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Estimation of chemical components and caloric values for muscles of some local fish in Karbala province, Iraq

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Abstract. The present work aimed at conducting a comparative study of the chemical components of the muscles of four teleosts in two different regions of each *Coptodon zillii* belonging to the Cichlidae and members of Cyprinidae, *Carabarus luteus*, *Cyprinus carpio* and *Cyprinion macrostomum*. This study concentrated on the determination of differences in the values of the chemical components of the muscles and calories for protein and lipid contents. In addition to this, it concentrated on the determination of the nutritional value of the studied fish. Samples were collected between November / 2018 and January / 2019 from Al- Hindiya market in Karbala province, Iraq. The results showed that the protein content was higher in the region 1 (R1) compared to the region 2 (R2) while the lipid content of the R2 was higher than that for the R1. These results were associated with the red muscle ratio in the two regions. The total protein content was recorded 19.69% in *C. zillii*, 25.42% in *C.luteus*, 21.92% in *C. carpio* and 23.51% in *C.macrostomum* while the total lipid content was 4.25% in *C. zillii* , 2.23% in *C. luteus*, 4.10% in *C. carpio* and 6.42% in *C. macrostomum*. Therefore, the statistical results indicated significant differences ($P < 0.05$) between the studied species in protein and lipid contents, while the differences were not significant ($P > 0.05$) among the *C.zillii*, *C.luteus* and *C.carpio* in the values of moisture content and between the *C.luteus* and *C.macrostomum* in ash content values. According to the lipid content values in the studied fish muscles, the *C. luteus* fish (2.23%) were in a low-lipid fish while the *C.carpio* (4.10%), *C.zillii* (4.52%) and *C.macrostomum* fish(6.24%) were in a medium-lipid fish.

Keywords: Chemical content, Fish muscles, Caloric value, Iraqi fish.

1. Introduction

Fish muscles are a healthy food for humans [1]. The most important characteristic of these muscles is their high content of high-biological proteins, minerals, vitamins and polyunsaturated fatty acids [2]. In addition, eating fish muscles contributes to the prevention and treatment of coronary heart disease [3]. Generally, the fish consist of three types of muscle fibers; red, white and intermediary or pink fibers. Red fiber form a thin lateral superficial layer under the skin. White fibers make up the larger mass of the musculature of fish [4] while the intermediary or pink fiber are located between the red and white muscle fibers [5]. The chemical components of fish muscles consist of protein, lipid, moisture, minerals, vitamins and polyunsaturated fatty acids, all of which contribute to the overall muscle composition. These components can differ according to their function and availability [6]. On the other hand, there are some exogenous and endogenous factors that affect chemical composition of muscles include season, environment site and feeding [7] ,[8], [9] species, size, sex, life cycle stage and muscle location in fish body [10] ,[11]. Therefore, the current work dealt with four local bony fish belonging to two different families of teleosts in order to know the differences in the components of the chemical composition of muscles and caloric values in two different regions of the body of the studied fish and thus determine the nutritional value of studied species.



2. Materials and Methods

2.1. Sampling

Twenty locally important fish species were chosen and collected for determination chemical components for muscles in four teleosts fish. These were *C.zillii*, *C.luteus*, *C.carpio* and *C.macrostomum*. Samples were collected from AL-Hindiyia market in Karbala province - Iraq between November 2018 and January 2019. They were transported to the laboratory to perform the tests associated with estimating the chemical components of the studied fish muscles. Two regions of the studied fish body were chosen, the first being the trunk region below the dorsal fin (R1] and the second region representing the caudal peduncle (R2]. Protein, lipid, Moisture (water] and ash contents were determined in each specimen's muscles according to the [12],[13]. The Caloric value (Energy] for protein and lipid content of fish muscle were estimated by [14].

2.2. Statistical Analysis

Statistical analyses were conducted using the IBM SPSS Statistical 25 software. The data of chemical components obtained from muscle fibers for two different regions in studied fish were analyzed using one-way analysis of variance (ANOVA] followed by Tukay's multiple comparison test. Variations were considered to be significant when P value ≤ 0.05 .

