APPLICATION OF PREBIOTIC MOS IN TROUT NUTRITION

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PRIMENA PREBIOTIKA MOS-A U ISHRANI PASTRMKI

Apstrakt

Ispitivan je uticaj manan oligosaharida (MOS) kao aditiva hrane, primenjenog u koncentraciji od 0,2% (O-I grupa riba) i 0,3% (O-II grupa riba) na morfometrijske karakteristike i osnovne proizvodne pokazatelje gajenja kalifornijske pastrmke. Ogled je sproveden na 450 riba podeljenih u tri grupe sa po 150 jedinki u svakoj grupi i trajao je 40 dana. Analizom dobijenih rezultata, ustanovljen je povoljan efekat primenjenog aditiva na morfometrijske pokazatelje tempa rasta riba, kako njihove završne komadne mase i završnih dužinskih mera, tako i njihovog prirasta, ali bez utvrđenih statistički značajnih razlika ($p>0,05$). Najveću prosečnu telesnu masu i dužinu tela kod ispitavanih grupa, ostvarile su pastrmke O-II grupe (118,49 g i 19,59 cm), zatim pastrmke O-I grupe (118,04 g i 19,58 cm), a najmanju K-grupa riba (115,94 g i 19,56 cm). Dodavanje MOS-a u smeše za ishranu pastrmki je imalo povoljan uticaj ($p>0,05$) na ostvarivanje niže konverzije hrane (HK) i boljih vrednosti osnovnih proizvodnih pokazatelja: faktora kondicije (FK), koeficijenta proteinske efikasnosti (PER), specifične stope rasta (SGR) i proizvodnog indeksa (PI) u odnosu na ribe K grupe, koje su hranjene smešama bez dodatka mananoligosaharida. Najbolje rezultate su ostvarile ribe O-II grupe, a iskazano u relativnim pokazateljima u odnosu na K grupu

riba: bolju konverziju hrane za 5,61%; bolju vrednost iskorišćenja proteina hrane za 5,94%; veću vrednost faktora kondicije za 1,73%; specifične stopa rasta za 2,26% i bolju vrednost proizvodnog indeksa za 8,27%.

Ključne reči: manan oligosaharid, kalifornijska pastrmka, proizvodni pokazatelji
Keywords: mannan oligosaccharides, rainbow trout, production indicators

INTRODUCTION

Prebiotics mannan oligosaccharides (MOS) and supplements based on it are complex carbohydrates derived from the cell wall of yeast *Saccharomyces cerevisiae* and are non-digestible food ingredients. The form present in the cell wall (α-1, 3 and α-1, 6 branched mannans) is particularly effective in binding to pathogens in the digestive tract of animals and fish (Spring et al., 2000). Their use contributes to the increased vitality of animals and fish, reduces mortality, stimulates production of immunoglobulins that enhance the immune system, and also improves the conversion and absorption of food, which leads to good production results and positive economic effect (Ferket et al., 2002) mannan oligosaccharides are now the most used in monogastric animal nutrition.

Considering the above facts relating to the applicability of biologically active substances as food additives, the aim of this paper is to show the potential of mannan oligosaccharides as a food additive on production characteristics of yearling rainbow trout (1 + years).

MATERIAL AND METHODS

The experiment was conducted on 450 of sorted and approximately uniform specimens of rainbow trout aged 1^+ years which formed three experimental groups of 150 fish each. Studied groups of fish were distributed into 3 individual pools of 20 m^3 volume, with the same water inlet of 24 l/sec, and the flow of water comprising of 69 changes within 24 hours. The experiment lasted 40 days.

Fish in all three experimental groups were fed with standard mixture for feeding fattening trout with 40% of the total protein. The control group of fish was fed feed without additives, and other experimental groups were fed diets supplemented with mannan oligo saccharides (MOS) as follows: O-I group was fed mixture containing 0.2% MOS and O-II group mixture containing 0.3% MOS.

The amount of food and number of daily meals were determined on a daily basis according to pre-determined food tables, adjusted to the water temperature and body weight of fish during the test (Phillips, 1970). Consumed food was chemically analyzed at the beginning of the experiment using standard testing methods (AOAC, 1990), except that the energy content was obtained by calculation. Ingredients and chemical composition of the mixture used for feeding fish in the experiment is shown in Table 1.

Table 1. Ingredients and chemical composition of the used mixture

Component ,%	K	O-I	O-II
Corn	11,30	11,10	11,00
Fish meal	48	48	48
Soybean meal	19	19	19
Sunflower meal 33%	3	3	3
Lime	1,9	1,9	1,9
Mono-Ca-phosphate	0,5	0,5	0,5
Iodized salt	0,3	0,3	0,3
Premix	1	1	1
Soybean oil	15	15	15
Mannan oligo saccharides (BioMos)	-	0,2	0,3
Average chemical composition of used mixtures (%) VSM			
Water	9,33	9,31	9,30
Ash	11,00	11,10	11,14
Proteins	40,39	40,41	40,35
Fibre	2,66	2,64	2,70
Dry matter (DM)	90,67	90,69	90,70
Metabolic energy ME MJ/kg (calculation)	15,06	15,10	15,08

