Journal of Animal and Veterinary Advances 11 (10): 1522-1526, 2012
ISSN: 1680-5593

The Effects of Feeds Containing High and Low Levels of Fullfat Soybean on the Growth Performance and Production Cost of Rainbow Trout (*Oncorhynchus mykiss*, W.)

Murat Bilguven and Mustafa Baris
Department of Aquaculture, Faculty of Aquaculture and Fisheries,
Mersin University, 33169 Mersin, Turkey

Abstract: Both the protection of sustainable aquaculture sources and production of low cost fish feeds via using of alternative cheaper protein sources instead of fish meal is one of the most important aims of feed producers. Soybean and soybean products are the most attractive feed stuffs in finfish feeds for these reasons. In this study, low (15%) and high (70%) levels of fullfat soybean meal in rainbow trout feeds were used and growth performance, feed consumption, feed conversion ratio and production cost of rainbow trout were investigated. The average live weight of 300 rainbow trout (*Oncorhynchus mykiss*) used in this experiment was 49.73±0.56 g. Two trial groups which were fed rations containing low and high levels of full fat soybean meal were formed. There were 3 replications for each treatment and the trial lasted 10 weeks. Experimental diets were prepared as isonitrogenous (42% CP) and isocaloric (14.65 MJ DE kg^{-1} feed). At the end of trial, there was no significant difference among the groups in terms of live weight, live weight gain and body composition except fat content ($p>0.05$) however, significant differences for feed consumption and feed conversion ratio between the groups were observed ($p<0.05$). Consequently, it is concluded that the fish fed with complete feed containing high level full fat soybean meal could be produced cheaper without any negative effect ($p<0.05$).

Key words: Rainbow trout, fullfat soybean meal, growth performance, production cost, weight gain, aquaculture

INTRODUCTION

Insufficient nutrition is one of the main problem not only many countries but also ours. Moreover, this situation will convert to the danger of starvation in a soon time unless the whole food resources do not use in a sustainable programme. However, the role of aquatic products in balanced and healthy nutrition is understood better day by day. Traditionally, fish meal is the main dietary protein source in fish feed formulation, especially for carnivorous fish species such as salmon and eel. In general, fish feed contains 5-50% of fish meal and shrimp feed contains marine animal protein at a level between 30-50%. The rapid development of aquaculture will result in a high demand and a shortage of supply for fish meal. Besides of the limited availability, fishmeal is also a relatively expensive ingredient in aqua feed. Development of fish production realized by fishery and aquaculture from 1950's to recent years is shown in Fig. 1 (Anonymous, 2005). Furthermore, the quality of fishmeal can vary to a large extent, concerning to nutritional composition, pathogen and contamination of biogenic amines. Many researches, therefore have been conducted

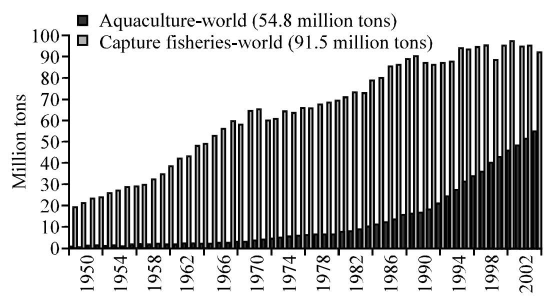

Fig. 1: Contribution of aquaculture to total world fisheries landings 1950-2003 (Anonymous, 2005) (Total global fisheries landings in 2003 was 146.3 million tons with aquaculture contributing 37.4% of total landings)

to search alternative protein sources as replacement of fishmeal in aquafeeds to produce cheaper feed for a long time (Hlophe *et al*., 2011). Soybean and its by-products is the most attractive feedstuff on this topic (Allameh *et al*., 2007; Ozkan *et al*., 2011). Total only seed production was 200.5 million tons in 2003 and 65.9% of this amount was soybean. Focusing on soybean is certainly because of