3. Results

Tables (1 and 2] show differences in the values of the chemical components of the muscles of four species of teleosts which including the protein, lipid, moisture (water] and ash contents in the studied body regions (R1and R2] of the studied species. The *C. luteus* had higher values for protein content ranging from 24.58 to 26.22% while the values were less in *C. zillii* which ranging between 19.38 - 20.78% in R1 region. The *C. luteus* fish also had higher values for protein content in R2, which ranging between 24.33 - 26.0%, while it recorded from 18.5 to 19.80% in *C. zillii* fish. According to these differences, the statistical results showed significant differences(P<0.05] among the studied species in protein and lipid content values (Table 3]. The statistical results revealed significant differences(P<0.05] between the values of protein content in R1 and R2 regions in *C. zillii*, but the differences were not significant (P>0.05] in *C. luteus*, *C. carpio* and *C. macrostomum* (Table 4]. The statistical analysis recorded significant differences (P<0.05] among the studied species when analyzing the results of the lipid content values statistically (Table 3] in addition to the significant differences (P<0.05] between the regions of R1 and R2 in *C.zillii*, whereas the differences were not significant(P>0.05] in *C. luteus*, *C. carpio* and *C.macrostomum* (Table 4]. The results showed a difference in the values of lipid content between the studied regions (R1and R2] in the studied species where the values in the R1 region were between 4.10 - 4.16% (*C.zillii*], 1.95 - 2.35% (*C.luteus*], 3.76 - 4.20% (*C.carpio*] and 5.52 - 6.29% (*C. macrostomum*] (Table 1] While the values in the R2 region were 4.50 - 5.26% (*C.zillii*], 2.10 -2.78% (*C.luteus*], 3.90 - 4.40% (*C.carpio*] and 5.84 - 6.68% (*C.macrostomum*] (Table 2].

Table 1. Chemical components for muscles in (R1] of studied species

Fish species /Weight (g]	Protein (%)	Lipid (%)	Moisture (%)	Ash (%)
<i>C. zillii</i> / 25 - 125	19.54	4.16	71.80	4.38
	20.74	4.15	70.56	4.50
	20.78	4.24	71.50	3.40

	20.48	4.10	70.82	4.40
	19.38	4.14	71.62	4.46
<i>Mean</i>	20.18	4.15		
<i>C. luteus/25 – 125</i>	25.72	2.05	70.56	1.56
	25.74	2.35	70.41	1.47
	26.22	2.03	70.26	1.20
	25.30	1.95	71.02	1.12
	24.58	1.96	72.10	1.18
<i>Mean</i>	25.51	2.06		
<i>C. carpio/25 – 125</i>	21.92	4.20	70.28	2.80
	21.80	4.16	70.84	2.92
	22.47	3.76	70.92	2.82
	22.94	3.90	69.85	3.29
	21.52	3.94	70.12	3.19
<i>Mean</i>	22.13	3.99		
<i>C. macrostomum/25 – 125</i>	24.61	6.29	67.58	1.30
	24.08	6.00	68.29	1.42
	23.22	6.28	68.60	1.50
	23.90	5.52	68.12	1.62
	22.94	6.14	67.89	1.20
<i>Mean</i>	23.75	6.04		

Table 2. Chemical components for muscles in (R2] of studied species

Fish species /Weight (g]	Protein (%)	Lipid (%)	Moisture (%)	Ash (%)
<i>C. zillii/25 - 125</i>	18.50	5.20	70.60	4.10
	19.70	5.26	69.84	4.30
	19.80	4.86	70.52	3.80
	19.40	4.50	69.70	4.40
	18.60	4.70	71.26	4.52
<i>Mean</i>	19.20	4.90		
<i>C. luteus/25 – 125</i>	25.60	2.67	69.72	1.82
	25.48	2.78	70.08	1.64
	26.10	2.26	70.22	1.36
	25.20	2.10	71.40	1.10
	24.33	2.22	71.42	1.30
<i>Mean</i>	25.34	2.40		
<i>C. carpio/25 – 125</i>	21.89	4.40	69.28	3.10
	21.60	4.30	70.76	3.32
	21.72	3.90	70.42	3.16
	22.10	4.12	69.30	3.78
	21.30	4.34	70.13	3.74
<i>Mean</i>	21.72	4.21		

