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Difference in Biochemical Composition and Nutritional Trait in Different Areas of Fillets of Dorsal, Venter-cha, and Ventral of *Carangoides fulvoguttatus*

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ABSTRACT
Environmental parameters are essential to the life cycle and physiological activities of fish. These environmental conditions can profoundly influence fish physiology, behavior, and their nutrition. The purpose of this study was to highlight nutritional properties of dorsal, ventercha and ventral fillets from sea fish Carangoides fulvoguttatus. Dorsal, ventercha and ventral fillet portions of Iranian sea fish (C. fulvoguttatus) analyzed for proximate constituents, energy values and pH. The proximate of C. fulvoguttatus fillets varied between three anatomical locations ventercha, dorsal and ventral. Moisture and fat content differentiated dorsal and ventercha from ventral in fish muscle. In particular, a relatively large variation observed in crude fat content, which trend of significant fat changes between the three portions was as follows: ventral>ventercha>dorsal. The results showed that the ventral part containing significantly less moisture (73.4%±0.7), but the ventercha part had protein content (15.7%±0.3) which was higher than the other two parts of muscle. The ventral part had higher fat content (7.13%±0.1). The energy value (127.08 kcal/100 g) in ventral part found the highest. The ventercha area containing highest protein content and ventral had highest lipid content (7.13%). The index of nutritional quality for protein was always higher in ventercha than in dorsal and ventral, that of fish being especially interesting because it is associated with a relatively lower energy value. The nutritional traits found best in ventral muscle due to highest dry matter and energy value with lowest moisture.

KEYWORDS
Carangoides fulvoguttatus; Dorsal; Proximate nutrients; Ventrecha and ventral

1. INTRODUCTION

Fish serves as a significant source of readily digestible animal protein and several critical elements. It is crucial for food security and poverty reduction in emerging nations [1]. The fish *C. fluvoguttatus* is popular and common market species in Iran, but it has particularly high rates of decomposition**.** Knowledge of the nutritional profile of fish can be very valuable, as this information can be used in a variety of ways to develop and maintain a product's market position, add value to a product, and target a specific market. In the last two decades, consumers have tended towards processed foods [2]. Lipid distribution in different areas of fish muscle varies greatly depending on the species, type of muscle and location of sampling in the muscle [3]. The presence of lipid components also affects the flavor of fish [4], [5]. Recently, the optimal use of fish fillets has been studied, which requires the use of fillet sections for different types of technological processing according to their chemical composition and mechanical properties [6]. The content of these components differs among species, and numerous environmental conditions, such as temperature, mating season, and the age and sex of the fish, might influence them. The proximate composition of fish bodies is affected by seasonal fluctuations in water temperature. However, researchers

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have yet to determine how these seasons influence the morphological characteristics and composition of fish bodies [7].

Although fish has a high nutritional value, it is sensitive to spoilage [8], [9], which is due to the composition of the fish, neutral pH, high water activity and the presence of a natural microflora with a potential for degradation [10]. Therefore, knowing the composition and physical and chemical characteristics of fish species are important indicators for determining the conditions of product processing and storage [11]. Usually, the upper part of the fish fillet has more protein and fat than other parts of the fish muscle. Different spoilage of different parts of fish muscle depends on the uniqueness of its biochemical composition. Because fish quality is affected by postmortem changes in body composition such as proteins and lipids, knowledge of biochemical composition helps processors identify optimal processing and storage conditions to determine the quality of fish and products. The four components of the edible parts of fish include water, protein, fat, and ash, which includes up to 98% of the total composition of fish tissue [12]. The lower the percentage of water in the body of the fish, the higher the percentage of dry matter, protein, fat, ash, energy value and finally the overall nutritional value of the fish. The aim of present study was to highlight compositional differences between dorsal, ventral and ventercha parts of *C. fulvoguttatus* fish fillets in Iran. It investigated whether and for which macronutrients dorsal, ventercha and ventral parts can be distinguished. The fat content of three parts focused with special attention both to some nutritional and technological quality indicators and percentage of contribution that each part can give to daily requirement of some nutrients.

2. MATERIALS AND METHODS

2.1. Materials

This research conducted at 2022 in Behbahan Khatam Alanbia University of Technology, Iran. Five fish *C. fulvoguttatus* randomly purchased from the Behbahan fish market. The fish packed in polystyrene boxes and covered with ice. The fish boxes immediately transported to laboratory, where fish samples weighed, measured and processed.

