3(2): 51-57 (2017) doi: 10.3153/JAEFR17007

Journal of
Aquaculture Engineering and Fisheries Research

E-ISSN 2149-0236

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

SLAUGHTER CHARACTERISTICS OF BIGHEAD CARP (*Hypophthalmichtys nobilis* Rich.) REARED IN POLYCULTURE BASED ON NATURAL FEEDING IN THE PONDS

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Received: 31.05.2016

Accepted: 26.08.2016

Published online: 01.01.2017

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Abstract:

An experiment on slaughter characteristics of bighead carp (*Hypophthalmichtys nobilis* Rich.) reared in polyculture of the same age, based on natural feeding in the ponds, was carried out at the Institute of Fisheries and Aquaculture – Plovdiv, Bulgaria. Some of the ponds (First Group) were not fertilized and others (Second Group) were supplemented with manure at the rates corresponding to the standards of organic production. The structure of polyculture was one and the same in all the ponds: K_1 – one-year old common carp (*Cyprinus carpio* L.) – 500 pcs.ha^{-1} (half being scale carp and the other half – mirror carp); Tp_1 – one-year old bighead carp (*Hypophthalmichtys nobilis* Rich.) – 300 pcs.ha^{-1}; A_1 – one-year old grass carp (*Ctenopharyngodon idella* Val.) – 100 pcs.ha^{-1}. The bighead carp reached a live weight of 0.766 kg under the experimental conditions, the fishes in the ponds fertilized with manure being about 13.6% heavier compared to fishes in the ponds of the other group. It was established that the slaughter yield and the relative share of the fillet in bighead carp were in average 54.3% and 35.4%, respectively, and, pond fertilization and the amount of phytoplankton did not have a statistically significant effect on fish development. The pond had a significant effect exerted through its area and by overgrowing with macrophytes. Infestation increase by up to 30% had a positive effect on the weight of the cleaned carcass, the fillet and the slaughter output.

Keywords: Bighead carp, Polyculture, Slaughter characteristics

Introduction

The technology of polyculture fish rearing is highly ecological (Nikolova, 2012). That is especially true for autochthonous polyculture based on natural feeding in the ponds. Such polyculture fully meets the standards of organic farming.

One of the most important components of the polyculture is the bighead carp (Xie, 2001). According to latest data, its annual production in Bulgaria amounts to 1 272.8 t, the species ranking third in the production structure after trout and common carp (MAF, 2015). Among the advantages of the bighead carp is its nutritional diet. Fishes of that species eat zooplankton, which develops in the ponds and the consumers increasingly prefer fish reared on natural food.

Consumers' preferences raise the interest in production systems based on natural feeding and in the quality of fish reared on natural food. At the same time, studies on autochthonous production ecosystems are still insufficient. Shi et al. (2013) studied the characteristics of the muscle nutritional composition of bighead carp fed on live food. Afzal et al. (2008) studied the growth performance of bighead carp in a monoculture system with and without supplementary feeding.

The slaughter characteristics are among the major indicators determining fish quality (Berka, 1986; Todorov and Ivancheva, 1992). They were studied in different fish species, breeds and hybrids (Hajinikolova and Grozev, 1996; Hajinikolova, 2004; Kocoura, et al., 2005) and under the conditions of different fish rearing technologies (Prikryl and Janecek, 1991; Nandeesha et al., 1998; Soliman et al., 2000; Papoutsoglou et al., 2001; Keshavanath et al., 2002; Nikolova, 2010; Varga et al., 2013).

Considering the insufficiency of data about the quality of fish reared in autochthonous polyculture, we set the aim of studying the slaughter characteristics of bighead carp reared in polyculture based on natural feeding in the ponds and the influence of some technological factors.

