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A Study of the Calculation of The Ratio of Red and White Muscles in Grass Carp (Valeneciennes, 1844) Ctenopharyngodon Idella and Silver Carp (Valeneciennes, 1844) Hypophthalmichthys Molitrix in the Holy Karbala Governorate

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P A P E R I N F O

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A B S T R A C T

This study was conducted on two types of bony fish that live in fresh water, (50) fishes were collected with five groups of different lengths.The study results in a sharp difference in the rate of ratio of red and white muscles based on the examined body area and the length group studied.The rates of red muscle ratios increased with the increment of the average of total length of fish as we headed towards the caudal area of the body, This is proven by the study of the correlation relationship, which ranged the value of the correlation coefficient (0.991,0.993), and the rates of total red muscle ratios in grass carp ranged between (12.34-20.18%), and in silver carp was between (14.43-22.18%), while the rates of total white muscle ratios in grass carp ranged between (87.31-79.60%), and in silver carp was between (85.50-77.49%), Thus, it is clear that the rates of white muscle ratios decrease with the increment of the average of total length of the fish as we head towards the caudal area of the body, This is proven by the study of the correlation relationship, which ranged the value of the correlation coefficient (-0.995, -0.988). Additionally, the statistical analysis of the results found out the differences recorded by calculating the total rates of the ratio of red and white muscles, as well as their rates within the studied body areas. There are significant differences ($p<0.05$) in grass and silver carp, grass and silver carp fish were considered among the steadfast fish, because they contain high rates of red muscles and they practice swimming in a slow, continuous and long way. The study involves a comparison about move active for studying fishes through measurement resparetary surface area, and measurement red and white muscles ratio. This study is the first of its kind locally.

1. INTRODUCTION

Iraq contains plenty of water areas estimated to be (5%) of its entire area represented by the Euphrates and Tigris rivers and their tributaries with marshes, reservoirs, lakes in addition to Shatt al-Arab extending from north to south till the Arabian Gulf.Additionally, there are the artificial ponds that are widely spread in the center and south specialized in breeding and propagating fish, and if invested perfectly, it would have been sufficient to meet the daily needs and more than that [1]. Local Iraqi fish represent a source of daily consumption in human life because it contains high nutritional value as well as health benefits in its muscles, which represent a fresh healthy food for humans [2].Bony fish is one of the largest varieties widespread and diverse in fresh and salty aquatic environments. it includes more than (20,000) species [3], and this breed is characterized by the fact that its internal structure consists of bones, and its lungs have evolved into bladders for floating that act as a part of water balance by controlling the amount of air in the air bladder [4]. However, in terms of external appearance there are multiple forms of it such as the compact form from the sides, or from the bottom up, or streamliner, or the snake, etc. . It is one of the animals with variable temperature [5], and grass carp is called exotic fish, which is an economic fish as it reaches large sizes that benefit the consumer (Bardach et.al.,1972).On the other hand, silver

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carp is called thick front head, and can reach a length of about one meter and sometimes weigh about (30) kilograms [6].

Muscle tissues of the fish occupy most of the body weight compared to other vertebrate animals, as it constitutes about (30-70%) of the total body weight in most types of fish, and extends from the head area to the tail and on both sides of the body of the fish [7] .This study aims to find out the differences related to the activity of movement by studying the histological characteristics of the red and white muscle by examining the ratio of muscle fiber in the different areas of the body (R1, R2).

2. MATERIALS AND METHODS

For this study, (50) fish of the two types studied from the Euphrates River were collected from different locations along the river within the Hindiya district, for the period from the beginning of November 2023 to the end of January 2024, using nets of different sizes.The ratio of red and white muscles were calculated according to the method shown below [8].

3. STATISTICAL ANALYSIS

differences between the total height of fish and the rates of red and white muscle ratios were tested according to the Statistical Package for Social Sciences 16.

