THE INFLUENCE OF PRODUCTION SYSTEMS ON THE NUTRITIONAL VALUE OF COMMON CARP AND ASIAN CYPRINIDS

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Abstract

The purpose of this paper is to identify the influence of production systems on the nutritional value of four fish species belonging to the Cyprinidae family.

The present study considered four species: Cyprinus carpio, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis and Ctenopharyngodon idella, reared in semi-intensive system, extensive system and in natural environment. Fish samples were harvested during summer months from Brateş Research and Development Farm – Galaţi (semi-intensive system), Cotul Chiului Experimental Base (extensive system) and from a natural environment represented by the confluence of the river Prut with the Danube river.

From each production system, 20 fish samples were analyzed belonging to the four species considered for the experiment. The biochemical composition of fish meat (water content, ash, proteins and lipids) was analyzed and compared for the selected 2 years old cyprinid species, reared in different systems.

The results have highlighted significant differences on the biochemical profile for the 4 species reared in the selected production systems. The biological material reared in the semi-intensive system had a higher proteins content and a lower lipids content compared to the extensive system or the natural environment, and the nutritional value of the fishes reared in the semi-intensive system was higher than the other samples analyzed.

Fish with preferable biochemical characteristics in human nutrition result following the application of the semi-intensive system in aquaculture, by supplementing the natural food of the biological material with fodders that improve the nutritive properties of the fish meat.

Key words: *Cyprinus carpio*, semi-intensive system

INTRODUCTION

Although there are numerous species of Asian cyprinids, in Romania only four species present particular interest. Common carp along side silver carp, big-head carp and grass carp are reared in extensive and semi-intensive poly-culture systems.

Fish meat provides a balanced nutrition for humans, thanks to a high content of easily digestible proteins, polyunsaturated fatty acids, microelements and vitamins soluble in lipids [10].

Fish proteins quality is considered superior to animal, milk or egg proteins [8].

The existence of various aquaculture types is explained by the availability of water surfaces that can be used to farm fish according to the market demands. Thus, aquaculture can be super-intensive, intensive, semi-intensive and extensive [4].

Common carp, silver carp, big-head carp and grass carp can also be found in the wild.

The current paper focuses on the influence that production types has on the nutritional quality of carp, silver carp, big-head carp and grass carp meat.

The biological material was monitored from Brateş Research and Development Farm – Galaţi (semi-intensive system), Cotul

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Chiului Experimental Base (extensive system) and from a natural environment represented by the confluence of the river Prut with the Danube river.

Aquaculture in an extensive system (ExS) is distinguished by a low population density and by the method of fish feeding, based on phytoplankton, zooplankton, plants and small invertebrates that grow following organic or inorganic fertilization of the basins in order to stimulate the growth of simple plants. These simple plants represent the base of the food chain in a pond used for fish farming [6].

Aquaculture in a semi-intensive system (SIS) is characterized by fish feeding with both natural food and nutrient rich fodder. Because of a higher population density than the extensive system, natural food present in the rearing ponds in not sufficient to ensure the adequate amount of nutrients. This is the reason why it is necessary to supplement the fish diet with fodders that complete the natural food [6].

In a natural environment (NE), fish completely depend on the food found in the aquatic ecosystem.

MATERIALS AND METHODS

The biological material was represented by approximately 2 years old fishes, belonging to the species: *Cyprinus carpio* (carp), *Hypophthalmichthys molitrix* (silver carp), *Hypophthalmichthys nobilis* (big-head carp) and *Ctenopharyngodon idella* (grass carp). From each species, 5 specimens were captured in each type of aquaculture. In the semi-intensive system, fishes were fed with an age appropriate fodder.

Anatomoponderal analysis was performed by dividing the biological material on anatomical sections: head, scales, fins, organs, torso, skin, meat and bones.

Biochemical analysis of fish meat was performed according to specific standards for each biochemical parameter.

Moisture was determined through official standard methods of analysis comprised in AOAC (1990) [1].