Materials and Methods

The study was carried out at the Institute of Fisheries and Aquaculture – Plovdiv in the frames of a research project on "Investigation on the possibility of introducing organic aquaculture in Bulgaria". Six carp-fattening ponds with a total area of 1.59 ha were used for the aim of the study. The ponds were divided into two groups: First group (three ponds) – without fertilization; Second group (three ponds) supplemented with cattle manure at the rate of 3000 kg.ha^{-1}. All the ponds were sterilized with burnt lime at the rate of 300 kg.ha^{-1}. During the 7-month vegetation period, 150 kg.ha^{-1} of burnt lime were additionally used. The rate of the applied fertilizers and burnt lime were in compliance with the standards of organic aquaculture. In order to achieve the experimental aim, polyculture based on natural feeding in the ponds, i.e. "autochthonous polyculture", was established (Privezencev, 1991). One and the same stocking structure was used in all the ponds: K_1 (one-year old common carp (*Cyprinus carpio* L.) – 500 pcs.ha^{-1} (half being scale carp and the other half – mirror carp); Tp_1 (one-year old bighead carp (*Hypophthalmichtys nobilis* Rich.) – 300 pcs.ha^{-1}; A_1 (one-year old grass carp (*Ctenopharyngodon idella* Val.) – 100 pcs.ha^{-1}. The initial mean weight of the common carp, bighead carp and grass carp was 0.031 kg; 0.021 kg; 0.039 kg, respectively. Routine methods applied in fishfarming were used for monitoring the environmental characteristics. Pond weed infestation was visually assessed in percentage of the total area. Four fishes from each pond were caught at the end of the vegetation season for studying the slaughter characteristics. The following indices of each individual were measured (kg): live weight; the weight of the cleaned carcass with skin and scales (without fins, intestines and head); of the skin with scales and subcutaneous fat; fins; the head without the gills; the gills; the total weight of the intestines and the fillet. The weight of the intestines also included blood and body fluids (Pokorny, 1988). The ratio between the separate body parts was calculated. The slaughter yield was calculated as a ratio of the cleaned carcass to the live fish weight and the relative share of the fillet to the cleaned carcass weight.

Polyfactor dispersion analysis was used for data processing. The linear equation model was of the following general type:

$$Yijk=\mu+Ti+Bj+eijk; \text{ (Model 1)}$$

where: Yijk(n) – studied parameter; μ – general average constant; Ti – fixed effect of pond fertilization (manure); Bj – fixed effect of j-th pond ar-

ea used in the formulae as a regressor, e (…) – a residual variance.

The influence of the rest of the technological factors on slaughter characteristics was studied by including them consecutively as fixed effects under the conditions of Model 1, as follows: pond area (Model 2), pond overgrowing with weeds (Model 3), amount of phytoplankton in the pond (Model 3a).

Results and Discussion

The results of the slaughter analysis of the bighead carp were presented in Tables 1 and 2. Under the conditions of the studied technology the bighead carp reached a mean live weight of 0.766 kg, the individuals in the fertilized ponds being about 13.6% heavier compared to those in the unfertilized ponds. The mean weight of the cleaned carcass was e 0.421 kg and that of the fillet – 0.272 kg.

In a study on the growth performance of bighead carp in monoculture system with and without supplementary feeding, Afzal et al. (2008) established that in ponds fertilized with organic and mineral fertilizers, without supplementary feeding with forages, fishes having an initial weight of 0.0114 kg, reached a live weight of 0.902 kg after 12-month rearing. In our trial with supplementing the ponds with manure, the fishes having an initial mean weight of 0.021 kg, reached a mean live weight of 0.815 kg for a comparatively shorter vegetation period (7-month rearing).

Pond fertilization improves the nutrient environment of planktonphages (Grozev et al., 1999). In our study fertilization did not have a significant effect on fish development (Table 2). In both variants fishes had an equal slaughter yield, however the fillet weight of the fishes in the fertilized ponds was higher. The relative share of the fillet to the cleaned carcass was 65.5% and 63.6%, respectively, the difference being statistically insignificant (Table 1).

Table 1. Results of the slaughter analysis of fishes in the experimental ponds, kg

Indices	Fertilized		Without Manure		Total		
	LS	±Se	LS	±Se	LS	±Se	CV
Live weight	815	5.03	717	5.03	766	3.40	21.77
Head (without gills)	238.9	12.55	218.8	12.55	228.8	8.49	18.18
Gills	32.9	2.97	29.2	2.97	31.1	2.01	31.71
Skin with scales	62.5	5.52	64.6	5.52	63.6	3.74	28.81
Fins	28.0	1.41	27.2	1.41	27.6	0.96	16.96
Intestines (total)	63.1	4.59	51.4	4.59	57.2	3.10	26.57
Carcass weight	451.9	32.40	390.4	32.40	421.1	21.92	25.50
Fillet (without skin)	295.8	22.17	248.3	22.17	272.1	15.00	27.01

Table 2. Relative share of the separate parts of the fish body, % of live weight

Indices	Fertilized		Without Manure		Total		
	LS	±Se	LS	±Se	LS	±Se	CV
Head (without gills)	30.0	0.65	30.6	0.65	30.3	0.44	7.14
Gills	4.3	0.35	4.1	0.35	4.2	0.24	27.70
Fins	3.6	0.10	3.8	0.10	3.7	0.06	8.51
Intestines (total)	7.8	0.28	7.1	0.28	7.4	0.19	12.50
Carcass weight	54.3	0.83	54.3	0.83	54.3	0.56	5.09
Fillet (without skin)	36.3	1.08	34.5	1.08	35.4	0.73	10.09

Out of the studied technological factors, the pond has an effect on the slaughter characteristics of bighead carp. The pond as a factor includes the whole complex of interrelated ecological and technological characteristics. The applied poly-factor dispersion analysis showed that under the conditions of the carried out experiment, the pond had a significant effect exerted through its area and weed overgrowing. The pond area is a significant source of variation for both the growth performance, which could be seen in the dynamics of the quantitative characteristics, and, the development, reported by the differences in the relative share of the carcass and the fillet.