<i>C. macrostomum</i> /25 – 125	23.60	6.68	66.64	1.40
	23.40	6.30	66.42	1.66
	22.90	6.82	68.42	1.58
	23.80	5.84	68.32	1.84
	22.68	6.62	67.50	1.40
Mean	23.27	6.45		

The current results showed a convergence in the values of the moisture content (water] in the R1 and R2 regions in the studied species, which ranged between 67.5 - 71.88% in the R1 region (Table 1] while values ranged between 66.64- 71.42%] in R2 region (Table 2], so the statistical results revealed a difference in the statistical differences between the studied fish, where they were not significant ($P > 0.05$] among *C. zillii*, *C. luteus* and *C. carpio*, whereas the differences were significant ($P < 0.05$] between *C. macrostomum* fish with the *C. zillii*, *C. luteus* and *C. carpio* (Table 3]. The statistical results did not show any significant differences ($P > 0.05$] between R1 and R2 regions in *C. luteus*, *C. carpio* and *C. macrostomum* (Table 4], while significant differences ($P < 0.05$] were found between R1 and R2 regions in *C. zillii* (Table 4]. The *C. zillii* had higher values for ash content in R1 and R2 regions, which ranged between 3.40-4.46% in R1 region (Table 1] while 3.80 - 4.52% in R2 region (Table 2]. Values in *C. carpio* ranged from 2.80 - 3.24% in R1 region (Table 1] and from 3.10 - 3.78% in R2 region (Table 2]. While the values were convergence in *C. luteus* and *C. macrostomum* (Tables 1 and 2], which ranged between 1.12 - 1.56% in R1 region and 1.10 - 1.82% in R2 region in *C. luteus* whereas the values were from 1.20-1.62% in R1 region and 1.40 -1.84% in R2 region in *C. macrostomum* . As a result of this variation in the ash content values, the statistical results indicated significant differences ($P < 0.05$] among the studied fish, but not significant ($P > 0.05$] between *C. luteus* and *C. macrostomum* (Table 3]. Also the statistical results did not show any significant differences ($P > 0.05$] between R1 and R2 regions in *C. zillii*, *C. luteus* and *C. macrostomum*, whereas there were significant differences ($P < 0.05$] in *C. carpio* (Table 4].

Table 3. Statistical analysis of chemical components for muscles of R1 and R2 regions in studied species.

Parameter	(I] Fish	(J] Fish	Mean Differences (I-J)	Std. Error	Sig.
Protein	<i>C. zillii</i>	<i>C. luteus</i>	-6.14200*	.33392	.000
		<i>C. carpio</i>	-2.52200*	.33392	.000
		<i>C. macrostomum</i>	-4.07600*	.33392	.000
	<i>C. luteus</i>	<i>C. zillii</i>	6.14200*	.33392	.000
		<i>C. carpio</i>	3.62000*	.33392	.000
		<i>C. macrostomum</i>	2.06600*	.33392	.000
	<i>C. carpio</i>	<i>C. zillii</i>	2.52200*	.33392	.000
		<i>C. luteus</i>	-3.62000*	.33392	.000
		<i>C. macrostomum</i>	-1.55400*	.33392	.001