Total ash was determined through calcination described in AOAC (1990) [1].

Raw protein content present in fish meat was determined using Kjeldahl method described in AOAC (17th edition), which involved protein digestion and distillation, where F (conversion factor) in equal to 6,25 [2].

Total fats were determined using the Soxhlet installation, equipped with Gerhardt Brand Multistate Controller, applying modified methods of ether extraction from AOAC (17th edition) [2].

The energy value of fish meat was determined by adding the product between proteins percentage from the sample with caloric coefficient 4,1 kcal/g and the product between lipids percentage from the sample with caloric coefficient 9,3 kcal/g.

Statistical analysis

All analysis were perform in duplicate.

Statistical analysis was conducted with the help of Excel instruments. The average values are presented the respective standard deviation. The statistical interpretation of data was performed in accordance with a significance threshold of $P<0,05$.

RESULTS AND DISCUSSIONS

Anatomoponderal analysis

The values obtained in anatomoponderal analysis for each specimen belonging to the species: common carp, silver carp, big-head carp and grass carp, can be found in table 1.

The biological material reared in semi-intensive system has a higher meat percentage compared to the biological material reared in extensive system or from the natural environment. The differences were significant, $p<0.05$. The average meat percentage obtained from the 4 species reared in semi-intensive system is 46.01%. For species reared in extensive system, the average meat percentage is 43,69% , while in the natural environment, the average meat percentage is 42.33%.

Meat percentage for carp (*Cyprinus carpio*) reared in semi-intensive system is by 1.17% or by 4.94% respectively higher compared to the meat percentage for carp reared in extensive system or natural environment respectively.

For silver carp (*Hypophthalmichthys molitrix*) reared in semi-intensive system, meat percentage is by 2.55% or by 3.30% respectively higher compared to meat percentage for silver carp reared in extensive system or natural environment respectively.

Table 1 Anatomoponderal distribution for the species: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), big-head carp (*Hypophthalmichthys nobilis*), grass carp (*Ctenopharyngodon idella*), reared in semi-intensive system (SIS), extensive system (ExS) and natural environment (NE)

Anatomical sections		Mass, g Average±SD*	Head, % Average±SD*	Torso, % Average±SD	Meat, % Average±SD*	Scales and skin, % Average±SD	Fins, % Average±SD*	Bones, % Average±SD*	Organs, % Average±SD*
SIS	Carp	2428±235	21.43±0.31	59.44±0.25	46.81±0.40	9.25±0.17	3.06±0.15	8.51±0.11	10.73±0.16
	Silver carp	2439±318	26.18±0.67	54.27±2.12	45.41±1.03	6.42±0.25	1.52±0.20	5.64±0.21	14.28±0.21
	Big-head carp	2657±177	35.81±0.19	50.39±1.47	42.06±1.70	4.93±0.29	2.07±0.21	5.83±0.15	8.55±0.11
	Grass carp	2708±409	16.93±0.45	56.92±0.84	49.74±1.48	6.62±0.21	2.50±0.07	3.88±0.18	19.51±0.20
ExS	Carp	2309±190	22.65±0.20	57.79±0.18	45.64±0.17	9.04±0.15	3.10±0.04	8.48±0.08	10.63±0.24
	Silver carp	2211±614	27.74±1.14	51.86±2.30	42.86±2.16	6.53±0.37	1.56±0.31	5.61±0.24	14.65±2.10
	Big-head carp	2453±113	37.20±0.15	49.33±0.23	39.90±0.28	5.29±0.19	2.32±0.11	6.19±0.08	8.69±0.22
	Grass carp	2570±257	18.16±0.97	55.43±2.02	46.34±1.98	6.87±0.19	2.88±0.11	4.16±0.09	20.47±2.34
NE	Carp	2157±126	23.41±0.73	54.12±1.29	41.87±0.68	9.11±0.22	3.17±0.22	8.25±0.23	13.62±0.25
	Silver carp	2176±163	28.92±0.27	50.91±0.41	42.11±1.13	6.47±0.33	1.49±0.09	5.58±0.24	15.12±0.23
	Big-head carp	2321±149	37.64±0.33	48.16±0.32	39.47±1.50	5.61±0.20	2.14±0.17	5.88±0.22	9.13±0.14
	Grass carp	2418±281	17.97±0.55	53.2±0.61	45.86±0.82	6.96±0.26	2.93±0.18	4.02±0.16	21.75±0.28

