INJURIES AND DEFORMITIES IN COMMON CARP FINGERLINGS GROWN IN DIFFERENT STOCKING DENSITIES – PRELIMINARY RESULTS

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POVREDE I DEFORMITETI KOD ŠARANSKE MLAĐI GAJENE U RAZLIČITIM GUSTINAMA NASADA - PRELIMINARNI REZULTATI

Apstrakt

Povrede i deformiteti predstavljaju pokazatelj narušene dobrobiti jer ukazuju na neodgovarajuće uslove gajenja i utiču na ponašanje, zdravstveno stanje i životni vek riba. Ove promene kod potrošača izazivaju odbojnost i mogu da smanje iskoristljivost ribljeg mesa. U ovom istraživanju utvrđeni su vrsta i karakter povreda i deformiteta na telu šaranske mlađi posle 96 dana boravka u tankovima sistema sa recirkulacijom vode (RAS). Mlađ je bila raspoređena u četiri gustine nasada: 1,31 kg/m^3, 2,62 kg/m^3, 3,94 kg/m^3 i 5,24 kg/m^3 (I, II, III i IV grupa). Grupa sa najmanjom gustinom nasada imala je najveću stopu preživljavanja (100%) i najmanje povreda i deformiteta. Povrede su najčešće uočene bočno, na sredini tela, kao i na repnom peraju. Prosečno su obuhvatale do 1% tela i na njihovu površinu, kao i na broj riba sa deformacijama nije uticala gustina nasada, ($p > 0,05$). Pojava deformitetea u različitim gustinama nasada kretala se od 1,60 to 6,92% ($p < 0,05$), a najčešće su zapažene lordoza i skraćenje gornje vilice. Detaljnije istraživanje karaktera i uzroka promena na telu može da doprinese pronalaženju optimalne gustine nasada za šaransku mlađ u tankovima, a time i poboljšanju proizvodnih rezultata i pružanju maksimalne zaštite njihove dobrobiti.

Ključne reči: šaran, RAS, gustina nasada, povrede, deformiteti, dobrobit
*Key words***:** *common carp, RAS, stocking density, injuries, deformities, welfare*

INTRODUCTION

Injuries and deformities can be often observed in fish in intensive rearing systems that are characterized by increased stocking density. In such condition the potential for injuries

caused by other fish such as skin lesions, scale loss, split fins and broken fin rays also increases, and they have been used as indicators of poor welfare (EFSA, 2008). Injuries are a precursor to subsequent infection and fish mortality, and healed wounds reduce the commercial value of afflicted fish. Skeletal deformities also represent an important economic problem in aquaculture. Deformed fish are less acceptable to consumers and it may be difficult to fillet. Deformities may have the physiological and behavioral implications, and they reflect an imbalance in the fish environment thus giving them importance in the terms of welfare (Kocour et al., 2006; Jaward et al., 2014). They may be associated with a degeneration of the bone structure with age, or genetic, nutritional, and environmental factors and management, or relate to each other, making difficult to determine a single causative agent (Argüello-Guevara et al., 2014).

Optimal stocking density for carp in tanks is not fully defined. In study by Karakatsoulis et al. (2010) 1.22 kg/m^3 was low and 4.89 kg/m^3 was high stocking density. Increased stocking density can deteriorate water quality and thus adversely affect the survival, growth and development of young carps. The aim of this study was to determine the incidence and character of injuries and deformities observed in common carp fingerlings in different stocking densities.

MATHERIAL AND METHODS

The study was carried out in recirculation aquaculture system (RAS) of the CEFAH (Centre for Fishery and Applied Hydrobiology of the Faculty of Agriculture, University of Belgrade, Serbia). In period of 96 days 450 specimens of common carp (*Cyprinus carpio*) with the initial weight of 10.48±0.02 g were held in 120-litre plastic tanks with constant water flow of 0.5 l/min. They were distributed in four groups in three replicate tanks according to the stocking density: 1.31 kg/m^3, 2.62 kg/m^3, 3.94 kg/m^3, 5.24 kg/m^3 (I, II, III and IV group, respectively). The groups were formed of apparently healthy, normal shaped fish with no injuries and damages of body and fins. Fish were fed 3% of the commercial extruded mixture (38% of proteins and 12% fat, "VZ Subotica"- Serbia), in relation to the ichthyomass. In tanks, the average water temperature was 21.69 °C, pH 8.34 and dissolved oxygen 4.52 mg/l.

On 96th day of the study all carps were harvested and fish with any kind of changes on their body were recorded by Nikon Coolpix P90 12.1MP Digital Camera. In digital images' analysis localization and character of the changes were determined. Bodily injuries are identified as: (1) *fresh lesion* - light red skin defect, or bleeding, (2) *older lesion* - lack of the skin or deeper tissues with signs of healing process at the edges, (3) *the scar* - a mark left on the skin or within body tissue where a wound has not healed completely and fibrous connective tissue has developed, and (4) *missing scales* - area without scales, with no signs of skin inflammation. The size of wounded area on the fish body was determined according to Adamek et al. (2007). Fin injuries were divided in three categories: (1) *splitting*, (2) *erosion* and (3) *thickening* (Noble et al., 2012). Deformities were classified as spine deformities - *lordosis* (1) and *scoliosis* (2), and mouth deformities - *shortened upper jaw* (3) and *shortened lower jaw* (4). Survival rate was determined as: the final number of the fish per group x 100 / the initial number of the fish per group. Data were analyzed by STATISTICA 8.0 Software (StatSoft, Inc. 2007), and Microsoft Office EXCEL 2007.