Macrophyte overgrowing in the experimental ponds had a significant effect on the studied characteristics. Infestation increase by 30% had a positive effect on the cleaned carcass weight ($F(7.346)$; $P<0.01$) and on the fillet ($F(6.448)$; $P<0.01$), (Table 3; Figure 1). Weed infestation (by up to 30%) had also a significant positive effect on the slaughter yield ($F(8.790)$; $P<0.05$).

When studying the slaughter characteristics of grass carp reared under similar conditions, it was established that the increase of macrophyte infestation of the ponds by up to 30% exerted a negative effect on the weight of the cleaned carcass (Nikolova and Dochin, 2011).

Bighead carp consumes mainly zooplankton but phytoplankton is also of great importance for that fish species not only for providing feeding conditions for zooplankton but also for direct consumption.

Xie (2001) mentioned that in recent decades, there had been a number of contradictory conclusions on the digestibility of algae by bighead carp, based on the results from gut contents. The author established that bighead carps are able to collect the smallest representatives of phytoplankton, significantly smaller than their filtering net meshes, suggesting that the secretion of mucus may play an important role in collecting such small particles. Dong and Deshang (1994) mentioned that for plankton organisms about 70 μm dia., the removal rates by bighead carp were similar to those by silver carp.

Table 3. Effect of the major technological factors on the slaughter characteristics of bighead carp

Model	Factor	Live weight	Intestines		Carcass weight		Fillet	
		kg	*kg*	*%*	*kg*	*%*	*kg*	*%*
	Manure	1.735	2.982a	2.715	1.665	0	2.118	1.209
1	Pond	27.241c	22.397c	0.806	23.579c	3.386a	18.497c	0.027
	Manure	2.474	3.649a	2.58	2.394	0.005	3.025a	1.194
	Pond area	12.423b	7.017a	0.013	12.773b	6.784a	12.224b	1.632
2	Pond	0.19	0.347	0.134	0.03	1.238	0.023	0.993
	Manure	1.51	2.962	3.736c	1.139	1.064	1.79	0.813
	Overgrowing	6.319b	3.341a	0.737	7.346b	8.790a	6.448b	0.831
3	Pond	0.702	0.146	0.746	1.369	3.432a	0.488	0.043
	Manure	0.598	0.88	0.344	0.809	0.283	0.721	0.223
	Phytoplankton	0.126	0.356	1.206	0.014	0.749	0.162	0.332
3a	Pond	16.356 c	12.503b	0.019	14.972b	4.004a	10.723b	0.035

a P<0.05; b <0.01; c P<0.001

Cooke et al. (2009) studied the effect of the amount of plankton on the development of bighead carp and they found out that there was a close interrelation between the biomass of the phytoplankton and the fish growth. The authors underlined that the insufficient amount of plankton biomass could be a limiting factor for growth.

Under the conditions of the carried out experiment, we established a significant effect of plankton development on growth and slaughter characteristics of bighead carp (Table 3; Figure 2). That was probably due to the slight differences in the amount of phytoplankton in the ponds included in the separate variants.