2.2. Body Length Measurement

The total body length measured from tip of mouth to end of upper lobe of caudal fin. The peritoneal cavity opened along a midline ventral incision. An incision made along dorsal fin to caudal fin, and another incision made behind opercula, excluding lateral and ventral fins, to remove all three fillets from each carcass. Each fillet weighed skin-on, then cut along line of rib insertion to obtain dorsal, ventercha and ventral fillets. After skinning, two dorsal fillets of each fish joined together and their total called "dorsal portion" and weighed. The same done with two ventral, ventercha fillets. Three dorsal, ventercha and ventral portions separately obtained from each fish finely diced, thoroughly mixed, and homogenized in mixer and homogenizer.

2.3. Proximate Composition Analysis

Moisture, ash, crude protein, and lipid contents were determined in the different muscle zones according to the methods outlined by the Association of Official Analytical Chemists (2005) [13]. The moisture content of the samples was determined by oven at 103 °C for 4 hours until a constant weight was reached. The amount of fat in the samples was measured with a Soxhlet apparatus, and the amount of protein in the samples was measured with a Kjeldahl apparatus, and the amount of ash in the samples was measured with Furnace at 550 °C for 6 hours until it reached a light grey color. All measurements were performed in triplicate.

2.4. pH Measurement

A 5 g subsample from each muscle zone was weighed out in triplicate. All samples were crushed separately using a homogenizer and mixed uniformly with 45 ml of distilled water. The pH of each sample was measured by a digital PHS-550 pH meter.

2.5. Energetic Value

The energy value was measured using Rubner's coefficients for fish muscle: 9.5 kcal/g for fat, 5.65 kcal/g for proteins [14], and Eder & Lewis (2005) [15] reported in kcal/g and kJ/g wet fillets.

2.6. Statistical Analysis

Results were presented as means ± standard error (SE). Mean values between muscle zones were then compared using a three-way analysis of variance (ANOVA) between individual pairs of muscle zones. All statistical analyses were performed using SPSS 18.0 at a significance level of 95% ($p < 0.05$).

3. RESULTS AND DISCUSSION

3.1. Total Body Length

The total fish weight was 656.5 g. The total body length was 38.5 cm and the width was 14.5 cm. The total weight of fish fillets was 284.6 g. The weight total of fish waste was found 371.9 g. The yield of fillets was 43.41% and the yield of waste was 56.59% of total mass (Table 1). The fish fillets at different parts can be seen in Figure 1.

Table 1. Biometric data, weights, and yields of fish.

Trait	Sea fish *C. fulvoguttatus*
Total average length (cm)	38.50
Body average weight (g)	656.50
Average width (cm)	14.50
Total fillets weight (g)[a]	284.50
Total waste weight (g)	371.90
Total fillet yield (%)[d]	43.41
Total waste yield (%)	56.59

Values are means of five fish.
[a]Flesh without skin. [d]Fillet yield=Fillets weight×100/Body weight.

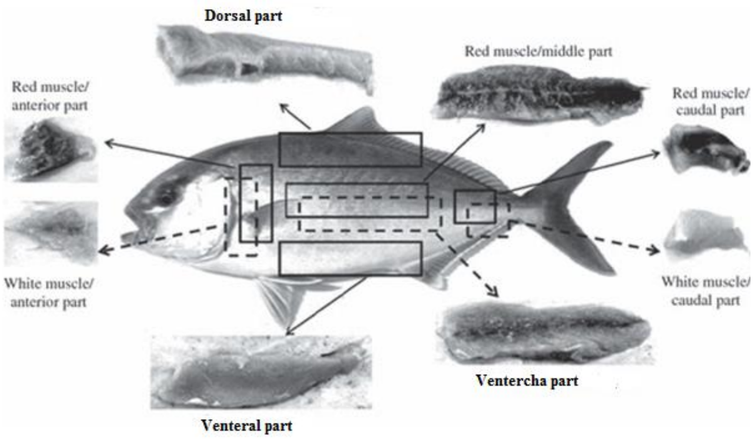

Figure 1. The fish fillets at different parts.

3.2. Proximate Composition

The percentage of ash in the dorsal part (6.03%) was significantly higher than in other parts of the fish ($p<0.05$) (Figure 2). Percentage fat content was shown to be highest in the ventral zone (fat: 7.13%). The dorsal fillet zone had the lowest amount of lipid content (1.38%). Lipid values were found to be significantly different between muscle zones ($p<0.05$) (Figure 3). The percentage of moisture was found to be significantly different between fillet zones ($p<0.05$) (Figure 4). The dorsal fillet zone had the highest amount of moisture (78.8%) and the ventral fillet had the lowest amount (73.4%). The percentage of protein between muscle zones was significantly different ($p<0.05$) (Figure 5).