4. RESULTS

The results of the current study to calculate the total rate of red muscle ratios showed a clear difference in the values of their rates in the length groups and in the two types studied.The values of their rates in grass carp ranged between (12.18 - 20.18%), while the values of their rates ranged between (18.18-14.43%) in the two silver carp fish as presented in Table (1 and 2).It was mentioned that the red muscle ratios vary according to the areas of the body studied in one fish. Thus, the rates of red muscle ratios in the back region (R2) were greater than their percentages in front area near the head (R1) .In the two types studied, and when analyzing these results statistically to clarify the differences recorded for the total red muscle ratios calculated for the studied weight groups, significant differences ($p<0.05$)) were observed in the two types studied as presented in **TABLE 3** On the other hand, the results of the statistical analysis to clarify the differences recorded for the red muscle ratios of the studied weight groups in the studied body areas (R1) and R2) noted the existence of significant differences ($P<0.05$) in the two types studied as presented in Table [4].

white muscles calculated for the studied weight groups, significant differences ($P<0.05$)) were observed in the two types studied as shown in Table (3).When analyzing the results of the statistical analysis to clarify the differences recorded for the ratio of white muscles for the studied weight groups in the studied body areas (R1 and R2), significant differences ($P<0.05$)) were observed in the two types studied as shown in Table [4].

The results of calculating the total rate of white muscle ratios showed a clear difference in the values of their rates for the studied length groups for the two types studied, as the values of their rates ranged in grass carp (79.60% - 87.13) while their rates ranged between 77.49 - 85.50) %) in silver carp as shown in Table (1 and 2). The ratio of white muscles vary according to the two body areas studied in one fish. It was observed that the ratio of white muscle in the posterior region (R2) are lower than those in the anterior region near the head (R1) in the two types studied. When analyzing the results statistically to clarify the differences recorded for the ratio of white muscles calculated for the studied weight groups. There were significant differences ($P<0.05$) in the two types studied as shown in Table 3. When analyzing the results of the statistical analysis to clarify the differences recorded for the proportions of white muscles for the studied weight groups in the studied body areas (R1 and R2), significant differences ($P<0.05$)) were noticed in the two examined types as shown in Table 4.

TABLE 1. Values of sums of lengths, weights and ratios of red and white muscles in the studied body regions (R1 and R2) in grass carp *C. idella*

Total Length range (mm)	NO. of Fishes	Total length average (mm)	Weight average	Percentage of red muscle average (%)		Percentage of white (%) muscle average		Total red muscle average (%)	Total white muscle average (%)
				R1	R2	R1	R2		
345-300	10	329.21 ± 2.15	1418.65 ± 1.59	11.15 ± 0.13	13.53 ± 0.07	88.14 ± 1.78	86.12 ± 2.34	12.34	87.13
365-345	10	368.32 ± 2.36	1717.89 ± 1.51	13.35 ± 0.14	15.21 ± 0.06	86.67 ± 1.87	84.28 ± 2.16	14.28	85.47

405-365	10	409.12 ± 2.29	2009.13 ± 1.58	15.93 ± 0.11	17.89 ± 0.07	84.25 ± 1.71	82.67 ± 1.91	16.91	83.46
445-405	10	442.34 ± 2.16	2319.10 ± 1.59	17.25 ± 0.10	19.48 ± 0.08	82.13 ± 1.74	80.29 ± 1.94	18.36	81.21
485-445	10	482.47 ± 2.37	2508.78 ± 1.56	19.15 ± 0.13	21.21 ± 0.06	80.78 ± 1.79	78.43 ± 1.86	20.18	79.60

TABLE 2. Values of sums of lengths, weights and ratios of red and white muscles in the studied body regions (R1 and R2) in silver carp *H. molitrix*

Length group (mm)	No. of fish	Total length (mm)	Fish weight (g)	Ratio of red muscle (%)		Ratio of whit muscle (%)		Total ratio Of red Muscle (%)	Total ratio of white muscle (%)
				R1	R2	R1	R2		
345-300	10	329.21 ± 2.15	1418.65 ± 1.59	13.34 ± 0.11	15.53 ± 0.08	86.54 ± 1.74	84.46 ± 2.32	14.43	85.50
365-345	10	368.32 ± 2.36	1717.89 ± 1.51	15.23 ± 0.12	17.96 ± 0.09	84.53 ± 1.83	82.87 ± 2.10	16.59	83.70
405-365	10	409.12 ± 2.29	2009.13 ± 1.58	17.87 ± 0.10	19.45 ± 0.06	82.15 ± 1.78	80.16 ± 1.95	18.66	81.15
445-405	10	442.34 ± 2.16	2319.10 ± 1.59	19.34 ± 0.13	21.12 ± 0.07	80.54 ± 1.72	78.76 ± 1.91	20.23	79.65
485-445	10	482.47 ± 2.37	2508.78 ± 1.56	21.21 ± 0.12	23.24 ± 0.08	78.78 ± 1.71	76.21 ± 1.83	22.18	77.49

TABLE 3. Differences that recorded between the value of total red and white muscle ratios in the mentioned studied types.

