POSSIBLE REPLACEMENT OF FISH MEAL BY SOY CONCENTRATE IN FEED FOR TROUT

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MOGUĆNOST ZAMENE RIBLJEG BRAŠNA SOJINIM KONCENTRATOM U ISHRANI PASTRMKE

Apstrakt

U uslovima intenzivnog gajenja kalifornijske pastrmke (*Oncorhynchus mykiss)*, troškovi ishrane čine 50 do 70% ukupnih troškova u proizvodnji. Tokom višegodišnjih istraživanja, došlo se do zaključaka da proteinska hraniva biljnog porekla u određenoj meri mogu da zamene riblje brašno (FM) i smanje troškove proizvodnje. Najčešće korišćeni biljni proteini u ishrani riba su sojini proizvodi. Međutim, uspešnost zamene ribljeg brašna zavisi od vrste ribe koja se gaji, uzrasta riba kao i tipa korišćenog sojinog proizvoda. Kao jedan od boljih alternativnih izvora proteina navodi se sojin proteinski koncretat (SPC). SPC se dobija ekstrakcijom proteina iz sojinog brašna i sadrži oko 70% proteina. U akvakulturi predstavlja dobru zamenu za riblje brašno, jer sadržaj i svarljivost proteina u SPC su slični kao u FM. Neutralnog je ukusa i standardno je dobrog kvaliteta u odnosu na promenljiv kvalitet FM.

Istraživanje je sprovedeno u „Centru za ribarstvo i primenjenu hidrobiologiju" ODPF Radmilovac. Mlađ kalifornijske pastrmke, prosečne nasadne mase 33,62g, hranjena je smešama koncentrata (44/20 Extra, proizvođača Veterinarski zavod Subotica) sa različitim procentualnim učešćem FM:SPC, i to: 100:0, 75:25, 50:50, 25:75 i 0:100.

Na osnovu dobijenih rezultata, nakon 60 dana hranjenja riba smešama koncentrata sa različitim učešćem FM i SPC, mogu se konstatovati statistički vrlo značajne razlike u masi i dužini tela. Najbolju završnu masu, kao i BWG, SGR, TGC i FER uz najmanji FCR imale su ribe hranjene smešom gde je odnos FM:SPC bio 75:25. Nasuprot tome, ribe hranjene smešom koncentrata bez učešća FM, imale su statistički vrlo značajno

niže vrednosti BWG, SGR, TGC i FER, pri čemu je FCR bio statistički vrlo značajno veći nego upotrebom drugih smeša.

Dobijeni rezultati ukazuju da je u ishrani mlađi kalifornijske pastrmke najopravdanije koristiti smešu u kojoj je odnos FM:SPC bio 75:25, kako zbog proizvodnih rezultata tako i zbog smanjenja cene koštanja samog proizvoda.

Ključne reči: Kalifornijska pastrmka, ishrana, riblje brašno, sojin proteinski koncentrat.

Keywords: Rainbow trout, nutrition, fish meal, soy protein concentrate

INTRODUCTION

As the aquaculture is in continuous development, expanding and intensifying (Bostock et al., 2009), it is essential to involve different components in fish feed (Tacon, 2005) and provide their maximal utilization. From the nutritional aspect, the best potential show components of animal origin, but are the most expensive, while components of plant origin have a lower nutritive potential, moderate prices and are more available at the market (Storebakken et al., 2000). In order to create better production results, due to high prices of certain components (Aas et al., 2009), it is essential to know requirements of different fish species. In this sense the nutrition and preparation of fish feed is highly important.

Rainbow trout (*Oncorhynchus mykiss)* as a carnivorous fish species requires high protein level in feed, mostly based on fish meal and owing to this feed accounts from 50 up to 70% of total production expenses (Tekinay at al., 2009). Due to the need to reduce production costs, replacement of fish meal by valuable plant proteins in fish feed has been a subject of many researches (Viola et al., 1982; Watanabe, 2002; Uran et al., 2008). A conclusion has been reached that protein rich feed of plant origin may be replaced by fish meal up to a certain degree (Refstie et al., 2005; Thiessen et al., 2005; Glencross et al., 2008; Marković et al., 2012).