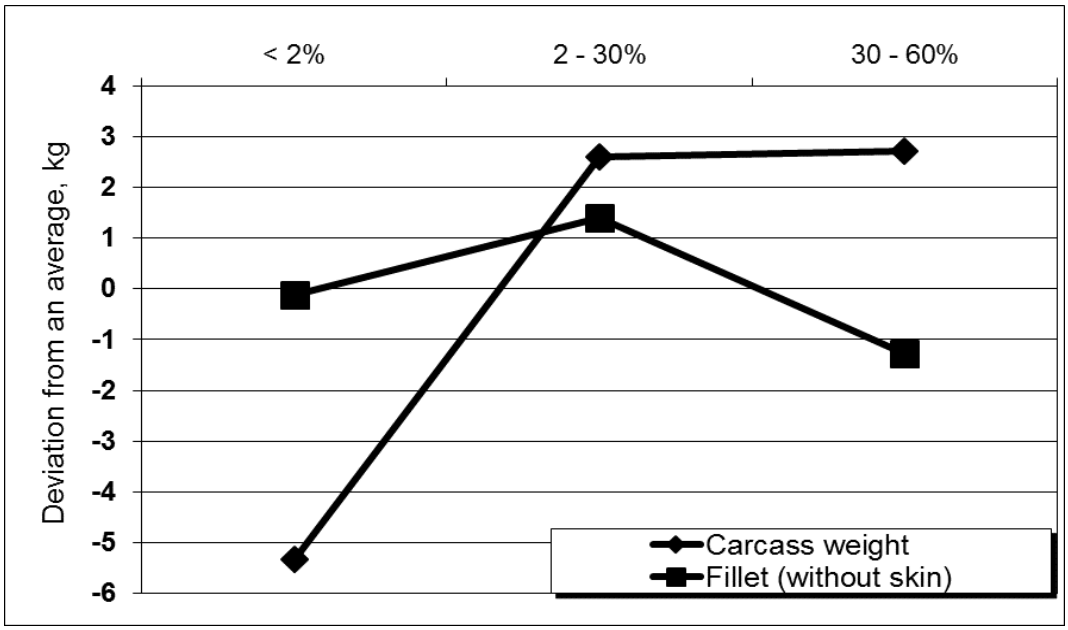

Figure 1. Effect of pond overgrowing on the slaughter characteristics of bighead carp

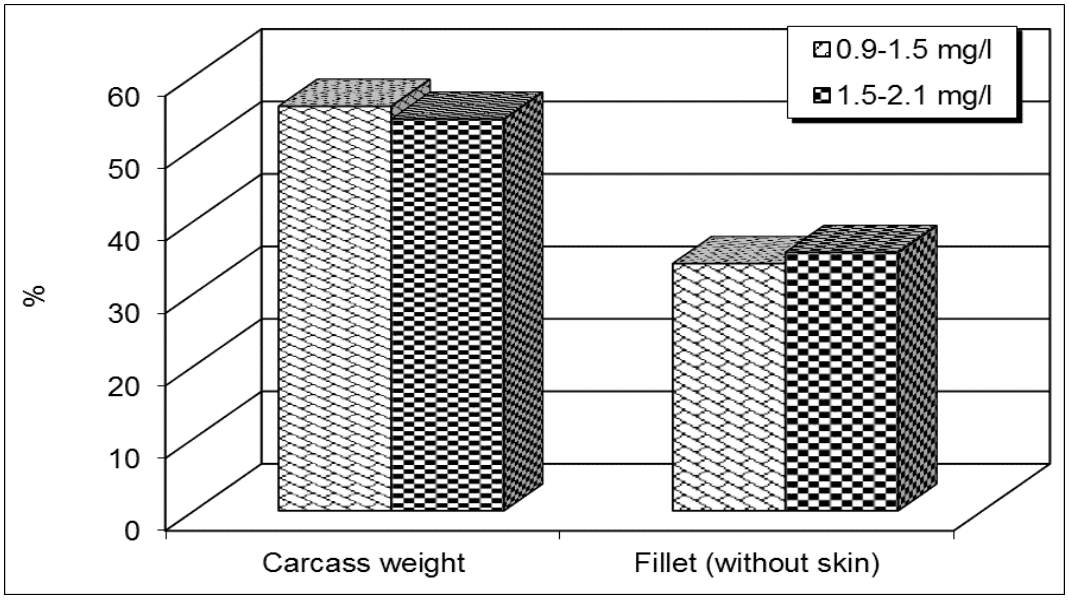

Figure 2. Effect of the amount of phytoplankton on the slaughter characteristics of bighead carp

Conclusion

Under the conditions of autochthonous polyculture of the same age (one-year old common carp (*Cyprinus carpio* L.) – 500 pcs.ha^{-1} (half being scale carp and the other half – mirror carp); bighead carp (*Hypophthalmichtys nobilis* Rich.) – 300 pcs.ha^{-1} and grass carp (*Ctenopharyngodon idella* Val.) – 100 pcs.ha^{-1}), the bighead carp reached a mean live weight of 0.766 kg, the fished in the fertilized ponds being about 13.6% heavier compared to the fishes in the unfertilized ponds. The slaughter yield of bighead carp and the relative share of the fillet were in average 54.3% and 35.4%, respectively. Pond fertilization and the amount of phytoplankton did not have a statistically significant effect on fish development. An effect on the slaughter characteristics was exerted by the pond through its area and macrophyte overgrowing. The increase of weed infestation up to 30% had a positive effect on the cleaned carcass weight, the fillet and the slaughter output.

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