

COMPARATIVE INVESTIGATIONS ON THE NUTRITIVE VALUE OF CARP FISH MEAT (CYPRINIDAE), GROWN AT ORGANIC AQUACULTURE CONDITIONS

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Abstract

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The aim of this study is to investigate the chemical composition and the caloric value of the carp meat (*Cyprinus carpio* L.), the bighead carp meat (*Aristichtuys nobilis* Rich.) and the grass carp meat (*Ctenopharyngodon iddela* Val.), grown at organic production technology application. The technology of carp, grass carp and bighead carp growing has had most of all an influence on fats contents. It has been established that their level has been authentically higher in bighead carp meat, as regards carp and grass carp meat, grown in ponds, where organic fertilization has been applied. The relative proteins share in the fish grown meat (77.0-84.5%) has been with a more clearly expressed differentiation depending on their species and has been within the limits of 77.0-79.6% for the bighead carp, 81.3% for the carp and 83.5-84.5% for the grass carp. The caloric values of meat has varied within 437.4-545.8 kJ.100 g⁻¹, 71 % (bighead carp) – 84.2% (grass carp) of which has been on the account of the proteins.

Key word: carp, grass carp, bighead carp, meat, quality, chemical composition, caloric values, organic production

Abbrevitions: Carp SF – the scaly form of carp; Carp MF – the mirror form of carp

Introduction

The nutritive value of fish has been determined either by the ratio between the edible and non-edible parts of the body, or by their chemical composition, on the basis of which the caloric value of their meat can be evaluated, as well. On the other hand, their chemical composition has been affected by a number of factors, like: the species, the sex, the age, the season, as well as by the environmental conditions, and by the technology of growing and feeding.

When traditional technologies for growing in polyculture in the carp farms of our country have been applied, the production of fish has consisted mainly from the carp and the herbivorous fish species, like silver carp, bighead carp and grass carp.

Nowadays, in many European countries, as regards warm-water ponds fish growing, the extensive and semi-intensive methods of fresh-water fish growing have been the prevailing ones, the greater part of production being obtained on the account of natural food (Kourzhil and Adamek, 2003). Therefore, carp

growing has been suitable for the application of technologies, based on natural food, which is the organic (biological) fish production technology, in itself.

Having in mind, that together with the efficient factors of fish production obtained, its quality is significant, as well, the aim of this study is to investigate the chemical composition and the caloric value of the carp meat (*Cyprinus carpio* L.), the bighead carp meat (*Aristichthuys nobilis* Rich.) and the grass carp meat (*Ctenopharyngodon iddela* Val.), grown at organic production technology application.

Materials and Methods

The investigation has been carried out within the frames of organic production technology, developed in the Institute of Fisheries and Aquaculture – Plovdiv. For the purpose of the experiments, eight ponds have been utilized, having a single area of 0.17-0.38 ha. The fish have been grown in polyculture, at a fish-stocking density of 500 ps.ha⁻¹ of carp (K₁) (*Cyprinus carpio* L.), (scaly and mirror form, at a ratio of 1:1); 300 ps.ha⁻¹ of bighead carp (T₁) (*Aristichthuys nobilis* Rich.), and 100 ps.ha⁻¹ of grass carp (A₁) (*Ctenopharyngodon iddela* Val). Organic fertilization has been applied in the experimental ponds No. 12, 17, 19 and 20, at a rate of 3000 kg.ha⁻¹, and in the control ponds No. 8, 15, 16, 18, fertilization has not been applied.

During the vegetation period (May–September), the physical and chemical indices of water have been reported, whose average seasonal values have been within the technological norms for the fish species grown: temperature - 21.8-23.6°C; pH – 7.55-8.3; oxygen dissolved in water – 4.4-12.77 mg.l⁻¹; chemical oxygen demands (COD) – 8.9-16.2 mg.l⁻¹.