The most frequently used plant proteins in fish feed are soy products. However the success in replacement of fish meal depends on the fish species, fish category and type of soy product used (Watanabe, 2002). Soy protein concentrate (SPC) is produced by the extraction of proteins from soy meal and contains around 70% of proteins, 20% of carbohydrates, 6% of ash and 1% oil. In aquaculture, SPC has many advantages as a alternative protein source in replacing proteins from fish meal (USSEC, 2008).The content of row proteins in SPC is similar to FM. The digestibility of proteins and the energy in soy protein concentrate are the same as in fish meal, and compared to soybean meal even higher (protein digestibility 96–97%). The level of amino acids in SPC is equal or higher than fish meal, with the exception of methionine and lysine. Soy protein concentrate has a considerably lower level of antinutritional factors than soybean meal, and indigestive or harmful carbohydrates (oligosaharides) are removed during SPC production process. It has a neutral taste due to oligosaharides removal and is of good quality standard compared to the variable quality of fish meal.

The main aim of research was to study the possibility of replacing fish meal by soy protein concentrate in diets for rainbow trout fry, i. e. the effects of diets containing different ratio of FM and SPC on production results and feed utilization.

MATERIAL AND METHODS

The research was carried out at the „Centre of Fishery and Applied Hydrobiology" ODPF Radmilovac. In 100 l aquariums equipped with water purification system and water flow of 2 l/min, ten individuals of rainbow trout (*Oncorhynchus mykiss),* average weight of 33,62 g and14,46 cm in body length were placed. During 60 days fish were fed diets produced by Veterinary Institute JSC Subotica (44/20 Extra), with different share of fish meal and soy protein concentrate (FM:SPC), in ratio: 100:0, 75:25, 50:50, 25:75, 0:100. Fish were fed three times a day by manual distribution, according to the temperature and total ihtiomass in four replicates (aquariums) for each type of feed examined.

During the research, in 15 days intervals, the weight (Radwag THB – 600) and lengths of fish were measured using an ichtihyiometer. Following equations were used for calculations of growth parameters:

Body weight gain **(BWG)** = $W_t - W_o$;

Fulton's factor **(FF)** = $(W / L^3) \times 100$;

Specific growth rate **(SGR)** = $(100 \times (\ln W_t - \ln W_o) \times t^{-1})$;

Thermal-unit growth coefficient **(TGC)** = $(W^{(1/3)} - W_o^{(1/3)}) / (T \times t) \times 1000$;

Feed efficiency ratio **(FER)** = $(W_t - W_o) \times D^{-1}$;

Feed conversion ratio **(FCR)** = $D / (W_t - W_o)$,

where W_t is the average fish weight at the end of the experiment (g), W_o - the average fish weight at the beginning of the experiment (g), W - body weight (g), L - body length (cm), t - number of feeding days, T - water temperature (°C), D - the feed amonut (g).

The results were analyzed by one-way analyses of variance model with feed diet as the factor, and the significant difference of pairs of treatments were tested by Tukey HSD test.

RESULTS AND DISCUSSSION

The ANOVA shows that fish between treatments were not significantly different in weight (F=0.443; p=0.776), length (F=1.679; p=0.207) and Fulton's factor (F=2.734; p=0.069) at the beginning of experiment (Table 1). After 60 days of the experiment, fish were significantly different in weight (F=42.975; p<0.001) and length (F=30.359; p<0.001).

Table 1. Fish weight and length at beginning and end of experiment

Measurements	Fish diets (FM : SPC)	Weight		Length		Fulton's factor	
		$\overline{x}$	c_v	$\overline{x}$	c_v	$\overline{x}$	c_v
Beginning	100 : 0	33.61	0.57	14.40	0.56	1.12	2.15
	75 : 25	33.69	0.19	14.43	0.33	1.12	0.94
	50 : 50	33.58	0.30	14.58	0.78	1.07	1.46
	25 : 75	33.55	0.63	14.49	1.09	1.10	3.22
	0 : 100	33.60	0.47	14.46	0.68	1.11	2.25
Final	100 : 0	58.52^{ab}	4.65	17.17^{ab}	1.78	1.12	1.82
	75 : 25	64.55^{a}	1.25	17.78^{a}	1.49	1.15	3.36
	50 : 50	56.65^{ac}	5.63	16.96^{ac}	2.17	1.13	1.02
	25 : 75	51.86^{c}	8.55	16.37^{c}	2.55	1.15	4.39
	0 : 100	39.79^{e}	3.80	15.45^{e}	1.29	1.07	6.41