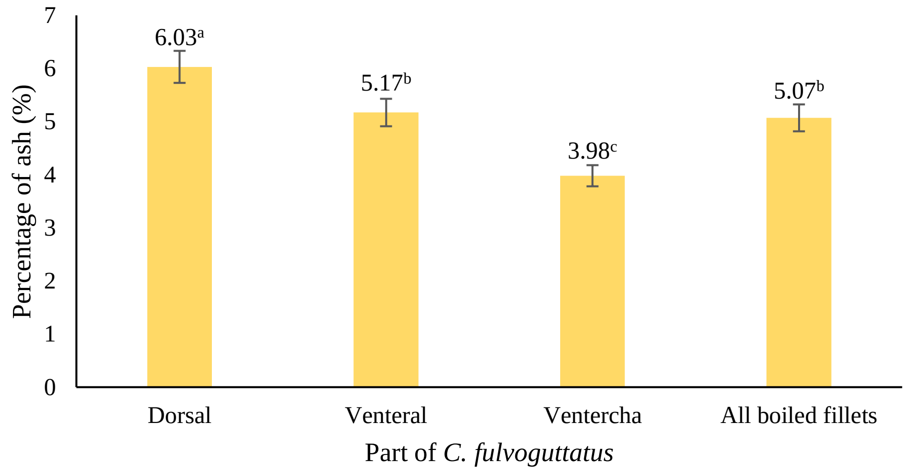

Figure 2. Percentage of ash at different parts.

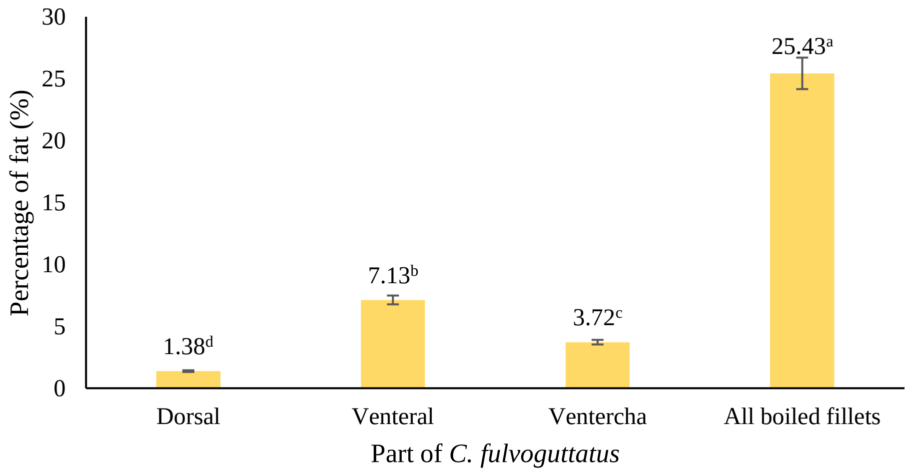

Figure 3. Percentage of fat at different parts.

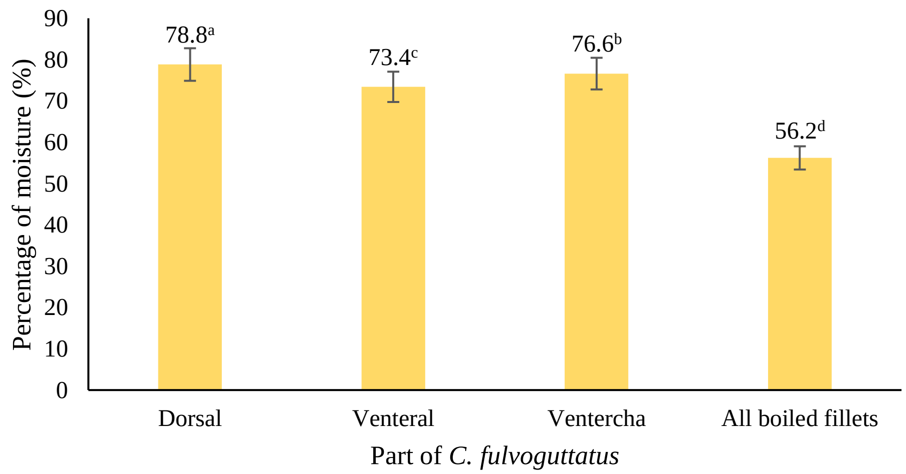

Figure 4. Percentage of moisture at different parts.

