAMEs) and operation of Gas Chromatography-Mass Spectrometry (GC-MS) equipment.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

AA: Arachidonic acid; **ANOVA:** Analysis of variance; **DHA:** Docosahexaenoic acid; **EPA:** Eicosapentaenoic acid; **FAME:** Fatty acid methyl ester; **FID:** Flame Ionization Detector; **GC-MS:** Gas Chromatography-Mass Spectrometry; **ICP-OES:** Inductively Coupled Plasma-Optical Emission Spectroscopy; **LA:** Linoleic acid; **MUFA:** Monounsaturated fatty acid; **PUFA:** Polyunsaturated fatty acid; **SAFA:** Saturated fatty acid; **SD:** Standard deviation.

SUMMARY

The objective of this work is to determine and compare the proximate composition, minerals and fatty acids in wild and cultured *Osteobrama belangeri*. Fatty acids are analyzed using Gas Chromatography-Mass spectrometry (GC-MS). Minerals analysis was carried out using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). Elements Na, K, Fe, Cu, Zn and Se are found higher in the wild fish whereas Ca, Mg and Mn are found higher in the cultured fish. Palmitic, oleic and linoleic acids are the main fatty acids found in all the samples. The wild fish contains a relatively higher level of ω-3 and ω-6 polyunsaturated fatty acids, particularly docosahexaenoic, linoleic and arachidonic acids. The results also reflect a low total ω-3:ω-6 ratio indicating a beneficial aspect for consumption. The results show that both cultured and wild species contain significant and comparable levels of valuable nutrients. The results indicate that *Osteobrama belangeri* can be cited as a good source of vital nutrients that include minerals

and fatty acids that have many health benefits. However, as a part of the effort to increase the population of the fish in the wild, it is suggested that the cultured variant of the fish, which is comparably just as nutritious as the wild fish be utilized for consumption while the wild is preserved and allowed to thrive.