Corresponding Author: Murat Bilguven, Faculty of Aquaculture and Fisheries, Mersin University, Yenisehir Campus, 33169 Mersin, Turkey

having more valuable nutrients and biological value of protein than the others. Cho *et al.* (1974) found that decreased fish meal in young rainbow trout (*Oncorhynchus mykiss*) feeds did not affect the growth performance and feed conversion ratio negatively where fish meal ratio are decreased from 35-16% and soybean meal ratio increased from 10-39%. Smith (1977) replaced to total fish meal by fullfat soybean meal in a trial feed and he declared that such as a diet can be used in rainbow trout feed successfully. Lovell (1980) used 72% fullfat soybean meal, 5% fish meal in a trial feed and 25% herring fish meal, 20% soybean meal and 5% fish oil in control feed. He reported that fish fed the ration containing fullfat soybean meal had more weighed than the control group's one. But these fish were possessing oil, significantly. Takeshi *et al.* (1995) replaced to fish meal at 60 and 80% by soybean meal found the similar results about growth performance and feed conversion ratio among the groups at a 60% usage of soybean meal. Diets, containing dehulled, solvent-extracted soybean meal in amounts corresponding to 0, 20 and 40% soybean protein of total protein were fed for 10 months to duplicate groups of Atlantic salmon (*Salmo salar*) weighing about 900 g held in sea water.

Fish fed the diet containing 20% soybean protein grew as well as fish fed the diet with high-quality fish meal as the sole protein source whilst the fish fed the diet containing 40% soybean protein grew significantly less. No significant differences were found for dressing percentage, condition factor or relative liver weight between the dietary treatments. Fish fed the control or the 20% Soybean Meal (SBM) diets were not significantly different in body fat content, whilst this was significantly lower in the fish fed the 40% SBM diet. There were no significant differences between the dietary treatments in body protein content (Olli *et al.*, 1995).

The present study was carried out to evaluate the effects of high/low level of dietary soybean source on growth performance of rainbow trout.

MATERIALS AND METHODS

Experimental fish and diets: This study had been performed in a commercial trout farm with a total of 300 rainbow trouts (*Oncorhyncus mykiss*, W.) (initial mean body weight, 49.73±0.57 g) was stocked into six cages with 50 fish per cage. Young fish were obtained from another fish farm. Fish were assigned randomly to these four diets. The cages made by plastic profile in 1×1×1 m and encircled with knotless net with 2 cm mesh size were settled into same channel type pond with 80 cm deep. Water temperature was 14.9-15.7°C and pH was 7.37-7.42 (WTW, PH/OXI 340i/SET, Germany) and water flow rate was 12 L sec^{-1} during the trial.

Two feeds used in the experiment: in the first diet (LSB) contained about 35% fish meal and 15% soybean and second one (HSB) contained 15% fish meal and 70% soybean (63% fullfat soybean meal +7% defatted soybean meal). Experimental diets were prepared as isonitrogenous (42% CP) and isocaloric (14.65 MJ DE kg^{-1} feed, Table 1). The whole feedstuffs are grinded to medium fine size (0.3 mm) before pelleting. Pellet size was 3 mm diameter and 7 mm in length. Table 2 shows nutritional composition of these two trial feeds. Essential amino acid composition of trial feeds are shown in Table 3.

Feeding trial: Each feed was given to two trial groups tested in triplicate. The trial continued for 84 days at biweekly periods and ended when all fish reached >200 g weight. Every 2 weeks, the whole fish starved fish before 24 h was taken from each cage then weighed as a group. Fish was fed twice a day, at 8 o'clock in the morning and at 6 o'clock in the evening according to free

Table 1: Composition of experimental fish diets

	Test diets (%)	
Foodstuffs	LSB	HSB
Fish meal	35.0	15.0
Bone-meat meal	5.0	5.0
Corn gluten	9.0	5.0
Soybean meal	15.0	7.0
Fullfat soybean meal	-	63.0
Wheat bran	30.4	3.1
Fish oil	4.3	-
Vitamin complex[a]	0.5	0.5
Mineral complex[b]	0.1	0.1
Dicalcium phosphate	-	0.3
DL-methionine[c]	0.1	0.4
Lignobond[d]	0.5	0.5
Butyl hydroxy toluene[e]	0.1	0.1
Total (%)	100.0	100.0