The ventrecha zone of the fillet had the highest protein percentage (15.7%), but because a large part of fish proteins belongs to enzymes and sarcoplasmic proteins which are very sensitive, this part is quickly subjected to enzymatic spoilage. The pH of the dorsal and ventrecha muscles was not significantly different from each other (Figure 5). There was a significant difference in pH value with the ventral fillet ($p<0.05$) and the ventrecha muscle zone. The difference in pH between different samples indicates the difference in their quality, so that the ventral fillet pH which was lower, its quality was also lower. The energy value showed a significant difference between the three muscle zones ($p<0.05$) (Figure 6). The ventral fillet had the highest percentage of energy (127.08 kcal/100 g), followed by ventercha and dorsal.

The ventrecha zone of the fillet had the highest protein percentage (15.7%), but because a large part of fish proteins belongs to enzymes and sarcoplasmic proteins which are very sensitive, this part is quickly subjected to enzymatic spoilage. The energy value showed a significant difference between the three muscle zones ($p<0.05$) (Figure 6). The ventral fillet had the highest percentage of energy (127.08 kcal/100g), followed by ventercha and dorsal. Oliveira et al., (2014) [16] showed 79.5% and 77.9% moisture, 17.6% and 16.1% protein, 0.6% and 2.5% total fat, and 0.9% and 0.8% ash in the dorsal and ventral parts of *Hemiodontichthys acipenserinus* fillet respectively. Martins et al., (2015) and Martins et al., (2017) [17], [18] analyzed proximate composition in the dorsal region of the studied sample. Differences in proximate values may be related to the sex, age, species and diet of the fish [19] as well as the muscle group analyzed.

Generally, the proximate composition of the fish fillets was similar to that found by Jensen et al., (2013) [20] in fish fillets from cultured species: 78.0% moisture, 18.6% protein, 1.0% total fat and 1.3% ash. Total fat can be up to 8%, but generally is 2-4% in low-fat fish and less than 2% in lean fish [21]. Although the belly part had more fat content than the other regions, it constituted only 21% of the fish fresh fillet. The fish can be classified as medium fat fish since the dorsal, ventrecha, ventral and tail areas have a fat content of less than 2% and have a cumulative percentage of 79% muscle.

The dorsal and ventrecha muscle regions had similar composition, while the ventral region presented lower moisture content and higher total lipid content. The ventral area is the area of the fish where lipids are deposited. The nutritional components of the upper zone of the ventercha muscle, specifically the middle and the lower part of the abdominal muscle were determined and their nutritional value was evaluated. The results showed that the average muscle protein content was 14.60%. Overall, the upper part of the ventrecha muscle feeding surface was the best option of nutritive value, followed by the middle part of the abdominal muscle [20].

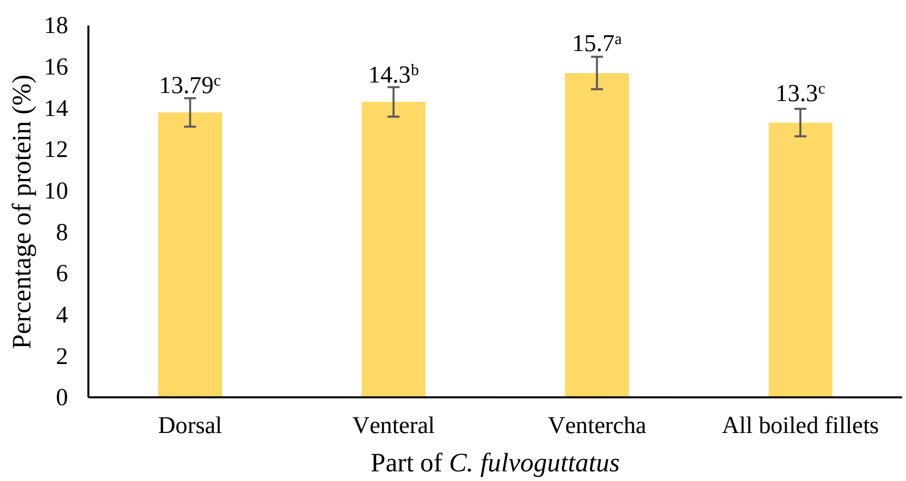

Figure 5. Percentage of protein at different parts.