Composition of used premix/kg mixture: Vitamin A 20000 IJ/kg; Vitamin D_3 3000;Vitamin E 80 mg/kg; Vitamin K_3 5 mg/kg; Vitamin B_1 15 mg/kg; Vitamin B_2 25 mg/kg; Vitamin B_6 15 mg/kg; Vitamin B_{12} 0,04 mg/kg; Vitamin C 500 mg/kg; Niacin 100 mg/kg; Ca-pantotenat 50 mg/kg; Biotin 1 mg/kg; Folic acid 4 mg/kg; Cholin chloride 100 mg/kg; Fe 40 mg/kg; Cu 10 mg/kg; Mn 40 mg/kg; Zn 40 mg/kg; J 10 mg/kg; Se 0,05 mg/kg; Co 1 mg/kg; Mg 50 mg/kg; Antioxidant BHT 100 mg/kg.

Based on the shown chemical composition of the mixture it can be concluded that the quality of the mixture was such that it meets the optimal nutritional requirements of rainbow trout and meets the requirements that are placed in the design of the experiment (NRC, 1993, Official Gazette of RS No.4/2010).

Control measurements of body mass and body length of fish were performed at the beginning, middle and end of the experiment. In order to determine the production characteristics of fish from each group two hours after feeding 20 individuals were caught, according to the method of random sampling. Individual body weight of fish was determined by measuring on a decimal technical scale (accuracy to 10-2 g) and body length using the ichthyometer (accuracy to 0.1 cm).

Based on the determined measurement results in order to determine the effect of mannan oligo saccharides as additive to the mixtures, the following product parameters were analyzed: total body weight gain, average individual weight gain and total body length, feed conversion ratio (FC), condition factor (FC), specific growth rate (SGR), protein efficiency ratio (PER) and production index (PI). In order to determine the hygienic conditions in the pools, indices of fish stocking density (Ig) and flow (Ip) were determined.

These parameters were calculated using the following forms:

$HK = H / TM_2 – TM_1$

$FK = TM_2 (g) / L_2^3 (cm)$

$SGR = [(TM_2 - TM_1) / (T_2-T_1)] \times 100$

$PER = Ptm / Up$

Where: H-consumed food; TM2 - Final body weight (g); TM1 - initial weight (g); L2 - Final total body length (cm); T2-T1 - the number of days the experiment; Ptm - gain of body weight (g); Up - consumption of protein (g).

According to Piper et al. (1982) the following was calculated:

$Ig = [TM / L] \times Q$ and $Ip = [TM / L] \times P$

Where: TM-weight (g); L - total body length (cm); Q - volume of the fish pool (m3), P - the water flow (l/sec).

Statistical analysis was performed using analysis of variance with assessment of statistical significance using the t-test.

RESULTS AND DISCUSSION

The results on the impact of adding different concentrations of mannan oligo saccharides in the feed mixture of rainbow trout on the performance are presented in Tables 2 and 3.

Upon completion of the experiment, i.e. 40 days, the highest body weight values were recorded in O-II fish group (118.49 g), followed by trout of O-I group (118.04 g), and the lowest in K-group (115.94 g). Average values of body length were highest in fish of O-II group (19.59 cm) and lowest in group K (19.56 cm). The differences of the final body weight and total body length of fish between the groups (Table 3) were not statistically significant ($p > 0.05$). Realized values of morphometric parameters analyzed directly influenced the results in the gain. Expressed in relative terms, O-II group fish achieved a higher average weight gain compared to fish in K group and 7.58% of the total body length of 7.50%, while the fish of O-I group for the same parameters had better results by 6.54% and 5.00%, respectively. For these two parameters between the groups statistical analysis did not establish a significant difference ($p > 0.05$).

Table 2. Comparative overview of the values of some production traits

Indicator	Groups		
	K	O-I	O-II
Initial body weight (beginning of trial), g	82,30	82,20	82,30
Average total body length (beginning of trial), cm	19,16	19,16	19,16
Production indicators at the end of the trial			
Average body weight (TM), g	115,94	118,04	118,49
Average total body length (L), cm	19,56	19,58	19,59
Total fish weight, kg	17,39	17,71	17,77
Total gain of body weight, kg	5,05	5,38	5,43
Average individual gain of TM, g	33,64	35,84	36,19
Difference (%)		6,54	7,58
Average individual increase of L, cm	0,400	0,420	0,430
Difference (%)		5,00	7,50
Total feed consumption, kg	9,06	9,15	9,20
Average daily feed consumption per fish, g	1,510	1,525	1,533
Difference (%)		0,99	1,55
Feed conversion ratio (FC)	1,795	1,702	1,695
Difference (%)		-5,21	-5,61
Protein efficiency coefficient (PER)	1,392	1,469	1,475
Difference (%)		5,49	5,94
Condition factor (FK)	0,0155	0,0157	0,0158
Difference (%)		1,50	1,73
Specific growth rate (SGR)	2,10	2,24	2,26
Difference (%)		6,54	7,58
Production index (PI)	2,421	2,601	2,622
Difference (%)		7,40	8,27