[a]Vitamin premix (mg kg^{-1} or IU kg^{-1} of dry matter): thiamine 40 mg, riboflavin 50 mg, pyridoxine 40 mg, calcium pantothenate 117 mg, nicotinic acid 200 mg, biotin 1 mg, folic acid 10 mg, cyanocobalamin 0.5 mg, choline chloride 2700 mg, inositol 600 mg, ascorbic acid 5000 mg, α-tocopherol 300 mg, menadione 20 mg, cholecalciferol 2000 IU, retinol acetate 5000 IU and α-cellulose was used as a carrier; [b]Mineral premix (g kg^{-1} of dry matter): calcium orthophosphate 1.80 g, calcium carbonate 5 g, ferrous sulphate 1.7 g, magnesium sulphate 1.8 g, potassium phosphate 3.0 g, sodium phosphate 1 g, aluminium sulphate 0.02 g, zinc sulphate 0.24 g, copper sulphate 0.20 g, manganese sulphate 0.08 g, potassium iodate 0.02 g. α-cellulose was used as carrier; [c]These additives were obtained by Sigma. [d]This commercial product is used as pellet binder. [e]Antioxidant powder

Table 2: Nutritional composition of experimental diets

	Test diets (Percetage as fed basis)	
Items	LSB	HSB
Dry Matter (DM)	92.59	92.27
Crude Protein (CP)	42.24	42.07
Crude oil	12.38	16.84
Crude fibre	2.05	1.92
Nitrogen Free Extract (NFE)	27.66	22.88
Ash	8.26	8.56
Digestible Energy (DE) (MJ kg^{-1})	14.63	14.67

Table 3: Essential Amino Acid (EAA) composition of test diets and essential amino acid requirement of rainbow trout (DM %)

Essential amino acid	LSB	HSB	Requirements of rainbow trout*
Arginine	2.59±0.03	3.19±0.04	1.5
Histidine	1.05±0.03	1.21±0.03	0.7
Isoleucine	2.11±0.11	2.40±0.11	0.9
Leucine	3.65±0.17	4.02±0.13	1.4
Lysine	2.88±0.18	3.81±0.18	1.8
Methionine	1.02±0.05	1.10±0.06	1.0**
Phenyalanine	1.98±0.05	2.39±0.06	3.1***
Threonine	1.66±0.15	1.80±0.15	0.8
Trytophan	0.41±0.09	0.48±0.09	0.2
Valine	2.33±0.13	2.60±0.13	1.2
EAA/Non EAA	1.08	1.54	-

*Anonymous (1993); **Methionine+cystine. The cystine replacement value for methionine on a sulphur basis has been determined to be about 42% for rainbow trout (Wilson, 1989); ***Phenylalanine + tyrosine. Growth studies indicate that tyrosine can replace or spare about 53% in rainbow trout (Kim, 1993)

feeding (*ad libitum*) method. It is supposed that all given feeds were consumed by fish. The amount of consumed feed was calculated by determining weight of lacking total feed.

Chemical analysis and calculations: Live weight gain was determined by fish final weight-initial weight; feed conversion ratio was calculated as feed consumed/weight gain. Dead fish were removed and recorded daily and number of the dead fish was taken into account before Feed Conversion Ratio (FCR) was calculated.

At the end of the experiment, fish weight gain, FCR, PER (Hepher, 1988), PPV (Wilson, 1989), SGR (Wilson 1989) and Condition Factor (CF) (Brown, 1957):

$$\text{PER} = \frac{\text{Live weight gain in an identified period (g)}}{\text{Consumed protein with the diet (g)}}$$

$$\text{PPV} = \frac{\text{Final carcass protein content} - \text{Initial carcass protein content}}{\text{Consumed protein with the diet}} \times 100$$

$$\text{SGR} = \left[\frac{\text{Ln}W_t - \text{Ln}W_0}{t - t_0}\right] \times 100$$

$$\text{CF} = \frac{W}{L^3}$$

and survival rate were calculated. Just before the start of the experiment, 5 fish were randomly collected for proximate carcass analysis and 7 fish from each treatment were sacrificed and pooled for total body and carcass composition analyses at the end of the experiment. The chemical compositions of the total body-carcass, complete feeds and feedstuffs were measured following AOAC Methods (Anonymous, 1995). Amino acid analysis of 0.1 mg samples hydrolyzed with 1 mL 6 N HCl for 24 h was made with an Eppendorf Biotronik LC 3000 (Eppendorf Cooperation, USA in 1999) microprocessor controlled amino acid analyzer.