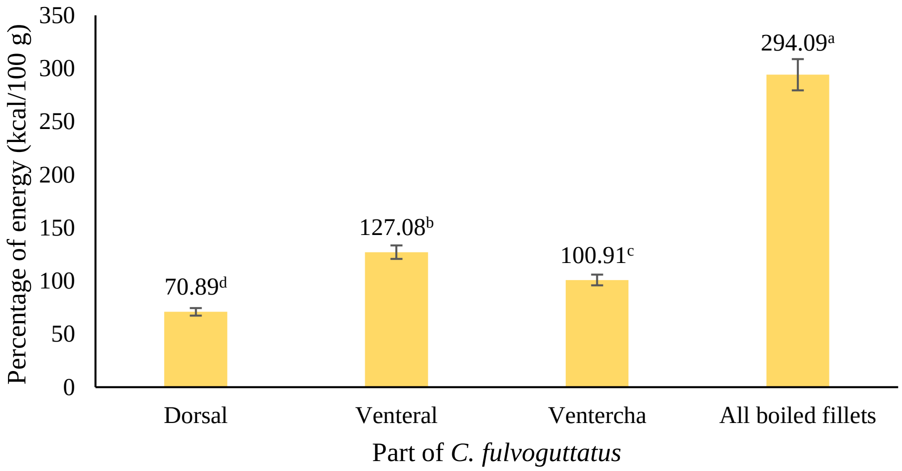

Figure 6. Fish energy at different parts.

Liu et al., (2019) [22] reported that the upper part of the abdominal muscle nutritional values was the best, followed by the bottom part. Different parts of the muscles of *Platax teira* had different nutritional compositions, but the overall difference was not large, and these results were similar to the present study results, due to different fish species. Following death, pH decreases in the raw fillets as stored glycogen is anaerobically broken down to lactic acid, and accumulates in the muscle. The present study showed that 20 min after slaughter, the pH of the fish fillet was 6.56, at 2 h after slaughter, it had decreased to 6.53 and then stabilized at 6.20. These observations are consistent with the results published by Watabe et al., (1989) [23] who reported that after cessation of blood circulation and oxygenation, lactic acid accumulates in fish muscle, leading to a decrease in pH from 7.40 to 6.00 and sometimes lower.

Usually, the amount of fat decreases with increasing water content in the muscles of fish. This was observed in the dorsal zone of Gish (*C. fulvoguttatus*) in the present study because this part of the fish had more water than its other parts (78.8%) and its fat content was the lowest (1.38%). Conversely, the ventral part of the fillet, which had a high-fat content (7.13%), had the lowest moisture content (73.4%). Moisture content in different parts of the fillet had a positive correlation with the ash and protein content. The fat content of the ventral part of the Gish fillet was the highest, but its pH value was the lowest, which may be due to the breakdown of triglycerides into free fatty acids, which decreases pH and leads to faster fish spoilage. The shelf life of the dorsal part of the fish fillet with the lowest amount of fat and the highest amount of moisture will be longer.

Analyzing the proximate composition of fish is a good indicator of the fish physiological state and health. Several previous studies have shown differences in lipid content in fish, which can be attributed to differences between species and other factors, such as moisture content being the main component of fish muscle, ranging from 65 to 90%, followed by protein and fat [24], [25]. The values of ash content in fish muscles are due to body metabolism and nutrition and depend on the amount of the mineral found in the aquatic environment. Previous studies suggest that ash content is the lowest compared to other components in fish muscles. It was reported that ash content values ranged between 1.2-1.5% which this ratio varies between species and depending on age, sex, environment, and season [26]. Therefore, the current results showed significant differences ($p<0.05$) and these differences are due to mainly to species, and nutrition.

Within this species, the dorsal part was significantly different from the ventral and ventercha parts in moisture and lipid contents (Table 2). In general, these three components are inversely related in fish flesh, as found by Testi (2006) [6]. Differences between the dorsal portion and the Ventral portion were less pronounced or non-significant for protein and ash content, but the protein and ash difference between these two parts was higher than the ventercha with a significant difference ($p<0.05$). The mean ratio between the ventral part and dorsal portion as to fat content was 5.16 for fish, while the mean ratio between the ventral part and ventercha portion was 1.92. To our information, the literature is devoid of data with which proximate of dorsal part and ventral and ventercha portions from this type of fish could be compared. The consumable segments of eleven freshwater fish species exhibit varied values. The protein level of the edible fraction averaged 18 to 23% (wet basis), fat content ranged from 0.6 to 7.3%, ash content varied between 0.9 and 1.5%, and moisture content was between 70 and 80% [27].