At the end of the vegetation period for the purpose of chemical analysis, by 3 ps of fish have been taken from each pond and from each fish species. The average end weight of fish has been indicated in Table 1. Samples have been prepared from their muscle tissue, which after homogenization have been analyzed to determine water contents (105°C, 24 h), proteins contents (Kjeldahl and Parnas-Wagner ni-

trogen distillation), fats contents (Soxhlet metod) and minerals contents (550°C). Fish analysis standard methods (Kiossev, 1978) have been applied, as well. Meat caloric value has been calculated on the basis of the chemical composition of fish and the rates of 23.9 kJ.g⁻¹ for the proteins and 39.75 kJ.g⁻¹ for the fats.

Results and Discussion

The results from the study of chemical composition and caloric value of carp, grass carp, and bighead carp meat, according to variants and ponds have been given in Table 1, and the averaged data of the indices traced have been reflected in Table 2.

The absolute values of proteins have been within the range of 14.01-16.03% for the carp and 15.0-17.23% for the grass carp and the bighead carp. The difference in protein contents in carp meat – SF and carp – MF from the experimental and the control groups has been within the limits of 1.3-2.4% and have been untrustworthy (P>0.05). By 8-11% higher absolute values have been reported in the grass carp and bighead carp meat, as regards those, which have been established in carp meat, although the differences have been untrustworthy.

The differentiation in fats values for the different species has been within 2.3-2.63% for the carp, 1.6-2.82% for the grass carp, and 2.24-4.5% for the bighead carp. A tendency has been reported for increasing fats level in grass carp and bighead carp meat, by increasing of their weight within 770-1500 g, at weight average values for these species within 669.5-933.8 g, and for the carp within 5.29-577 g. The differences in fats values between grass carp and bighead carp, and between carp and bighead carp have been mathematically proved at P<0.05.

As regards water contents, the differences in carp meat for the separate groups has been within the order of 0.6-1.2%, having in mind that the absolute values for the mirror and the scaly form of carp have been of one and the same order. Lower absolute values within 1.0-3.8% have been reported for grass carp and bighead carp meat, as regards those of carp meat,

Table 1**The chemical composition of the meat of carp, grass carp and bighead carp**

Pond №	Fish species	Weight, g	% of wet matter					Relative share, %	
			Water	Protein	Fats	Minel contents	Dry matter	Protein	Fats
6	Carp -sf	647	82.52	14.01	2.38	1.09	17.48	80.15	13.62
	Carp -mf	690	82.21	14.35	2.49	0.95	17.79	80.66	14
	Grass carp	878	81.68	15.64	1.6	1.08	18.32	85.37	8.73
	Bighead carp	885	80.17	15	3.82	1.01	19.83	75.64	19.26
15	Carp -sf	661	80.33	16.03	2.45	1.19	19.67	81.49	12.46
	Carp -mf	738	81.84	14.84	2.28	1.04	18.16	81.72	12.55
	Grass carp	701	80.99	16.36	1.61	1.04	19.01	86.06	8.47
	Bighead carp	868	78.8	16.24	3.78	1.18	21.2	76.6	17.83
16	Carp -sf	380	81.67	15.12	2.09	1.12	18.33	82.48	11.4
	Carp -mf	414	82.43	14.21	2.34	1.02	17.57	80.87	13.3
	Grass carp	-	-	-	-	-	-	-	-
	Bighead carp	350	80.27	16.3	2.42	1.01	19.73	82.62	12.27
18	Carp -sf	428	82.76	14	2.24	1	17.24	81.21	12.99
	Carp -mf	466	82.66	14.22	2.15	0.97	17.34	82	12.4
	Grass carp	733	80.24	16.25	2.52	0.99	19.76	82.23	12.75
	Bighead carp	575	80.35	16.49	2.24	0.92	19.65	83.92	11.4
12	Carp -sf	546	81.76	15.15	2.03	1.06	18.24	83.06	11.13
	Carp -mf	494	82.1	14.93	2.06	0.91	17.9	83.41	11.08
	Grass carp	856	80.58	16.25	2.18	0.99	19.42	83.67	11.22
	Bighead carp	1100	78.18	16.49	4.5	0.83	21.82	75.57	20.62
17	Carp -sf	313	82.64	14.11	2.09	1.16	17.36	81.29	11.87
	Carp -mf	300	82.23	14.5	2.23	1.04	17.77	81.6	12.55
	Grass carp	385	81.56	15.68	1.59	1.17	18.44	85.03	8.62
	Bighead carp	771	78.02	16.51	4.29	1.18	21.98	75.11	19.5
19	Carp -sf	597	81.1	15.33	2.63	0.94	18.9	81.11	13.9
	Carp -mf	647	81.56	14.85	2.53	1.06	18.44	80.53	13.72
	Grass carp	1446	79	17.23	2.82	0.95	21	82	13.43
	Bighead carp	719	79.6	15.73	3.68	0.99	20.4	77.11	18.04
20	Carp -sf	568	81.86	14.98	2.22	0.94	18.14	82.58	12.24
	Carp -mf	536	81.82	14.75	2.46	0.97	18.18	81.13	13.53
	Grass carp	1048	79.41	17.2	2.43	0.96	20.59	83.54	11.8
	Bighead carp	722	79.2	16.75	3.1	0.95	20.8	80.53	14.9