Fish production cost was calculated with complete feed price multiplied by FCR. The price of feed ingredients is concerned in early 2011.

Statistical analyses: In this trial, Randomized Block Design Model was performed to observe the differences. All statistical analyses were performed using the statistical package, SPSS 17.0 for Windows (Anonymous, 2008). The significance of treatment effects on the different parameters measured were determined by one-way ANOVA followed by Tukey's multiple comparison test where appropriate. Differences were reported as significant if p<0.05. Results shown in Table 4 and 5 are reported as means±SD (n = 3 and 5, respectively).

Table 4: Growth performances and feed efficiency of rainbow trout fed experimental diets*

	Test diets ($\bar{X} \pm S_{\bar{x}}$)	
Items	LSB	HSB
Duration of feeding (day)	84	84
Total fish number	150	150
Initial weight (g)	50.13±2.44	49.33±1.11
Final weight (g)	215.85±6.49	223.38±7.75
Average live weight gain (g)	165.72±8.49	174.05±11.75
Average feed consumption (g)	213.78±9.43[a]	240.2±11.32[b]
Feed Conversion Ratio (FCR)	1.29±0.02[a]	1.38±0.04[b]
Protein Efficiency Ratio (PER)	2.37±0.07[a]	1.72±0.10[b]
Protein Productive Value (PPV)	6.76±0.05[a]	6.51±0.08[b]
Specific Growth Rate (SGR)	1.74±0.11	1.80±0.13
Condition Factor (CF)	1.35±0.06[a]	1.58±0.08[b]
Survival rate (%)	89.3±7.02	84.7±3.06
Complete feed price	0.534	0.397
Fish production cost (€ kg^{-1})	0.689±0.04[b]	0.548±0.07[a]

*Results are means±SD (n = 3). Means in the same row that do not share a common superscript letter differ significantly (p<0.05)

Table 5: Nutritional composition of total body and carcass at the end of trial* (%)

	Test diets ($\bar{X} \pm S_{\bar{x}}$)	
Items	LSB	HSB
Initial carcass		
Moisture	75.51±0.80	75.51±0.80
Crude protein	12.87±0.20	12.87±0.20
Fat	3.84±0.40	3.84±0.40
Ash	2.66±0.20	2.66±0.20
Final total body		
Moisture	71.04±0.30	71.41±0.30
Crude protein	15.79±1.10	14.66±0.40
Fat	5.04±0.10[a]	7.67±0.01[b]
Ash	3.23±0.60	3.59±0.70
Final carcass		
Moisture	68.30±0.02	67.94±0.20
Crude protein	18.98±0.01	19.45±0.40
Fat	6.16±0.01[a]	8.03±0.10[b]
Ash	2.18±0.02	2.41±0.20

*Results are means±SD (n = 5). Means in the same row that do not share a common superscript letter differ significantly (p<0.05)

RESULTS AND DISCUSSION

Performance of fish in feeding trial: Results of fish performance in feeding are shown in Table 4. Furthermore, live weight in several feeding periods can be shown in Fig. 2. As can be shown in Fig. 2, no significant differences were observed for live weight and live weight gain and diets did not present any significant alteration in live weight or live weight gain. Therefore, it is concluded that live weight gain is not affected by high level fullfat soybean meal. On the other hand, significant difference was observed in the average feed consumptions of LSB and HSB. Moreover, the difference between LSB and HSB for FCR, PPV, PER and CF was statistically significant ($p<0.05$). There were significant differences ($p<0.05$) in FCR, PER, PPV and SGR, respectively among fish fed with different diets (Fig. 3). Mortality rate was statistically insignificant ($p>0.05$) in all dietary treatments during the experimentation.