REFERENCES

1. Behera B, Das P, Ngachan S. Strategies for improving fish production in Loktak Lake. Ecology. 2009:29-40.
2. Molur S, Walker S. Report of the workshop on. Conservation assessment and management plan for freshwater fishes of India. Zoo Outreach Organisation; 1998. p. 1-156.
3. Menon AGK. Threatened fishes of India and their conservation. Kolkata, India: Zoological Survey of India; 2004.
4. Vishwanath W. IUCN red list of threatened species: Osteobrama belangeri [internet]; 2010. IUCN Red List of Threatened Species [cited Mar 7 2021]. Available from: https://www.iucnredlist.org/en.
5. Shearer KD. Factors affecting the proximate composition of cultured fishes with emphasis on salmonids. Aquaculture. 1994;119(1):63-88. doi: 10.1016/0044-8486(94)90444-8.
6. Narayan B, Miyashita K, Hosakawa M. Physiological effects of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)—a review. Food Rev Int. 2006;22(3):291-307. doi: 10.1080/87559120600694622.
7. Grigorakis K, Alexis MN, Taylor KDA, Hole M. Comparison of wild and cultured gilthead sea bream (Sparus aurata); composition, appearance and seasonal variations. Int J Food Sci Technol. 2002;37(5):477-84. doi: 10.1046/j.1365-2621.2002.00604.x.
8. Alasalvar C, Taylor KDA, Zubcov E, Shahidi F, Alexis M. Differentiation of cultured and wild sea bass (Dicentrarchus labrax): Total lipid content, fatty acid and trace mineral composition. Food Chem. 2002;79(2):145-50. doi: 10.1016/S0308-8146(02)00122-X.
9. Ashraf M, Zafar A, Rauf A, Mahboob S, Naureen A, Qureshi N. Nutritional values of wild and cultivated silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*). Int J Agric Biol. 2011;13(8530):1560.
10. Hossain MA, Almatar SM, Al-Abdul-Elah KM, Yaseen SB. Comparison of proximate composition and fatty acid profiles in cultured and wild marine fishes in Kuwait. J Appl Aquacult. 2012;24(3):199-209. doi: 10.1080/10454438.2012.678790.
11. O'Neill B, Le Roux A, Hoffman LC. Comparative study of the nutritional composition of wild versus farmed yellowtail (*Seriola lalandi*). Aquaculture. 2015;448:169-75. doi: 10.1016/j.aquaculture.2015.05.034.
12. Álvarez V, Medina I, Prego R, Aubourg SP. Lipid and mineral distribution in different zones of farmed and wild blackspot sea bream (*Pagellus bogaraveo*). Eur J Lipid Sci Technol. 2009;111(10):957-66. doi: 10.1002/ejlt.200800282.
13. Bogard JR, Thilsted SH, Marks GC, Wahab MdA, Hossain MAR, Jakobsen J, *et al*. Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. J Food Compos Anal. 2015;42:120-33. doi: 10.1016/j.jfca.2015.03.002.
14. AOAC. Official methods of analysis of AOAC International. 21st ed. Gaithersburg, MD: AOAC International; 2019.
15. Singh MB, Sarojnalini Ch, Vishwanath W. Nutritive values of sun-dried Esomus danricus and smoked Lepidocephalus guntea. Food Chem. 1990;36(2):89-96. doi: 10.1016/0308-8146(90)90093-J.
16. Metcalfe LD, Schmitz AA, Pelka JR. Rapid preparation of fatty acid esters from lipids for gas chromatographic analysis. Anal Chem. 1966;38(3):514-5. doi: 10.1021/ac60235a044.
17. FAO. Protein quality evaluation. Rome, Italy: Food and agriculture organization of the United Nations; 1991.
18. Ljubojevic D, Trbovic D, Lujic J, Bjelic-Cabrilo O, Kostic D, Novakov N, et al. Fatty acid composition of fishes from inland waters. Bulg J Agric Sci. 2013;19(1):62-71.
19. Rahnan SAbd, Huah TS, Nassan O, Daud NM. Fatty acid composition of some Malaysian freshwater fish. Food Chemistry 1995;54(1):45-9.
20. Gokoglu N, Yerlikaya P. Chemical composition of fish. Sci Technol, Refrigeration and freezing. 2015:5-37.
21. Sarower EM, Belal Hoss M, Minar MH. Biochemical composition of an endangered fish, Labeo bata (Hamilton, 1822) from Bangladesh waters. Am J Food Technol. 2012;7(10):633-41. doi: 10.3923/ajft.2012.633.641.
22. Swapna HC, Rai AK, Bhaskar N, Sachindra NM. Lipid classes and fatty acid profile of selected Indian fresh water fishes. J Food Sci Technol. 2010;47(4):394-400. doi: 10.1007/s13197-010-0065-6, PMID 23572659.
23. Mnari A, Bouhlel I, Chraief I, Hammami M, Romdhane MS, El Cafsi M, *et al*. Fatty acids in muscles and liver of Tunisian wild and farmed gilthead sea bream, Sparus aurata. Food Chem. 2007;100(4):1393-7. doi: 10.1016/j.foodchem.2005.11.030.
24. Nath AK, Patra A, Sen B, Dey D, Das I, Mukherjee I, *et al*. Fatty acid compositions of four edible fishes of Hooghly Estuary, West Bengal, India. Int J Curr Microbiol Appl Sci. 2014;3(7):208-18.
25. Hohmann CD, Cramer H, Michalsen A, Kessler C, Steckhan N, Choi K, *et al*. Effects of high phenolic olive oil on cardiovascular risk factors: A systematic review and meta-analysis. Phytomedicine. 2015;22(6):631-40. doi: 10.1016/j.phymed.2015.03.019, PMID 26055128.
26. Rodrigues BL, Da Canto ACVDCS, Costa MPD, Silva FAD, Mársico ET, Conte-Junior CA. Fatty acid profiles of five farmed Brazilian freshwater fish species from different families. PLOS ONE. 2017;12(6):e0178898. doi: 10.1371/journal.pone.0178898, PMID 28614390.
27. Jabeen F, Chaudhry AS. Chemical compositions and fatty acid profiles of three freshwater fish species. Food Chem. 2011;125(3):991-6. doi: 10.1016/j.foodchem.2010.09.103.
28. Connor WE. Importance of n-3 fatty acids in health and disease. Am J Clin Nutr. 2000;71(1);Suppl:171S-5S. doi: 10.1093/ajcn/71.1.171S, PMID 10617967.

Cite this article: Devi NL, Sarojnalini C. Proximate, Minerals and Fatty Acids Compositions in Different Muscles of Wild and Cultured *Osteobrama belangeri* (Valenciennes, 1844). Asian J Biol Life Sci. 2022;11(2):578-85.