Studied Feature	Table (T) value	Calculated (T) value	Significant Level (0.05)
Red muscle ratio (%)	1.15295	0.146393	Significant
White muscle ratio (%)	1.05798	0.165394	Significant

TABLE 4. Differences that recorded between the value of red and white muscle ratios at the studied body areas (r1 and r2) in the mentioned studied types.

Studied Feature	Significant level (0.05)	Table (T) Value	Calculated (T)value	Region
Ratio of red muscle (%)	R1	1.13601	0.14964	Significant
	R2	1.6945	0.143287	Significant
Ratio of white muscle (%)	R1	1.102884	0.156168	Significant
	R2	1.01151	0.175405	Significant

5. DISCUSSION

The results of the current anatomical study shows that the muscle tissue in the current studied fish is composed mainly of two types of motor muscles: the red muscle, which is located directly under the outer skin of the fish in a small area of it, and the white muscle, which is located above the red muscle and it represents the largest part of the muscle tissue, and can be distinguished by color, location, and appearance.These results are consistent with local studies such as study [9] and [10], It was cleared by [11] when studying the fish of carp ordinary and Khashni that the red muscle is located under the skin directly and extended from behind the head to the tail in the form of a thin layer surface . It is characterized by small diameter, containing high percentages of fat, and rich in mitochondria, and animal starch in which is little [12]. The location of the white muscle above the red muscle is occupied by the largest part of the muscle tissue and is characterized by a large diameter containing low percentages of fat, few mitochondria, and a lot of animal starch [13].

The function of the muscles in fish varies according to the type of muscle in them.The red muscle has specialized in long, continuous and slow swimming, while the white muscle has specialized in short, intermittent and fast swimming, in the sudden rush when escaping from predators or when chasing their prey when feeding [14].

The current results showed a significant variation in the rates of ratios between red and white muscles in the two studied areas (R2 and R1) and in the two types studied, where it appeared that the average percentage of red muscle was less than the average percentage of white muscle in both regions and types, and this is consistent with the results of local studies such as study [15] and [16].

The current results showed a sharp difference in the rate of the red muscle ratio according to the studied length group of fish, and here gives us clear evidence that there is continuous growth and this growth increases the rates of the red muscle ratio with the total weight of the fish, which leads us to increase the functional role of the red muscle when swimming fish in their aquatic environment [17].The incremant of the rate of red muscle ratio is mainly the result of the increase in the number of muscle fibers as well as the increase in their size. It is clear to us the increase in activity and speed in large fish compared to small fish [18]. This explains that small fish depend in their early life on the muscles that provide them with the oxygen they need to sustain their metabolic processes such as motor activity for them, and this is before the gills grow in their efficient and good form. In addition, the muscle tissue in fish enables it to determine the level of motor activity according to the rate of the ratio of red and white muscles. More over , the appropriate motor level for the fish can be developed through it [19].

The current results showed that the rate of the percentage of red muscle is clearly different in the two examined areas (R2 , R1) In the two types studied, the rate of the ratio of red muscle in the posterior body area (R2) was higher than the rate of the ratio of red muscle in the anterior body area (R1), and this indicates that the rate of the percentage of red muscle increases towards the posterior body area (tail peduncle). This is due to the importance of this area in terms of motor, which is in conjunction with the tailfin of the common movement organ, that is called the basic organ of movement in the fish. This in turn shows the increase in the ratio of red muscle fiber that is rich in blood and fatty processing. It is the main source of energy processing during the long and continuous motor activity This increase in the ratio of red muscle earns the muscle sufficient muscle flexibility for its fibers, which it needs in its contraction and relaxation, and thus be efficiently for its functional roles appropriate to the movement it needs [20].These results are consistent with local studies such as study[21] and [22].

