



A STUDY OF THE ACCOUNTING OF THE PERCENTAGES OF RED AND WHITE MUSCLES AND THE ESTIMATION OF PROTEINS AND LIPIDS IN DIFFERENT REGIONS OF THE ABU MULLET, *PLANILIZA ABU* (HECKEL, 1843)

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Abstract

The current work aimed at conducting a comparative study the percentage of red and white muscles using Image J software and estimation of proteins and lipids in different regions from *P. abu* body, which belongs to the Mugilidae. The samples were collected between April and May- 2019 from the Karmat Ali river, north of Basra city in Iraq. The results showed a difference in the percentages of red and white muscles in the studied regions, which recorded 5.42%, 12.67%, 15.66%, 20.15%, 32.62%, 43.64% in R1, R2, R3, R4 R5 and R6 region, respectively, so the statistical results indicated significant differences ($P < 0.05$) in the red muscle percentage in the studied regions. The results revealed a decrease in the percentage of white muscles from the region R1 (94.58%) to the region R6 (56.36%). These percentages recorded significant differences ($P < 0.05$) in white muscle percentage in the studied regions. The protein content values were higher than the lipid content values of red and white muscle in the studied regions of the *P. abu* body. The protein values ranged from 15.90% to 17.56% while the lipid values were between 6.16 - 7.45% in the red muscle in the R1 region to R6 region, respectively. However, the protein values in white muscles were ranging from 22.13% to 20.43% and the lipid values from 1.16% to 2.33% in the R1 region to R6 region, respectively. The results pointed that the mean of caloric (energy) values for protein and lipid contents in red muscle was 67.54 and 60.67 kcal/g while it was 85.30 and 16.00 kcal/g in white muscle, respectively.

Key words: Mugilidae, Fish muscles, Chemical composition.

Introduction

The Mugilidae is one of the economically important fish families in Iraq for its nutritional value. These fish are freshwater, brackish, pelagic and Potamodromous, they are found in Iraqi waters in the Tigris and Euphrates rivers (Unlu *et al.*, 2000). The muscular system in fish is composed of three types of muscle fibers, red fibers form a thin lateral superficial under the skin, white fibers make up the major mass of the myotom while pink muscle fibers are found between red and white muscle fibers. These fibers differ in morphological and biochemical features with a variation of fish species (Rabah, 2005, Mansour, 2018). The percentage of red and white muscle fibers influenced according to endogenous and exogenous factors which related with fish species and environmental factors (Johnston *et al.*, 2000, Mansour, 2005, Karahmet *et al.*, 2014, AL-Muhanna *et al.*, 2019). The current study

aims to estimate the red and white muscle percentages in different regions in the *P.abu* fish. In addition to estimating the proteins and lipids in the two types of muscles, then determining the nutritional value of the studied fish muscles.

Materials and Methods

Sampling

Forty of *P.abu* fish ranging in length between 100-200 mm and weights from 75 to 175 g, were collected between April and May-2019 from the Karmat Ali river, north Basrah city, Iraq. These samples were transferred to the laboratory to do the required analyses.

Calculate the percentages of red and white muscles

P.abu fish body was divided into six regions starting from behind the head. These regions were R1 (the first region) to the caudal peduncle representing R6 (the

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Table 1: The percentage of red and white muscles in body regions of *P.abu*.

Body region	Red muscles	White muscles
R1	5.42 ^a ±1.20	94.58 ^a ±1.20
R2	12.67 ^{ab} ±4.46	87.33 ^a ±4.46
R3	15.66 ^b ±5.51	84.34 ^a ±5.51
R4	20.15 ^{cb} ±3.49	79.95 ^b ±3.49
R5	32.62 ^{cb} ±1.49	67.38 ^c ±1.49
R6	43.64 ^c ±1.45	56.36 ^d ±1.45

Data are the mean ± the standard deviation of the mean (n = 20). Within each individual column, significant differences between the percentage of red or white muscles in body regions (R1- R6) of *P.abu* are indicated by different letters ($p < 0.05$).

posterior region) (Mansour, 2005). The distance between each region is equal to 2 cm. Then, the red and white muscle regions were defined for each region. The ImageJ software was used in the calculation of red and white muscle percentages.

Estimation of protein and lipid content

According to A.O.A.C (2000), the methods were used to estimate the protein and lipid contents and caloric (energy) values in the red and white muscles in the studied body regions.

Statistical Analysis

Statistical analyses were performed using the SPSS version 25 software. The data were analysed using an independent-samples T-test. Differences were considered to be significant when $p < 0.05$.

Results

Table 1, shows the differences in percentages of the red and white muscle in the studied regions (R1 to R6) of the *P.abu* fish. The red muscle percentage reached 5.42% for the region R1 and 43.64% for the region R6 while the percentages of white muscle reached 94.58% for the region R1 and 56.66% for the region R6 (Table 1). The statistical results recorded significant differences ($p < 0.05$) in the red and white muscles percentages among the body

Table 2: Protein and lipid percentage in red and white muscles of *P.abu*.

Body region	Red Muscles		White Muscles	
	Protein (%)	Lipid (%)	Protein (%)	Lipid (%)
R1	15.90*±0.36	6.16**±0.07	22.13*±0.18	1.16**±0.12
R2	16.61*±0.11	6.31**±0.11	21.82*±0.12	1.42**±0.12
R3	16.83*±0.13	6.57**±0.10	21.40*±0.10	1.74**±0.10
R4	17.08*±0.10	6.88**±0.10	21.36*±0.10	1.96**±0.10
R5	17.33*±0.11	7.08**±0.10	20.82*±0.10	2.06**±0.10
R6	17.56*±0.10	7.45**±0.10	20.43*±0.10	2.33**±0.10

Data are the mean ± the standard deviation of the mean (n = 20). * indicates a significant difference in protein between red and white muscles of the body region ($p < 0.05$). ** indicates a significant difference in lipid between red and white muscles of the body region ($p < 0.05$).

regions from R1 to R6 (Table 1). The current results indicated an increase in the percentages of red muscle from the anterior region (R1) towards the posterior region (R6) in *P.abu* whereas the values of white muscle percentages tended to decrease from the region R1 to the region R6 (Table 1).