The same letters are denoted to treatments with no difference between

The fish fed by diets with 100% of SPC, had significantly ($p<0.001$) lower average weight and body length compared the fish fed by the remaining diets. By using feed with 75% FM and 25% SPC the highest average weight and length of fish has been achieved. Significantly ($p<0.001$) lower average weight has been gained after 60 days by using feed with 50% FM and 50% SPC, as well as with 25% FM and 75% SPC. By using fish feed with 100% of FM, significantly higher average weight has been gained ($p=0.032$) compared to the average weight of fish fed 25% FM and 75% SPC. Similar result was confirmed by Mambriniet al. (1999). A slightly lower effect on the average length ($p=0.018$) than on fish weight ($p<0.001$) had the diet with 50% FM, and 50% SPC.

The different ratio between FM and SPC provided significant difference between average values for all growth parameters and feed utilization (Zhao et al., 2010).The maximum average values for BWG, SGR, TGC and FER have been achieved in fish fed by 75% FM and 25% SPC, while the minimum with fish fed without FM in diet. Reverse was obtained for FCR (Table 2).

Table 2. Fish growth parameters and utilization of fish diets

Measurement	Fish diets (FM : SPC)	BWG		SGR		TGC		FER		FCR	
		$\overline{X}$	c_v	$\overline{X}$	c_v	$\overline{X}$	c_v	$\overline{X}$	c_v	$\overline{X}$	c_v
Final	100 : 0	24.91^{ab}	11.60	0.89^{ab}	9.17	1.17^{ab}	9.92	0.97^{ab}	5.42	1.03^{a}	5.20
	75 : 25	30.87^{a}	2.67	1.05^{a}	2.01	1.40^{a}	2.22	1.19^{a}	2.56	0.84^{a}	2.51
	50 : 50	23.07^{bc}	13.66	0.84^{bc}	10.73	1.10^{bc}	11.66	0.93^{b}	10.41	1.08^{a}	11.39
	25 : 75	18.31^{c}	24.38	0.70^{c}	19.88	0.90^{c}	21.31	0.74^{b}	27.15	1.46^{a}	**36.72**
	0 : 100	6.18^{e}	25.03	0.27^{e}	23.03	0.33^{e}	23.46	0.28^{c}	25.18	3.75^{e}	26.72
	Rez. ANOVE	F=41.562; p<0.001		F=45.390; p<0.001		F=44.109; p<0.001		F=40.001; p<0.001		F=22.222; p<0.001	

The same letters are denoted to treatment with no difference between

The average values of the growth parameters in fish fed by diets with 100% of SPC were significantly different from average values of all growth parameters of fish fed by diets with lower FM content. Also fish fed with 75% FM and 25% SPC differed significantly in all growth parameters, except for FCR, from fish fed 25% FM and 75% SPC. Similar research by Drew et al. (2007) showed that by replacing FM up to 29% with canola protein concentrate normal growth was observed in salmon fry.

Average BWG, SGR and TGC were significantly ($0.01<p<0.05$) different in fish fed 100% FM compared the fish fed 25% FM and 75% SPC. Significantly different ($0.01<p<0.05$) were average values of BWG, SGR, TGC and FER in fish fed FM:SPC in ratio 75:25 and 50:50.

CONCLUSION

Obtained results in this study show that there are no significant differences in the final fish weight, growth parameters and feed utilization if FM is replaced by SPC up to 50%. By replacement of FM with over 75% SPC, rainbow trout fry stops feeding after one month thus provide lower values of growth parameters.

By observing the production characteristics, the best growth (30.87 g) and feed utilization rate (1.19) with the lowest conversion coefficient (0.84), has been obtained when fish were fed with diet where the ratio between fish meal and soy protein concentrate was 75:25.

ACKNOWLEDGEMENTS

The present study was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, through the project "Improvement of production capacities of carp (Cyprinus carpio) through nutrition and selective breeding programs" (Project number: TR 31075).

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