

## COMPARATIVE ANALYSIS OF THE PRODUCTION OF DIFFERENT STOCKING CATEGORIES OF CARP IN SEMI-INTENSIVE SYSTEMS

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### UPOREDNA ANALIZA PROIZVODNJE RAZLIČITIH NASADNIH KATEGORIJA ŠARANA U POLUINTENZIVNOM SISTEMU GAJENJA

#### *Apstrakt*

Šaran (*Cyprinus carpio*) je kao slatkodvodna vrsta široko zastupljena kada je u pitanju farmsko gajenje riba u centralnoj i istočnoj Evropi. Na području Srbije, "klasična" poluintenzivna proizvodnja je dominantan tip gajenja riba, sa preko 95% ukupno proizvedenog šarana, a zasnovana je na kombinaciji prirodne i dodatne hrane (žitarica i smeša koncentrata). Kada je reč o gajenju različitih kategorija šarana u okviru jednog proizvodnog objekta, uglavnom se pristupa gajenju samo jedne kategorije. Razlog tome su jednostavniji i manji manipulativni procesi prilikom izlova kao i sama ishrana riba, naročito kad su u pitanju žitarice i ručno hranjenje. Cilj ovog istraživanja je bio da se analiziraju mogućnosti gajenja mešanog nasada različitih kategorija šarana u odnosu na gajenje samo jedne kategorije.

Ekperiment je realizovan na proizvodnom ribnjaku OZZ "Despotovo" iz Despotova. U toku jedne proizvodne sezone, na ribnjačkim površinama A, B i C, analiziran je uticaj kombinovanog i nezavisnog gajenja dvogodišnjeg (S1+) i konzumnog šarana (S2+) na proizvodne karakteristike u poluintenzivnom sistemu gajenja, upotrebom peletirane hrane.

Na osnovu dobijenih podataka o masi riba i količine potrošene hrane, dobijeni su rezultati ostvarenog prirasta (BWG) i koeficijenta konverzije hrane (FCR). Gajenjem jedne kategorije šarana ostvaren je bolji BWG nego kombinovanim gajenjem dve uzrasne kategorije riba u okviru istog proizvodnog objekta. Rezultati ostvarenog prirasta pokazali su razlike između jezera (A = 2 287 kg/ha; B = 1 399 kg/ha; C = 988 kg/ha). Razlog tome je potencijal prirasta nasadenih kategorija riba, jer se kod S1+ ostvaruje oko 3 puta veći prirast nego pri gajenju starije kategorije (S2+). FCR je takođe bio najniži pri gajenju samo S1+ (2.26). Pri kombinovanom gajenju S1+ i S2+ vrednost FCR bila viša (2.41) nego u jezeru A, ali i znatno niža nego pri gajenju S2+ u jezeru C (3.2).

Korišćenje peletirane hrane sa višim sadržajem proteina (35/7), dodatno je uticalo na postizanje boljih rezultata kod S1+ gajene u jezeru A, nego kod S1+ i S2+ gajene u jezerima B i C. Ovo potvrđuju i drugi istraživači, koji ukazuju da je prirast riba bolji ukoliko je riba hranjena smešom sa većim sadržajem proteina, posebno onih životinjskog porekla. Razlike u FCR-u se pripisuju bržem metabolizmu koji je prisutan kod mlađih kategorija riba.

Na osnovu vrednosti ostvarenog prirasta riba, gajenjem samo S1+ (A = 2 287 kg/ha) ili S2+ (C = 988 kg/ha), postiže se za 10% niža vrednost nego pri kombinovanom gajenju S1+ i S2+ (B = 1 399 kg/ha). Razlog tome je što mlađe kategorije riba (usled zbijenijih branhiospina) bolje iskorišćavaju sitnije organizme koji čine prirodnu hranu, kao i sitnije frakcije dodatne hrane koja se brže raspada u vodi kada se u ishrani riba koristi peletirana hrana.