RESULTS AND DISCUSSION

The highest survival rate and the lowest occurrence of injuries and deformities in the lowest stocking density (Group I) were recorded. Differences in the number of surviving fish are not statistically significant ($P > 0.05$), but differences in the number of fish with bodily changes are significant ($P < 0.05$) (Table 1).

Table 1. Survived, injured and deformed fish at the end of the study (%)

Group	Survived fish* (%)	Injured fish (%)			Deformed fish (%)		Fish affected by any type of change** (%)
		body + fins	body only	fins only	injuries + deformities	deformities only	
I	100	-	2.22	-	2.22	-	2.22
II	92	2.41	7.23	-	1.20	1.20	12.05
III	93	10.40	4.00	1.60	0.80	0.80	17.60
IV	88	1.89	4.40	2.52	1.89	4.40	15.09

* $P > 0.05$ (Chi-Square test); ** $P < 0.05$ (Chi-Square test)

Affected fish have had single or multiple lesions on the body and/or on the fins, as well as single or multiple deformations along with some injury or separately. In Table 2 the incidence of injuries at certain areas on the body and their categorization by character of the process is shown.

Table 2. Localization and category of lesions in the fish with injuries

Type	Ranking according the incidence		Category*			
	Localization	%	1	2	3	4
body injuries	lateromedial	26.53	4.08	8.16	-	**16.33**
	tail base	18.37	2.04	12.24	4.08	-
	dorsolateral	16.33	2.04	4.08	4.08	6.12
	ventrolateral	16.33	2.04	12.24	2.04	-
	dorsocranial	10.20	4.08	2.04	2.04	2.04
	upper lip	8.16	-	6.12	2.04	-
	lower lip	6.12	4.08	2.04	-	-
	behind operculum	4.08	2.04	2.04	-	-
	laterocranial	4.08	-	2.04	2.04	-
	behind dorsal fin	2.04	-	2.04	-	-
fin injuries	tail fin	28.57	-	24.49	2.04	/
	dorsal fin	26.53	-	26.53	-	/
	anal fin	12.24	-	8.16	4.08	/
	pelvic fin	2.04	-	2.04	-	/

* *body injuries*: (1) fresh lesion, (2) older lesion, (3) the scar, and (4) missing scales; *fin injuries:* (1) splitting, (2) erosion and (3) thickening

Most frequently, the lack of scales in the middle of the fish body i.e. lateromedial and erosion of the tail i.e. caudal fin were observed. At all localizations there were lesions in regeneration process (category 2), followed by fresh injuries and scars (categories 1 and 3). Erosion was the most common change of fins followed by thickening, while splitting was not observed. Erosion results in loss of both the epithelial fin tissue and the whole or part of the fin ray. Thickening refers to nodular, opaque thickening along the distal edge of an affected fin. (Noble et al., 2012).

The integrity of the skin-scale complex provides a relatively impermeable barrier to water and electrolytes. Epidermal damage such as scale loss, wounds and ulcers can result in a loss of body water and changed ion balance, which produces an osmotic stress that potentially can be life threatening. Ulceration affecting as little as 10% of the body surface area can result in high acute mortality. The degree of mortality is directly related to the amount of skin damage (Bouck and Smith, 1979). In this study, average size of skin area under lesions (%) was (Mean ± SD): 0.90 ±0.00 (Group I), 0.66 ± 0.33 (Group II), 1.04 ± 0.68 (Group III) and 0.77 ± 0.75 (Group IV). According to Kruskal-Wallis test stocking density did not affect the size of surface under injuries, and Mann-Whitney U test showed no significance in results of the groups (both $P > 0.05$). In Table 3 the incidence of deformities in affected fish is showed, as well as the incidence of deformities in the each group.

Table 3. The incidence of deformities

Type	Ranking according the incidence		Incidence in groups** (%)			
	Category	%	I	II	III	IV
Spine deformities	lordosis	8.77	2.22^{ab}	2.41^{ab}	1.60^{a}	6.92^{b}
	scoliosis	5.26				
Mouth deformities	shortened upper jaw	8.77				
	shortened lower jaw	5.26				
Total deformed among affected fish		26.32*				

* $P < 0.05$ (Kruskal-Wallis ANOVA); ** $P > 0.05$ (Chi-Square test, calculated on the total number of fish/group); No significant difference between values marked with the same letter ($P > 0.05$); Significant difference between values marked with different letters ($P < 0.05$) (Mann-Whitney U test)

Almost one third of all affected fish have had some deformity ($P < 0.05$), and the most common were abnormal, V-shaped curvature of the caudal vertebral column (lordosis), and shorten upper jaw. Spinal and mouth deformities were equally represented (both 14.03% of cases). Al-Harbi (2001) has found spinal deformity in 18.2% of deformed fish and predominant types of spinal deformities were lordosis and scoliosis. Kocour et al. (2006) included a possibility that some mouth deformities could be a consequence of pathogen infestations.

Group III had the lowest percent of deformed fish and Group IV the highest (1.60 and 6.92%, respectively) ($P < 0.05$). The occurrence of deformities was not significantly influenced by the treatment ($P > 0.05$).

CONCLUSSIONS

In this study, most frequently the lack of scales in the middle of the body and erosion of the tail fin were observed. The most common deformities were lordosis and shorten upper jaw. Differences between the groups in the number of fish with bodily changes are significant ($P < 0.05$). Stocking density did not show the influence on average size of damaged skin area and number of fish with deformities per group ($P > 0.05$). This study provides a basis for further research with more detailed analysis of the changes and their causes in different stocking densities. Finding the optimum density for carp fingerlings in tanks is important for achieving good production results and maximum protection of fish welfare.

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