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## **INVESTIGATIONS ON THE CHEMICAL COMPOSITION OF CARP (*CYPRINUS CARPIO* L.), BIGHEAD CARP (*ARISTICHTHYS NOBILIS* RICH.) AND PIKE (*ESOX LUSIUS* L.) DURING DIFFERENT STAGES OF INDIVIDUAL GROWTH**

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### **Abstract**

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The purpose of this study is to trace the chemical composition of muscle tissue of the sexually aged female fish and of the eggs obtained from them, as well as of the rearing of fingerlings from carp (*Cyprinus carpio* L.), bighead carp (*Aristichthys nobilis* Rich.) and pike (*Esox lusius* L.). Differences in the biochemical composition of fish tissue during the different stages of individual growth (female fish, eggs, fingerlings) have been established. Species specificity for the indices investigated between the carp, the bighead carp and the pike has been proved. A tendency for increasing the relative share of fats and for decreasing the relative share of proteins from the eggs has been reported towards fingerlings and muscle tissues. The dry matter content decreases from the eggs (31.2–34.4%) towards the muscle tissue (21.8–25.8%) and the fingerlings (14.5–15.1%). A significant to a great dependence between the muscle tissue and the eggs has been established as regards the proteins and fats contents in them.

*Key word:* carp, bighead carp, pike, chemical composition, female fish, muscle tissue, fingerlings, eggs

### **Introduction**

Investigations concerning the change of fish biochemical composition as regards the study of their biology and physiology have been carried out by many authors (Klejmenov, 1962; Hadjinikolova and Tzekov, 1990; Ottolenghi et al., 1995; Hadjinikolova et al., 2000; Olivera – Novoa et al., 2002; Hadjinikolova and Zaikov, 2006). However, as far as the complex study of chemical composition of the female fish, eggs and larvae obtained from them is concerned, the number of such investigations has been rather limited

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(Maljarevskaja and Birgher, 1965; Zalepuchin, 2007).

The female fish evaluation before spawning according to a complex of features, characterizing the level of metabolism allows to prognosticate approximately the future breeding capacity (Bogeruk and Maslova, 2002).

The simultaneous study of female fish and eggs will allow to make an assessment, at which biochemical indices of theirs the eggs will possess the greatest supply of nutritious substances, necessary for the growth of physiologically full value fish (Maljarevskaja and Birgher, 1965).

According to Zalepuchin (2007), the accomplishment of a complex investigation of the triad “spawner quality – eggs and sperm quality – fingerlings quality” will allow to implement the poly-functional principle for quality assessment of carp fish producers – the main objects of pond fish farming. The significance of eggs and seminal fluid quality is the greatest one in the triad of the objects investigated, because it is in them, where the metabolistic changes during the period of gamete-genesis, ageing and spawning are realized.

At conditions of pond-fish reproduction, eggs quality has the decisive significance, in whose qualitative characteristics the physiological and biochemical changes, which take place in spawner organism, are reflected.

On the other hand, eggs quality has a significant impact upon qualitative characteristics of the embryos survival during the incubation period and of the larvae survival in the period of endogenous nutrition before their transfer towards active outer nutrition (Zalepuchin, 2007).

The purpose of this study is to trace the chemical composition of muscle tissue of the sexually aged female fish and of the eggs obtained from them, as well as of the growing up fingerlings from carp (*Cyprinus carpio* L.), bighead carp (*Aristichthys nobilis* Rich.) and pike (*Esox lusius* L.).

## Material and Methods

The investigations upon the muscle tissue chemical composition of matured female fish, of the eggs obtained from them and of the fingerlings have been carried out in June-July 1996 with carp and bighead carp fish, and in March-April with pike. The weight of the fish investigated has been 3.5 kg of carp, 7.0 kg of bighead carp, and 1.5 kg of pike, respectively. The 30-40 days old larvae have had 1 g max weight.

The laboratory samples for chemical analysis have been prepared from the eggs, the fingerlings body and the muscle tissue of a representative number of fish from the species studied, which after homogenization have been used to determine the following indices: moisture (105°C, 24 h), proteins (Kjeldahl and Parnas-

Wagner nitrogen distillation), fats (Soxshlet method), and mineral salts (550°C). Methods for fish standard analysis have been used (Kiossev, 1978). On the basis of their chemical composition, the energy value has been theoretically calculated when using the coefficients of 23.9 kJ.g<sup>-1</sup> for the proteins, 39.75 kJ.g<sup>-1</sup> for the fats and 17.49 kJ.g<sup>-1</sup> for the carbohydrates. The quantity of carbohydrates has been obtained by means of re-calculation (Maljarevskaja and Birgher, 1965).