[23] mentioned that fish families are completely different in the rate of the percentage of red muscle in the muscle tissue. This is related to the nature of their life in the aquatic environment in which they live, that gives a clear picture of their motor activity. The percentage of red muscle in the Scombridae family was (26.1%), which is an active family in movement, while the Squaloidae family reached (14.3%), which is a medium or moderate family of motor activity.On the other hand, the percentage of red muscle in the Chimaeridae family is (0.6%), a family whose motor activity is inert. These different percentages of the rate of red muscle give a clear picture of its motor activity in the aquatic environment in which it lives [24]. From observing the current results, we find that grass and silver carp fish are active fish in movement, because the total rate of red muscle ratio in grass carp fish ranged between (12.34-20.18%), while in silver carp fish ranged between.(%22.18-13.43)

The current results showed that the rate of the percentage of white muscle is clearly different in the two areas studied of the body (R2 , R1) and in the two types studied, the rate of the percentage of white muscle in the front body area (R1) was higher than the rate of the percentage of white muscle in the back body area (R2). This indicates that the rate of the percentage of white muscle decreases towards the posterior body area, and thus it becomes clear that there is an inverse correlation between the rate of the percentage of white muscle and the total longitudinal rate of thickness. This denotes a decrease in the average percentage of white muscle as the total longitudinal rate of thickness increases and towards the posterior body area. These results are consistent with local studies such as [25,26].

The division shown by Mansour [27] on the average ratios of the red and white muscle related to muscle tissue and its characteristics related to appearance for the body of the fish illustrates that grass and silver carp fish fall within the fish Stayers fishes because it contains a high rate of red muscle and it practices swimming in a slow, continuous and long way. The average percentage of fiber to muscle tissue varies between different fish species and it is influenced by a number of important factors including their diet, temperature level, intensity of lighting, and some vital activities such as movement and speed in their aqueous medium [28].

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Arabic Abstract

أجريت هذه الدراسة على نوعين من الأسماك العظمية التي تعيش في المياه العذبة, تم جمع (50) سمكة ذات خمس مجاميع من الأطوال المختلفة, وأوضحت نتائج الدراسة اختلافًا واضحًا في معدل نسب العضلات الحمر والبيض باختلاف المنطقة الجسمية المدروسة ومجموعة الطول المدروسة, فازدادت معدلات نسب العضلات الحمر بازديادمعدل الطول الكلي للسمك كلما اتجهنا باتجاه المنطقة الذيلية للجسم, وهذا ما أثبتته دراسة علاقة الارتباط التي تراوحت قيمة معامل الارتباط فيها (0.993,0.991), وإن معدلات نسب العضلات الحمر الكلية في سمك الكارب العشبي تراوحت بين (12.34-20.18%), وفي سمك الكارب الفضي تراوحت بين (14.43-22.18%), بينما معدلات نسب العضلات البيض الكلية في سمك الكارب العشبي تراوحت بين (87.31-79.60%), وفي سمك الكارب الفضي تراوحت بين (50.85- 77.49%),ولهذا يتضح إن معدلات نسب العضلات البيض تقل بازدياد معدل الطول الكلي للسمك كلما اتجهنا باتجاه المنطقة الذيلية للجسم, وهذا ما أثبتته دراسة علاقة الارتباط التي تراوحت قيمة معامل الارتباط فيها (-0.995 , -0.988), ولوحظ عند التحليل الإحصائي للنتائج لمعرفة الفروقات المسجلة بحساب المعدلات الكلية لنسب العضلات الحمر والبيض,وكذلك معدلاتها ضمن مناطق الجسم المدروسة, وجود اختلافات معنوية ($p<0.05$) في سمك الكارب العشبي والفضي, اعتبر سمك الكارب العشبي والفضي ضمن الأسماك الصامدة؛ لاحتوائها على معدلات نسب عالية من العضلات الحمر وهي تمارس سباحتها بطريقة بطيئة ومستمرة وطويلة, وتعد هذه الدراسة هي الأولى من نوعها محليًا.