Moglo bi se zaključiti da se bolji rezultati BWG i FCR ostvaruju ukoliko se gaji samo jedna kategorija riba. Međutim, na osnovu preračunatog odnosa u nasadu S1+ i S2+ (20 : 80) u okviru istog jezera i ostvarenog prirasta (kg/ha) u individualnom gajenju, može se zaključiti da je prirast viši za oko 10% pri gajenju mešanog nasada S1+ i S2+.

*Ključne reči: kategorije šarana, ribnjački objekti, poluintenzivna proizvodnja, peletirana hrana*

*Keywords: carp categories, fishponds, semi-intensive production, pelleted feed, natural food*

## INTRODUCTION

Common carp (*Cyprinus carpio*) is one of the most widely cultured freshwater fish species in Central and Eastern Europe (Masilko et al., 2014). Semi-intensive and extensive production systems are favoured in order to provide economically feasible production, with low investments in technological processes and accordingly low production.

In Serbia, semi-intensive production is the dominant type of production. Over 95% of carp is produced on the basis of the combination of natural food and supplemental feed (wheat and/or formulated compound feed) (Marković et al., 2013). In recent years, in order to intensify carp production, row cereals are substituted up to different levels with compound pelleted or extruded feed formulations. This type of supplemental feeding is applied to all fish categories, from fingerlings to marketable size fish. As a result, higher production per surface area is achieved, from 1500 kg/ha up to over 3000 kg/ha (Marković et al., 2009).

Common carp is usually reared in polyculture with other freshwater fish: Chinese carps (grass carp, silver carp, and bighead carp) and predatory fish (pike perch, pike, catfish). This type of fish farming has advantages compared to monoculture since fish more efficiently use space and food available in the pond. Additionally, positive interactions between compatible fish species with different diets and ecology are intensified (Lin and Peter, 1991).

In carp production, usually, one stocking category of fish is farmed in a single pond. The reason for this is in its simplicity, easier handling during harvest and feeding (when fish are fed by hand). The aim of this study is to analyze possibilities for combined culturing of different stocking categories of carp and their comparison with the production of only one stocking category.

## MATERIALS AND METHODS

The experiment was carried out at the fish farm OZZ "Despotovo" (Despotovo, Serbia). During one production season, the effects of combined and single production of two years old and marketable size carp (S1+ and S2+) in three fish ponds were analyzed. Ponds A and C were stocked with one stocking category, S1+ and S2+, respectively, while fish pond B was stocked with combined stocking categories S1+ and S2+ in 20:80 ratio (Table 1).

**Table 1.** Stocking densities and average fish weight in fish ponds

<b>Fish pond</b>	<b>A</b>	<b>B</b>	<b>C</b>
Fish pond production area (ha)	35	25	16
Total number of stocked fish (kg)	11 464	10 465	6 902
Stocking density (kg/ha)	327.5	418.6	431.4
Average fish weight S1+ (kg)	0.103	0.210	/
Average fish weight S2+ (kg)	/	0.710	0.780

During the production season, fish from ponds B and C were fed pelleted feed containing 25% of proteins and 7% of lipids, manufactured by "Bafi" (Novi Sad, Serbia). Later, during the season, when the water temperature dropped under 20°C, fish were fed pelleted feed containing 20% of proteins and 7% of lipids. Fish from pond A were fed with pelleted feed with 35% of proteins and 7% of lipids, while during the colder period, with feed containing 25% of protein and 7% of lipids. Fish were fed at 2-2.55% of the total fish biomass, twice a day, around 9 h and 13 h to increase the natural food utilization. In order to monitor fish health and determine the total biomass, fish were sampled every 15 days. For detailed adjustment of the amount of supplemental feed added to ponds, development of natural food (zooplankton and zoobenthos) was determined, and environmental variables were measured once per month.

Based on obtained results, average fish weight, fish growth rate and the amount of utilized feed were determined.