Table 2. Proximate and energy value of fish.

Site of *C. fulvoguttatus*	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Energy (kcal/100 g)	pH
D	78.8	13.79	1.38	6.03	70.89	6.53
Vl	73.4	14.3	7.13	5.17	127.08	6.25
Va	76.6	15.7	3.72	3.98	100.91	6.56

Values are means of five fish. D = dorsal portion; Vl = ventral portion. Va = venter-cha portion.

Results literature review showed that the boiling method reduced moisture, fat, protein and energy contents of fish *C. nigrodigitatus* than to control decreased while dried material and carbohydrates increased in this cooking method [28], which only moisture and protein content in the present study agreed with result of this researcher. Overall differences observed in the nutritional composition of *C. nigrodigitatus* could be explained by some variation of extrinsic factors (geographic areas, quality of water (temperature, salinity and turbidity), quality and availability of food, migration) and intrinsic factors (species, breeding period, age, sex and size at capture).

3.3. pH Value of Fish

The pH of the dorsal and ventrecha muscles was not significantly different from each other (Figure 7). There was a significant difference in pH value with the ventral fillet ($p<0.05$) and the ventrecha muscle zone. The difference in pH between different samples indicates the difference in their quality, so that the ventral fillet pH which was lower, its quality was also lower. The pH of fish tissues is affected by the environment in which the fish resides. Fish have diverse reactions to the reduction in seawater pH linked to ocean acidification. Coastal marine animals reside in inherently dynamic habitats that necessitate physiological adaptations to variability, including changes in pH and related carbonate chemistry factors [29], [30], [31], [32].

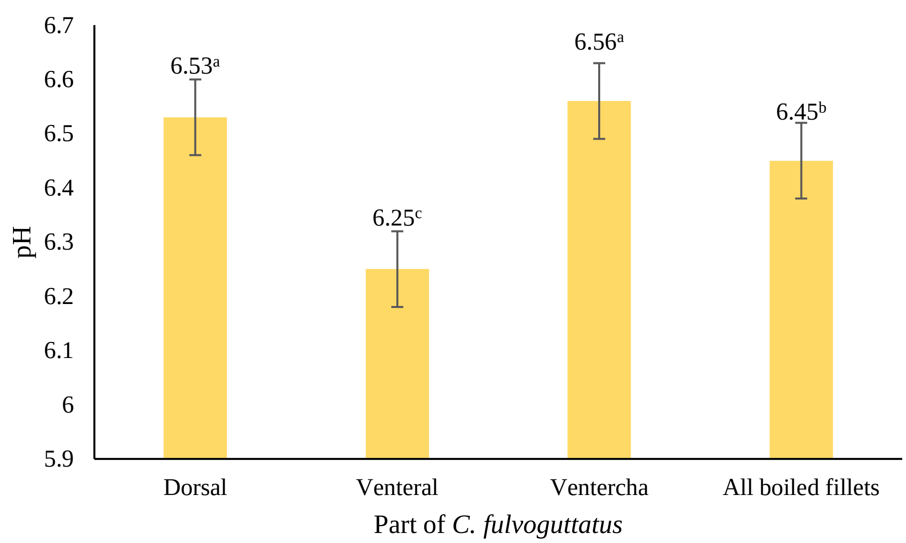

Figure 7. Fish pH at different parts.

4. CONCLUSION

The proximate composition was different for the analyzed parameters in different muscle regions of the fish (dorsal, ventral and ventercha), while protein was the component that had the highest proportion of constituent parts in all the analyzed fish muscle regions. The distribution of total fat content was considered heterogeneous, with a higher lipid content observed in the ventral area (7.13%), indicating this as the fat deposition. As a result, the ventral area had the lowest moisture content (73.4%). The Quality index of the dorsal region was associated with a lower energy value (70.39 kcal/100 g) in comparison with the other parts 127.08 kcal/100 g for ventral and 100.91 kcal/100 g for ventercha.

AUTHOR CONTRIBUTION

All author contributed equally to the main contributor to this paper. All authors read and approved the final paper. **Ali Aberoumand**: Writing (review & editing), writing (original draft), formal analysis, supervision, conceptualization, funding acquisition. **Fatemeh Fardaei**: Writing (review & editing), writing (original draft), investigation, formal analysis.

CONFLICTS OF INTEREST

The authors do not have any conflict of interest. This is declaration that the document includes the correct information. This is declaring the authors have any conflicts of interest to the outcome of their work.

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