	<i>C. macrostomum</i>	<i>C. zillii</i>	4.07600*	.33392	.000
		<i>C. luteus</i>	-2.06600*	.33392	.000
		<i>C. carpio</i>	1.55400*	.33392	.001
Lipid	<i>C. zillii</i>	<i>C. luteus</i>	2.49800*	.19741	.000
		<i>C. carpio</i>	.69200*	.19741	.014
		<i>C. macrostomum</i>	-1.54800*	.19741	.000
	<i>C. luteus</i>	<i>C. zillii</i>	-2.49800*	.19741	.000
		<i>C. carpio</i>	-1.80600*	.19741	.000
		<i>C. macrostomum</i>	-4.04600*	.19741	.000
	<i>C. carpio</i>	<i>C. zillii</i>	-.69200*	.19741	.014
		<i>C. luteus</i>	1.80600*	.19741	.000
		<i>C. macrostomum</i>	-2.24000*	.19741	.000
	<i>C. macrostomum</i>	<i>C. zillii</i>	1.54800*	.19741	.000
		<i>C. luteus</i>	4.04600*	.19741	.000
		<i>C. carpio</i>	2.24000*	.19741	.000
Moisture	<i>C. zillii</i>	<i>C. luteus</i>	-.18200	.44692	.976
		<i>C. carpio</i>	.40600	.44692	.801
		<i>C. macrostomum</i>	2.72400*	.44692	.000
	<i>C. luteus</i>	<i>C. zillii</i>	.18200	.44692	.976
		<i>C. carpio</i>	.58800	.44692	.567
		<i>C. macrostomum</i>	2.90600*	.44692	.000
	<i>C. carpio</i>	<i>C. zillii</i>	-.40600	.44692	.801
		<i>C. luteus</i>	-.58800	.44692	.567
		<i>C. macrostomum</i>	2.31800*	.44692	.000
	<i>C. macrostomum</i>	<i>C. zillii</i>	-2.72400*	.44692	.000
		<i>C. luteus</i>	-2.90600*	.44692	.000
		<i>C. carpio</i>	-2.31800*	.44692	.000
Ash	<i>C. zillii</i>	<i>C. luteus</i>	2.77600*	.15984	.000
		<i>C. carpio</i>	.88600*	.15984	.000
		<i>C. macrostomum</i>	2.64800*	.15984	.000
	<i>C. luteus</i>	<i>C. zillii</i>	-2.77600*	.15984	.000
		<i>C. carpio</i>	-1.89000*	.15984	.000
		<i>C. macrostomum</i>	-.12800	.15984	.853
	<i>C. carpio</i>	<i>C. zillii</i>	-.88600*	.15984	.000
		<i>C. luteus</i>	1.89000*	.15984	.000
		<i>C. macrostomum</i>	1.76200*	.15984	.000
	<i>C. macrostomum</i>	<i>C. zillii</i>	-2.64800*	.15984	.000
		<i>C. luteus</i>	.12800	.15984	.853
		<i>C. carpio</i>	-1.76200*	.15984	.000

Table 5. shows the caloric values (energy] of the protein and lipid contents for muscles of the studied species. The results elucidated that *C.macrostromum* had higher total energy values of 150.20 kcal/g compared with the lowest value in *C.zillii* which was 119.37 kcal/g while the values recorded 121.75 and 124.5 kcal/g in *C.luteus* and *C.carpio* respectively.

Table 4. Statistical analysis of chemical components for muscles between R1 and R2 regions in each studied species.

Fish species	Parameter	F value	Sig. value
<i>C.zillii</i>	Protein	6.901	0.030*
	Lipid	24.786	0.001*
	Moisture	5.563	0.046*
	Ash	0.000	0.987
<i>C.luteus</i>	Protein	0.180	0.683
	Lipid	4.903	0.058
	Moisture	0.439	0.526
	Ash	0.795	0.399
<i>C.carpio</i>	Protein	2.005	0.195
	Lipid	3.208	0.111
	Moisture	1.364	0.276
	Ash	5.665	0.045*
<i>C.macrostromum</i>	Protein	1.665	0.233
	Lipid	2.925	0.126
	Moisture	1.389	0.272
	Ash	2.283	0.169

Table 5. Total means of protein, lipid contents and caloric (energy] values of studied species