Following growth parameters were calculated:

Body weight gain (BWG) (kg) = final body weight (kg) – initial weight (kg);

Obtained gain (kg/ha) = (total final weight (kg) – total initial weight (kg)) / production area (ha);

Feed conversion ratio (FCR) = total feed consumed / total weight gain

## RESULTS AND DISCUSSION

Measured environmental parameters in ponds were in the acceptable range for culturing of common carp. Additionally, there were no major differences between ponds in these parameters.

The values of fish growth rate and feed conversion ratio are shown in Table 2.

**Table 2.** Production parameters at the end of the rearing season

Fish pond		A	B	C
Carp fry S1 <sup>+</sup>	Total harvest (kg)	91 520	20 554	/
	Average biomass (kg)	1 036	1 050	/
	BWG (kg)	0.933	0.840	/
Marketable size carp S2 <sup>+</sup>	Total harvest (kg)	/	24 890	22 715
	Average biomass (kg)	/	2 610	3 150
	BWG (kg)	/	1.900	2.370
Harvest per surface areas (kg/ha)		2 615	1 817	1 420
Total obtained growth rate (kg)		80 056	34 979	15 813
Growth rate per surface area (kg/ha)		2 287	1 399	988
Feed conversion ratio		2.26	2.41	3.2

Higher BWG was obtained in carp categories reared separately (A S1<sup>+</sup> = 0.933 kg; C S2<sup>+</sup> = 2.37 kg) than in carp categories reared together (B S1<sup>+</sup> = 0.84 kg; B S2<sup>+</sup> = 1.9 kg). Total obtained growth rate of fish was relatively different between ponds (A = 2 287 kg/ha; B = 1 399 kg/ha; C = 988 kg/ha). This is probably due to differences in growth potential of reared fish, where S1<sup>+</sup> stocking category achieves approximately three times higher growth rate than older fish category - S2<sup>+</sup>. FCR was also the lower in pond (A) stocked with S1<sup>+</sup> (2.26). In the pond with combined rearing of S1<sup>+</sup> and S2<sup>+</sup>, FCR value was slightly higher (2.41) than in pond A, but considerably lower than in C stocked with S2<sup>+</sup> (3.2).

Pelleted feed with higher protein content (35/7) additionally positively influenced the growth rate of S1<sup>+</sup> fish in pond A. These results are in line with the study of Rai and Bista (2001) concluding that fish growth rate is higher in fish fed diet with higher protein level, especially of animal origin. Singh et al. (2011) reported that differences in FCR can be attributed to higher level of metabolism that characterizes younger individuals.

Based on the obtained values of fish growth rate, by rearing only one fish category S1<sup>+</sup> (A = 2 287 kg/ha) or S2<sup>+</sup> (C = 988 kg/ha), 10% lower values are achieved compared to combined rearing of S1<sup>+</sup> and S2<sup>+</sup> (B = 1 399 kg/ha). One of the possible reasons for these differences is better utilization of small size classes of natural food (<250 µm) i.e. Rotifers, Copepods, smaller Cladocerans, zoobenthos, due to smaller inter-gill raker spacing in younger carp (Budy and Haddix, 2005), as well as utilization of small particles of pellets present in the water due to high dissolving properties of this type of feed.

## CONCLUSION

In semi-intensive fish production as a dominant type of fish farming, higher amounts of supplemental feed are used during natural food depression, in order to provide good growth and health of fish. According to our results, it can be concluded that higher BWG and FCR are obtained when only one stocking category of fish is reared. However, comparing the ratio in stocking densities of S1<sup>+</sup> and S2<sup>+</sup> from the same fishpond (20 : 80) and the obtained growth rate (kg/ha) in individual rearing of S1<sup>+</sup> and S2<sup>+</sup>, it can be concluded that 10% higher growth rate is attained in combined fish rearing. An additional reason for favoring combined rearing of different stocking categories of carp is the lower price of pelleted feed with inferior protein levels that compensates for a slightly higher FCR value.

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