Table 2, shows the values of the protein and lipid content ratios in the red and white muscles of the studied body regions (R1 to R6) in *P.abu* fish. The results recorded that the protein ratios ranged from 15.90-17.56% in R1 and R6 regions in red muscle respectively, while lipid values ranged from 6.16 to 7.45% in R1 and R6 regions respectively. The protein and lipid content ratios recorded different values for the body regions from the region R1 to the region R6 in the white muscles. The protein ratios ranged from 22.13 to 20.43%, while the lipid ratios were between 1.16 and 2.33% in R1 and R6 regions, respectively (Table 2).

Table 2, also shows that the values of protein content in the red muscle were less than for that in the white muscle in all studied regions, while the lipid content of the red muscle was greater than that for the white muscle lipid content. The statistical results revealed significant differences ($P < 0.05$) in the proteins and lipids contents in the red and white muscles of the studied regions (R1 to R6).

The current results revealed a difference in the caloric (energy) values of proteins and lipid contents in the red and white muscles in the body regions studied in *P.abu*. The energy values of the protein content ranged from 63.60-70.24 Kcal/g while the energy values of the lipid content ranged from 55.44-67.05 kcal/g in red muscles in R1 and R6 regions, respectively (Table 3). However, the energy values of protein content in the white muscle ranged from 88.52 kcal/g in the region R1 and 81.72 kcal/g in the region R6 (Table 3) whereas the energy values for the lipid content ranged from 10.44 kcal/g in the region R1 and 20.97 kcal/g in the region R6 (Table 3).

Discussion

The musculature system of fish is composed of three types; red, white and pink muscles. In fish, red muscles form a small superficial layer near the lateral line and under the skin, while the white muscles make up the large mass of the musculature system. Pink muscles lie between red and white muscles (Stickland, 1997, Mansour, 2005, Rabah, 2005). The percentages of muscle fiber of fish differ according to species, ratio of muscles, individuals in the same species, muscles location in body, function and fish growth, variation between families and influence by environmental

Table 3: Caloric (Energy) values for Protein and lipid contents in red and white muscles of *P.abu*

Body region	Red Muscles		White Muscles	
	Energy value of protein (Kcal/g)	Energy value of lipid (Kcal/g)	Energy value of protein (Kcal/g)	Energy value of lipid (Kcal/g)
R1	63.60	55.44	88.52	10.44
R2	66.44	56.79	87.28	12.78
R3	67.32	59.13	85.60	15.66
R4	68.32	61.92	85.44	17.64
R5	69.32	63.72	83.28	18.54
R6	70.24	67.05	81.72	20.97
Mean	67.54	60.67	85.30	16.00

factors (temperature, light, exercise and diet) (Johnston *et al.*, 2000, Nejedli *et al.*, 2007). All these factors are correlated with the mode of life (Mansour, 2005). Therefore, the results indicated a variety of the percentage of red and white muscles in the studied regions of *P.abu* body. This variation is due to the growth of red and white muscles that reflex an increase in the size and number of the muscle fibers called hyperplasia and hypertrophy (Rowlerson and Vegetti, 2001).

In the current study, an increase was found in the percentage values of red muscles from the anterior region to the posterior region of the body relative to the fork length of the studied fish, while the percentages of white muscles showed a decrease towards the posterior region although they form a large mass of muscle tissue, This is may be due to the continued growth of the small muscle fibers as a result of hyperplasia and hypertrophy in the fish body, especially the posterior region which forms with caudal fin the main locomotory organ of fish (Al-Badri, 1985, Stickland, 1997, Mansour, 2005).

There are many components that contribute to the chemical composition of fish muscles. These components include protein, lipid, moisture and ash that differ according to their availability and function (Huss, 1988, Bosch, 2012). There are endogenous and exogenous factors that play a role in the muscle (meat) chemical composition which include species, sex, muscle location, physiological status, food type, season and environment (Shearer, 1994, Hantoush *et al.*, 2015, Mansour; 2018). The muscle chemical composition may also vary at the different positions of the fish body. These differences can largely be attributed to that fish have two main muscle types, red and white muscle. The red muscle is used for slow and sustained swimming whereas the white muscle is used for fast and burst swimming (Love, 1980).

The current results revealed a difference in the percentage of proteins and lipids in the red and white muscle regions of the *P.abu* fish. Protein values were

higher than lipid values due to increased white muscle mass compared with red muscles in the fish body which reflected their values on protein content. The protein content in fish was 25% while the body lipid content was between 2-10% (Shearer, 1994, Ackman, 1989). The results showed that the percentages of proteins in the white muscles was greater than that in red muscles. Unlike protein, the percentage of lipid had high values in red muscle and this difference in the values of protein and lipid percentages is mainly due to the differences in the location of red and white muscles in the different regions

in the body (Bosch, 2012, Mansour, 2018, AL-Muhanna *et al.*, 2019) in addition to the difference in a role played by the red and white muscles in the fish body (Love, 1980).

Conclusions

The current study revealed difference in percentages of red and white muscles in different regions of the body that reflect the differences in the location of the muscles in the body and therefore affect the values of the content of proteins and lipids in the fish body.

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