Fish species	Total protein %	Energy value (kcal/g]	Total lipid %	Energy value (kcal/g]	Total energy value (kcal/g]
<i>C.zillii</i>	19.69	78.76	4.52	40.68	119.37
<i>C.luteus</i>	25.42	101.68	2.23	20.07	121.75
<i>C.carpio</i>	21.92	87.68	4.10	36.90	124.58
<i>C.macrostromum</i>	23.51	94.04	6.24	56.16	150.20

4. Discussion

Chemical muscle components of fish is the analysis of Protein, lipid, moisture(water] and ash contents of the fish [15] and is a good index of its physiological state and health [16]. The current work has elucidate variations in the chemical components of muscles in four teleosts fish which appear to be related to the muscle location in fish body. These results are in agreement with that of [10], [5] and [11] who each reported that, in different sites in the same body, the chemical composition of the fish may change in relation to differences in muscle location, size, species, sex and feeding conditions [17] pointed to increase in the values of protein, lipid and decrease moisture content (water] when studying the effect of seasonal variations on the chemical composition and bioaccumulation of heavy metals in Nile tilapia(*Oreochromis niloticus*] and linking these results with the seasonal changes of winter and spring, unlike summer and autumn. Therefore, the current results are consistent with previous studies on the effect of endogenous and exogenous factors [6] on chemical composition of fish muscles. The current results elucidated that in all the studied fish, there is a good amount of protein content in the muscle and used as food for consumers in Iraq because of their economic value [18] studied the effect of the seasonal variations on the chemical composition of the muscles of five fresh water fish and found that these fish contain a good amount of proteins in their muscles which can be used as healthy food.

Several previous studies have shown difference lipid content in fish and can be attributed mainly to differences among species. Lipid content values may be influenced by factors such as feeding habits, food type, age change, reproduction stage, hunting season [19] And muscle location in the body [4] , [5] , [10] , [11]. The current observation revealed that the four studied species had a lipid content ranging from medium to low content. The *C.luteus* fish can be classified as low lipid (2-4%) while *C. carpio*, *C.zillii* and *C.macrostromum* are classified as medium lipid (4-8%) [20].

[12] indicates that the moisture content of the fish is the percentage or amount of water in the muscle or fish body, and there is in the fish in two forms, one of which is linked to protein and the other form is free. These forms are characterized by specific biological roles but are not as important as food. Several previous studies indicate that moisture content [water] is the major component of chemical composition in fish muscles, which ranges from 65-90% followed by protein and lipid [21]. The values of moisture content in fish muscles are influenced by factors such as season, nutrition, sex, reproductive cycle [22] and muscle location in the fish body [4]. Therefore, the current results indicated differences in the values of moisture content in the regions of the body studied in the studied species.

The values of ash content in fish muscles are a reflection of body metabolism and nutrition [9]. These values are also a reflection of the large numbers of minerals found in the aquatic environment [23]. Previous studies also suggest that ash content is the lowest chemical component compared to other components in fish muscles. [9] reported that ash content values were different in five freshwater fish, ranging from 1.28% in *Barbs xanthopterus* and 3.25% in *Liza abu*. [24] noted that ash content values ranged between 1.2-1.5%. This ratio varies between species and individuals depending on factors such as age, sex, environment, and season [25]. Therefore, the current results showed significant differences between the studied species and these differences may be due mainly to species, nutrition.

Previous studies have indicated differences in caloric values [energy] in the fish body. These differences are due to seasonal variations which are related to feeding habits, reproductive cycle and storage of energy reserves [26]. Calories values [energy] are a reflection of the values of protein and lipid contents in the fish body. The muscle energy pattern differs from the energy pattern of the reproductive cycle and sexual maturity [27]. In the current study, the values of calories [energy] are a reflection of the values of protein and lipid contents for muscles, which showed a difference in the values of calories, which reflect significant differences in protein and lipid contents in the studied species.

5. Conclusions

The difference in the chemical components of the fish body regions studied in the current study is due mainly to the difference in species, size and location of muscles in the fish body. Depending on lipid content values, *C. luteus* fish were classified as low-lipid fish while *C. zillii*, *C. carpio* and *C. macrostomum* in medium-lipid fish.

6. References

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