1 – ponds No. 6, 15, 16, 18 – without application of organic fertilization;

2 – ponds No. 12, 17, 19, 20 - with application of organic fertilization;

Carp SF – the scaly form of carp;

Carp MF – the mirror form of carp.

Table 2

The average values of chemical composition of the meat of carp, grass carp and bighead carp (n = 4)

Chemical composition		Without application of organic				With application of organic fertilization			
		Carp -sf	Carp -mf	Grass carp	Bighead carp	Carp – sf	Carp – mf	Grass carp	Bighead carp
Weight, g	X	529	577	770.7	669.5	506	494.3	933.8	828
	Sx	84.16	95.84	66.69	147.89	75.25	83.54	254.1	105.59
	Cv	27.6	27.87	12.23	38.26	25.76	29.27	47.19	22.00
Water, %	X	81.82	82.29	80.97	79.9	81.84	81.93	80.14	78.75
	Sx	0.634	0.202	0.509	0.425	0.364	0.173	0.67	0.445
	Cv	1.34	0.42	0.89	0.92	0.77	0.36	1.45	0.98
Protein, %	X	14.79	14.41	16.08	16.00	14.89	14.76	16.59	16.37
	Sx	0.565	0.171	0.274	0.392	0.312	0.108	0.438	0.256
	Cv	6.62	2.06	2.41	4.25	3.63	1.27	4.57	2.7
Fats, %	X	2.29	2.32	1.91	3.07	2.24	2.32	2.26	3.89
	Sx	0.092	0.081	0.374	0.492	0.156	0.125	0.298	0.365
	Cv	6.96	6.09	27.66	27.8	12.05	9.29	22.87	16.25
Min. cont., %	X	1.1	0.98	1.04	1.03	1.03	0.99	1.01	0.99
	Sx	0.045	0.024	0.032	0.063	0.061	0.04	0.059	0.084
	Cv	7.16	4.22	4.35	10.55	10.37	6.89	1013	14.71
Relative share, %									
Protein		81.35	81.37	84.5	79.6	81.99	81.68	83.53	77.0
Fats		12.6	13.21	9.56	15.27	12.33	12.84	11.38	18.31
Energy									
kJ.100 g ⁻¹		444.5	437.4	456.6	504.4	444.9	445.0	486.3	545.8
% from protein		79.5	78.7	84.2	75.8	79.9	79.3	81.5	71.7

although the differences have been statistically untrustworthy.

The minerals contents in carp meat has been within the limits of 0.83-1.18%, a tendency for their change depending on the variants of fish growing not being reported, and the differences among the average values have not been mathematically proved.

The relative share of proteins of the fish investigated has been within the order of 77-84.5%, for the carp being 81.3%, for the grass carp being 83.5-84.5% and for the bighead carp being 77.0-79.6%.