## Results and Discussion

The general conclusion data, reflecting the chemical composition of the investigated groups of eggs, fingerlings and muscle tissue meat for the separate fish species have been given in Table 1, 2 and 3. They allow marking the existing differences in the biochemical composition of the objects investigated in the process of the individual growth of fish organism.

The water content in the eggs varies from 65.57% (pike) to 68.83% (bighead carp) and from 84.9% (carp) to 85.65% (pike) in the body of 40-days old fingerlings. The values obtained for water content in the eggs of carp and bighead carp have been close to those indicated by other authors, as well (Zelepuchin, 2007). The water quantity in the muscle tissue has been within the limits of 74.2% (bighead carp) – 78.15% (pike). These data have confirmed Klejmenov's investigations (1962) for water content differences depending on fish age and on tissues and organs investigated.

As far as proteins are concerned, differentiation in the values has also been reported depending on the investigated object. Eggs values (25.69–27.16 %) are higher, while muscle tissue values are lower (14.42–16.21%). The proteins level in the growing up fish body has the lowest values, which are within the limits of 11.67–12.18%. A similar tendency for lower values in their body has been also reported for the fats (0.46–1.91 %). The fats level in eggs samples is within narrower limits 2.35–2.72 %, while in the muscle tissue samples it varies from 6.34–10.26 %.

The minerals contents in the eggs is by 56.4% (carp), 68.4% (bighead carp) and 70.6% (pike) higher

**Table 1**  
**Chemical composition of eggs, fingerlings and muscle tissue from carp female fish, having weight of 3.5 kg**

Indices	Water	Protein	Fats	Mineral contents	Energy	
					Total κJ.100g <sup>-1</sup>	% from protein
% of wet matter						
Eggs *	68.22	25.69	2.35	1.47	736.6	83.4
Fingerlings	84.90	11.82	1.87	1.41	356.8	79.2
Muscle tissue	74.55	16.21	8.3	0.94	717.3	54.0
% of dry matter						
Dry matter	31.18					
Eggs	-	82.4	7.5	4.7	-	-
Dry matter	15.10					
Fingerlings	-	78.25	12.37	9.38		
Dry matter	25.45					
Muscle tissue	-	63.7	32.6	3.7	-	-

\*carbohydrate 1.67%

**Table 2**  
**Chemical composition of eggs, fingerlings and muscle tissue from bighead carp female fish, having weight of 7.0 kg**

Indices	Water	Protein	Fats	Mineral contents	Energy	
					Total κJ.100 g <sup>-1</sup>	% from protein
% of wet matter						
Eggs *	68.83	25.82	2.52	1.65	737.9	83.63
Fingerlings	85.14	11.67	1.91	1.28	354.8	78.6
Muscle tissue	74.2	14.56	10.26	0.98	755.8	46.05
% of dry matter						
Dry matter	31.17					
Eggs	-	82.84	8.08	5.29		
Dry matter	14.86					
Fingerlings	-	78.56	12.84	8.6		
Dry matter	25.8					
Muscle tissue	-	56.43	39.77	3.8		

\* carbohydrate 1.18 %

values as regards the values reported for the muscle tissue of the fish species indicated.

The dry matter content in pike eggs is 34.43%, and that of carp and bighead carp it is 31.18%. The

dry matter content in the fingerlings as compared to that of the eggs decreases by more than 2 times, that is why the water level in them increases considerably. It is considered that still during the course of embry-

**Table 3**  
**Chemical composition of eggs, fingerlings and muscle tissue from carp female fish, having weight of 3.5 kg**

Indices	Water	Protein	Fats	Mineral contents	Energy	
					Total kJ.100g <sup>-1</sup>	% from protein
% of wet matter						
Eggs *	65.57	27.16	2.72	1.86	804.2	80.7
Fingerlings	85.65	12.18	0.46	1.71	309.4	94.0
Muscle tissue	78.15	14.42	6.34	1.09	596.7	57.8
% of dry matter						
Dry matter	34.43					
Eggs		78.88	7.9	5.4	-	-
Dry matter	14.35					
Fingerlings		84.87	3.21	11.92	-	-
Dry matter	21.85					
Muscle tissue		66.0	29.0	5.0	-	-

\*carbohydrate 2.69%

onic fish growth, most probably, water enrichment of the gall bladder, the eggs and the pre-vital space starts on the account of environmental water (Maljarevskaja and Birgher, 1965).