** Standard deviation*

For big-head carp (*Hypophthalmichthys nobilis*) reared in semi-intensive system, the meat percentage is by 2.16% or by 2.59% respectively higher compared to the meat percentage for big-head carp reared in extensive system or natural environment respctively.

Grass carp (*Ctenopharyngodon idella*) reared in semi-intensive system has a meat percentage by 3.40% or by 3.88% respectively higher compared to the meat percentage for grass carp reared in extensive system or natural environment respectively.

Biochemical analysis

The biochemical profile of the biological material is presented in table 2.

For common carp (*Cyprinus carpio*) reared in semi-intensive system, the protein percentage in meat was by 4.96% or by 3.79% respectively, higher compared to protein percentage in the meat of carp reared in extensive system or natural environment respectively. Lipids percentage in the meat of carp reared in semi-intensive system was by 1.01% or by 0.59% respectively, lower compared to lipids percentage in the meat of carp reared in extensive system or natural environment respectively. The differences were significant ($P<0.05$).

Regarding the protein percentage found in the meat of silver carp species (*Hypophthalmichthys molitrix*), the values were by 2.02% or by 1.10% respectively, higher compared to the protein percentage in the meat of silver carp reared in extensive system or natural environment respectively. Lipids registered values in the meat of silver carp reared in semi-intensive system by 1.37% or by 0.88% respectively, lower than lipids percentage in the meat of silver carp reared in extensive system or natural

environment respectively. The differences were significant (P<0.05).

The meat of big-head carp (*Hypophthalmichthys nobilis*) reared in semi-intensive system registered protein percentage by 2.70% or by 1.45% respectively, higher compared to the protein percentage in the meat of big-head carp reared in extensive system or natural environment respectively. In semi-intensive system, lipids percentage in the meat of big-head carp were by 0.74% or by 0.12% respectively, lower compared to the lipids percentage in the meat of big-head carp reared in extensive system or natural environment respectively.

Grass carp (*Ctenopharyngodon idella*) reared in semi-intensive system had a protein percentage in the meat by 6.19% or by 2.95% respectively, higher compared to the protein percentage in the meat of grass carp reared in extensive system or natural environment respectively. The differences were significant (P<0.05).

The moisture/protein ratio, which highlights the maintenance status of the biological material, varies inversely proportional with biomass accumulation. As the fish gets older, it accumulates proteins and lipids to the detriment of moisture, according to Robert R. Parker [9].

For the species reared in semi-intensive system, M/P ratio value in lower, which suggests a better maintenance of the biological material, compared to the same species reared in extensive system or natural environment.

Table 2 Biochemical parameters analysed in the meat of the species: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), big-head carp (*Hypophthalmichthys nobilis*),grass carp (*Ctenopharyngodon iella*) reared in semi-intensive system (SIS) extensive system (ExS) and natural environment (NE)