Table 3. Average values of body weight (g) and total body length (cm), 40 days of the experiment

Group	n	$\bar{x}$	min	max	$S_{\bar{x}}$	Sd	t- test
Average values of body weight							
K- group	20	115,94	108,20	124,30	1,040	4,649	p>0,05
O-1 group	20	118,04	113,50	127,60	0,950	4,248	
O-2 group	20	118,49	110,10	128,30	1,032	4,634	
Average values of total body length							
K- group	20	19,56	19,18	19,91	0,061	0,273	p>0,05
O-1 group	20	19,58	19,16	19,93	0,063	0,283	
O-2 group	20	19,59	19,15	19,95	0,066	0,287	

Obtained results are in agreement with the data reported by researchers who established that the addition of MOS to mixtures for various species of fish, has stimulating effect on increase of growth and weight gain, but without statistical significance (Binh et al., 2008; Dimitroglou et al. , 2011; Sara et al. 2011).

Based on the obtained production results (Table 2) it can be concluded that the presence of MOS in the mixtures for fattening trout, O-I and O-II group of fish, caused realization of greater feed intake and better feed conversion value and the ratio of protein efficiency. The lowest total food consumption had fish in group K (9.06 kg), and the highest trout in O-II group (9.20 kg) and average daily feed intake of fish in the O-II group was by 1.55%, and O-I group by 0.99% higher than in the K group.

In the analysis of feed conversion (FC) as the interaction of growth and food consumption, it is evident that the best value for this production parameter was achieved by O-II fish group (1.695), followed by O-I group (1.702), and the worst results of the value of this parameter were established for the fish group K (1.795). As for the relative values of utilization of food protein/protein efficiency (PER), it was found that the O-II group fish performed better for this parameter compared to the group K by 5.94%, while the O-I group of trout by 5.49% in comparison to the K group. Significance test for differences in determined average values for feed intake, conversion and utilization of proteins in food pointed to the absence of a statistically significant difference ($p > 0.05$).

The results in terms of feed conversion are in accordance with the results of Hossu et al. (2005*)* who found that the addition of MOS had positive impact on feed conversion in the experiment with gilthead (*Sparus aurata*), but without significant differences. Similar results have been presented by Peterson et al. (2010): the addition of MOS (0.2% and 0.4%) had no significant effect on feed conversion. However, the results obtained in the present study are somewhat lower than the data of Staykov et al. (2005), who reported that the addition of prebiotics to trout food induced increase of the efficiency of utilization of food by 9.01% and 10.16% ($p < 0,05$). Also, Čuljak et al. (2006) indicate that the addition of MOS of 0.6% to carp food contributed to a better feed conversion ratio values by 22.81% ($p < 0.05$) and PER by 22.49% ($p < 0. 05$).

Average values of condition factor (FC) as an indicator of relations of body weight and total body length of fish, indicate that the groups of fish where the MOS was applied as a diet supplement, achieved better value of the condition factor. Compared with the K group

of fish, O-II group had better values of this parameter by 1.73%, and trout of O-I group by 1.50%, which justifies the above statement that the application of 0.3% MOS in food achieved the best weight and length gain of the tested fish.

According to the data presented in Table 2, it can be concluded that the fish of O-II group compared to K group achieved better values of fish specific growth rate (SGR) by 7.58% and O-I group of fish by 6.54%. Statistically significant differences between the groups were not observed ($p > 0.05$). The obtained results were in line with that of other researchers Binh et al. (2008), Sarah et al. (2011), while slightly lower in terms of significance were results reached by Čuljak et al. (2006), Ognean et al. (2009).

The value of production index (PI) ranged from 2.421 (K group) to 2.622 (O-II group). The highest value of this ratio was observed in fish of O-II group, and as a result more vitality and better feed conversion in this group.

Stocking index values ranged from 0.0044 (K group) to 0.0045 (O-I and O-II group), while flow index values ranged from 0.0556 (K group) to 0.0567 (O-II group). The recorded values of Ip and Ig are in accordance with standards of sanitation for raising trout (Piper et al. 1982, Klontz, 1991). From the results of fish mortality in this study, it can be concluded that the use of MOS in the mixtures had no effect on mortality, and that the applied stocking density and carried hygienic measures caused low percentage of deaths and good health of the fish.

CONCLUSIONS

Based on the conducted research, it can be concluded that the use o mannan oligo saccharides (MOS) added to mixtures for rainbow trout had a positive effect on the tested production results: morphometric indicators of fish growth rate, feed conversion, condition factor, protein efficiency ratio, specific growth rate and production index.

This especially relates to best production results achieved in the O-II grou fish, which used MOS in concentration of 0.3%. Slightly lower values of recorded production parameters of fish in O-I group, which were fed mixture containing 0.2% MOS, while the lowest studied parameters were established in the K group of trout. Despite the favourable effect, the differences in average values of production parameters between studied groups were not statically significant ($p > 0.05$).

For this reason, there is a need for further research in order to find the optimal dose of mannan oligo saccharides as food additive, which would allow a wider application in intensive fish farming.

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