By determining the relative share of plastic and energy-producing substances in the dry matter content, the tendency of increasing fats level and decreasing proteins level has been more clearly outlined from the eggs towards the fingerlings and the muscle tissue. The relative share of mineral salts in the dry matter content of carp, bighead carp and pike larvae is within the limits of 8.6–11.9% and is higher as compared to that in the eggs dry matter content (from 68% to 2 times) and of the muscle tissue (from 65% to 2 times). The proteins comprise 78.2–84.87% of the dry matter content in the eggs and fingerlings and within the limits of 56.43–66.0% of the muscle tissue dry matter content. When being re-calculated towards the dry matter content the relative share of the proteins in the 40-days old fingerlings is close to that of the eggs.

Concerning the high water content in the body of the growing up 30–40 days old fingerlings, smaller contents of organic substance has been reported in

their live mass as compared to that of the eggs. The higher organic substance contents in the eggs live mass presupposes also its higher nutritious substances supply. This has been reflected also upon the energy value, which in the eggs is within the limits of 736.6–804.2 kJ.100g<sup>-1</sup> and surpasses by 2 times the energy value of fingerlings body (309.4–356.8 kJ.100g<sup>-1</sup>). The energy value reported for the muscle tissue of the female fish has been within the limits of 596.7–755.8 kJ.100g<sup>-1</sup>, on the account of proteins being 46.05–57.8%, while for the eggs and fingerlings that percent has been within the limits of 78.6–94%. This more sensible change of the relative share of proteins in the female fish muscle tissue after spawning has been due most of all to their lower proteins level.

It has been established (Loughna and Goldspink, 1985) that concerning the period of sexual ageing more than 60% of the total proteins synthesis has been concentrated in the internal organs and only about 10–20% in the muscle tissue. A similar tendency has been observed in previous investigations of the brook trout (*Salvelinus fontinalis*) (Hadjinikolova et al., 2003). The data from these studies have supported this the-

sis and have explained the lower proteins contents in the muscle tissue of the sexually aged female fish after spawning. In previous studies (Hadjinikolova, 2004) it has been established that in the muscle tissue of carp, having weight of 1.0–1.5 kg and of bighead carp, having weight of 5–8 kg investigated during the period October – November, proteins level has been at an average of 17.5% (carp) – 18.6% (bighead carp), i.e., at the end of the active vegetation period the fish increase the level of energy-producing and plastic substances in their body.

Values in the order of 17.13% for proteins, 8.0% for fats and 26.8% for the dry matter content in the muscle tissue have been recommended as a standard for carp female fish (Bogheruk and Maslova, 2002).

The correlation coefficients between the eggs and the muscle tissue as regards proteins and fats contents have been determined (Table 4).

A significant and negative correlation between proteins contents of the muscle tissue and the eggs has

**Table 4**  
**A correlation between proteins and fats contents**

n=4	Muscle tissue /Eggs	
	Protein	Fatts
r	-0.632	-0.82
p	0.367	0.18

been established. A similar dependence has been determined when studying female fish from Crucian carp (*Carassius carassius*) and their eggs-generation and larvae and from bream (*Abramis brama*), as well, (Maljarevskaja and Birgher, 1965).

As regards fats, the connection between the muscle tissue and the eggs has been big and reverse ( $r = -0.82$ ).

The equations deduced have shown a tempered dependence between proteins level in the muscle tissue and the eggs ( $R^2 = 0.399$ ), at a relative variation share of 40% and a significant dependence between meat and eggs ( $R^2 = 0.67$ ), as regards fats, at a relative variation share of 67.1%.

The preliminary investigations carried out have

given the possibility to draw a general conclusion that the results from the biochemical investigations and their mathematical interpretation can serve as the basis for the development of perspective physiological and biochemical methods for quality assessment of the producers, the eggs and the growing up fingerlings at conditions of aquaculture and improvement of pond-fish farming biotechnique.

## Conclusions

Differences in the biochemical composition of fish tissue during the different stages of individual growth (female fish, eggs, fingerlings) have been established. Species specificity for the indices investigated between the carp, the bighead carp and the pike has been proved.

A tendency for increasing the relative share of fats and for decreasing the relative share of proteins from the eggs has been reported towards fingerlings and muscle tissues.

The dry matter content decreases from the eggs (31.2–34.4%) towards the muscle tissue (21.8–25.8%) and the fingerlings (14.5–15.1%).

A significant to a great dependence between the muscle tissue and the eggs has been established as regards the proteins and fats contents in them.

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