Biochemical parameters		Moisture (%) Average±SD*	Proteins (%) Average±SD*	Lipids (%) Average±SD*	Total ash (%) Average±SD*	M/P**	Energy value, kcal/100g
SIS	Carp	71.31±0.16	22.31±0.15	4.73±0.29	1.55±0.01	3.19	135.46
	Silver carp	79.34±0.16	16.63±0.17	1.78±0.28	2.13±0.02	4.77	84.74
	Big-head carp	78.29±0.24	17.86±0.15	2.42±0.36	1.32±0.02	4.38	84.74
	Grass carp	75.27±0.13	20.18±0.05	2.74±0.04	1.78±0.14	3.72	108.22
ExS	Carp	75.47±0.21	17.35±0.22	5.74±0.26	1.24±0.02	4.35	124.52
	Silver carp	80.34±0.44	14.61±0.15	3.15±0.68	1.38±0.06	5.49	89.20
	Big-head carp	80.43±0.10	15.16±0.06	3.16±0.09	1.20±0.01	5.31	91.54
	Grass carp	80.05±0.11	13.99±0.16	4.12±0.12	1.28±0.02	5.72	95.68
NE	Carp	74.75±0.14	18.52±0.15	5.32±0.22	1.36±0.01	4.04	125.41
	Silver carp	80.29±0.05	15.53±0.17	2.67±0.18	1.47±0.02	5.17	88.50
	Big-head carp	79.50±0.07	16.42±0.17	2.54±0.10	1.27±0.02	4.84	90.94
	Grass carp	77.92±0.21	17.22±0.15	3.47±0.06	1.33±0.01	4.52	102.87

** Standard deviation*
*** moisture/protein*

In common carp (*Cyprinus carpio*) reared in semi-intensive system, the protein quantity accumulated (22.31%) was higher than the quantity obtained by Ćirković et. al for the same species reared in a similar system (15.59%), while the moisture (71.31%) and lipids content (4.73%) were lower than the values obtained by Ćirković et. al (moisture = 75.02%, lipids = 6.85 %) [5]. The differences were significant p<0.05.

The biochemical parameters values for farmed silver carp (*Hypophthalmichthys molitrix*) obtained by Muhammad Ashraf (moisture = 77.89%, protein = 16.11%, lipids

= 2.23%) are lower compared to the values obtained for silver carp reared in semi-intensive system (moisture = 79.34%, protein = 16.63%, lipids = 1.78%), except lipids values. Comparing the values obtained for silver carp in natural environment in our experiment (moisture = 80.29%, protein = 15.53%, lipids = 1.47%) with the values obtained by Muhammad Ashraf (moisture = 78.79%, protein = 15.50%, lipids = 2.19%), it can be observed that the values respect the same tendency with the biochemical parameters obtained for farmed silver carp [3]. The differences were significant $p<0.05$.

The results obtained for big-head carp (*Hypophthalmichthys nobilis*) in semi-intensive system were higher for moisture (78.29%) and protein (17.86%) content than the values obtained by Hoseini et. al (moisture = 77.80%, protein = 17.13%) for the same species reared in a similar system, but the lipids content for big-head carp reared in semi-intensive system (2.42%) was lower than the value obtained by Hoseini et. al (3.4%) [7]. The differences were significant $p<0,05$.

The biochemical parameters for grass carp (*Ctenopharyngodon idella*) reared in semi-intensive system (moisture = 75.27%, protein = 20.18%, lipids = 2.74%) are comparable to the values obtained by Muhammad Ashraf for farmed grass carp (moisture = 74.30%, protein = 20%, lipids = 2.52%), the differences were insignificant $p>0.05$. The values obtained in our experiment for grass carp from natural environment (moisture = 77.92%, protein = 17.22%, lipids = 3.47%) differ considerably from the values obtained by Muhammad Ashraf for wild grass carp (moisture = 74.79%, protein = 19.46%, lipids = 2.71%) [3]. The differences were significant $p<0.05$.

The energy value of the biological material reared in semi-intensive system was higher for all 4 analysed specie compared to the energy value of the species reared in extensive system or from natural environment, according to table 2.

CONCLUSIONS

The production system influences directly the nutritional value of the meat belonging to the species: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), big-head carp (*Hypophthalmichthys nobilis*) and grass carp (*Ctenopharyngodon idella*).

Feeding diets consisting of natural food supplemented by fodders, species and age appropriate, leads to the growth of muscle mass and to protein and lipids accumulation in the detriment of moisture.

In the semi-intensive production system, the biological material has a superior nutritional value and maintenance status.

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