A lower relative share of fats has been reported in grass carp meat – 9.56-11.38%, in carp meat it has

been respectively within the limits of 12.3-13.21% and in bighead meat – 15.27-18.31%. The data have indicated that the relative share of fats in bighead carp meat, concerning the variant without applying organic fertilization has been higher by 15.6% (as regards the MF carp) – 59.7% (as regards grass carp), and concerning the variant with organic fertilization application, by 42.6% (as regards the MF carp) – 60.9% (as regards grass carp). The tendency has been for higher values in the variant with organic fertilization application, juxtaposed with that without organic fertilization application in the ponds.

The values of water contents in the meat of two

years' old carp and grass carp have been higher, and of proteins and fats contents - lower in accordance with those established in previous investigations when these species have been grown in poly-culture and traditional fish-stocking and feeding methods have been applied. As regards bighead carp, the levels of indices investigated have been close to those determined in previous investigations, at weight of 800–900 g (Hadjinikolova, 2004).

The data analysis has outlined certain differences in the chemical composition of fish investigated, which have been more clearly expressed as regards fats. At the conditions of the experiments carried out, the relative share of proteins in bighead carp has been lower, and that of fats higher as compared to their share in carp and grass carp meat.

From the caloric value data (Table 2) it has been evident that 78.7- 79.9% of carp meat calories, 81.5-84.2% of grass carp meat and 71.7- 75.8% of bighead carp meat have been on the account of the proteins.

The caloric value of bighead carp meat has been by 10.0% - 22.6% higher as compared to that of carp and grass carp meat, which has been due to the higher relative share of fats, contained in it. By using the classification made by Klejmenov (1962), we can highlight that the meat of the two-years' old carp, grass carp and bighead carp can be ranked among the category of the medium-fatty fish (with fats contents of 1-5%).

Having in mind, that the contents of poly-unsaturated n-6 fatty acids in carp fats can reach up to 21.1%, and of n-3 – 4.3% (Hadjinikolova, 2004), and in bighead carp fats, the level of n-6 fatty acids is respectively 9.7%, while of n-3 – 30.5 % (Steffens, 2006), it follows that their higher level has qualified the investigated fish meat as the source of the essential for men' health fatty acids.

The nutrition spectrum of bighead carp, which consumes only natural food, has been the limiting factor for the higher contents of polyunsaturated n-3 fatty acids in its meat. It has been proved that the fatty acids contents depends on the components of fresh-

water fish food, which feed on phyto- and zoo-plankton, rich of n-3 polyunsaturated fatty acids (Steffens, 2006).

By comparing the data for proteins contents in the meat of fish investigated with those of the other meats (Table 3), it can be seen that the relative share of proteins in their meat has been higher than that of pork and lamb. The bighead carp meat has been close to the veal, and the grass carp meat to the chicken, according to the relative share of proteins. The relative

Table 3
The relative share of proteins in some categories of meat (according to Chirkovich, 2002)

Index	Meat category			
	Pork	Lamb	Veal	Chicken
Relative share of protein, %	40.44	58.0	77.0	84.6

share of proteins in carp meat has been higher by 29-50% as regards that of pork and lamb, by 4% as regards that of bighead carp and by 2.8-3.5% lower as regards their contents in chicken and grass carp meat.

Conclusions

The technology of carp, grass carp and bighead carp growing has had most of all an influence upon fats contents. It has been established that their level has been authentically higher in bighead carp meat, as regards carp and grass carp meat, grown in ponds, where organic fertilization has been applied.

The relative proteins share in the fish grown meat (77.0-84.5%) has been with a more clearly expressed differentiation depending on their species and has been within the limits of 77.0-79.6% for the bighead carp, 81.3% for the carp and 83.5-84.5% for the grass carp.

The caloric values of meat has varied within 437.4-545.8 kJ.100 g⁻¹, 71% (bighead carp) – 84.2% (grass carp) of which has been on the account of the proteins.

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