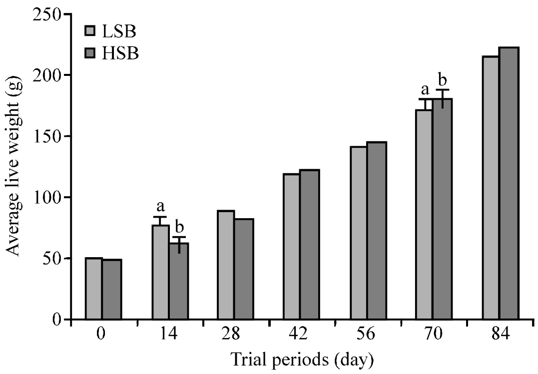

Fig. 2: Average live weight in several periods (g). Bars show the means and bars with different letters are different ($p<0.05$)

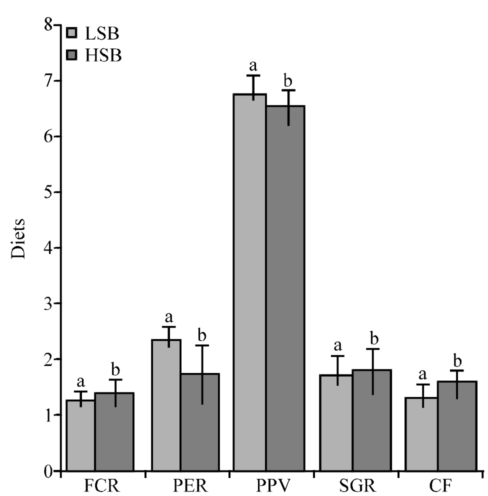

Fig. 3: The relationship between FCR, PER, PPV, SGR, CF and diets. Bars show the means and bars with different letters are different ($p<0.05$)

Total body and carcass composition: There were no significant differences in moisture, crude protein or ash in whole fish body and carcass (Table 5) but the difference between LSB and HSB for fat in total body and carcass was found to be statistically important ($p<0.05$). The group fed by the ration containing high level fullfat soybean meal is found markedly fatty.

In this study, the effect of soybean level in rainbow trout feeds was found insignificant. In this study, present results are in line with those reported by Cho *et al.* (1974), Smith (1977), Lovell (1980), Takeshi *et al.* (1995) and Refstie *et al.* (2000). On the contrary, there are other studies reported significant decreasing live weight gain in fish fed with rations containing high soybean and low fish meal (Refstie *et al.*, 1997; Olli *et al.*, 1995). However, Gropp (1976) and Tiews *et al.* (1976) claimed that soybean could be replaced by fish meal at 25 or 50% levels in rainbow trout feeds by supplementing only with methionine it is obvious that there is no any common view at this point when we cite many references up to today. Certainly, it can be attributed to different environmental conditions (rearing in freshwater or sea, water temperature, water quality, fish species, different fish size, different heat treatment of soybean, different ingredients in the feeds and their interactions with each other, etc.), genetic factors and methodological errors.

When live weight gain and FCR increase as a general rule, PER decreases. Therefore, the results about live weight gain, PER, PPV and SGR are in agreement with Steffens (1989)'s findings. Results indicated that high level fullfat soybean could be included in rainbow trout diets without significantly reducing weight gain, PER, PPV, SGR, survival rate and increasing FCR.

HSB is heavier than LSB for live weight gain but this difference can be attributed to fat content of HSB. Thus, fat content in carcass and total body of HSB are (18.7 and 26.3%) higher than those of LSB. Lovell (1980) has also obtained similar results on this topic.

CONCLUSION

In this study, usage of high level soybean in fish feeds has created a big advantage in fish production cost. Higher the difference in the price between soybean and fish meal is higher soybean can be used in rainbow trout diets to produce cheaper feed. Sometimes live weight gain can be lower or duration of standard size can be longer when soybean was used high proportions so, every commercial farm produced their own feed should make a diet formulation strategy and feeding plan for chancing feedstuff price.

Consequently, soybean and by-products will continue to be the most used ingredients in aquafeeds because of its price and nutrient content in the future. Nevertheless, more studies must be carried out to replace fish meal by soybean totally.

REFERENCES

Allameh, S.K., N.M. Soofiani and J. Pourreza, 2007. Determination of digestible and metabolizable energy of fishmeal and soybean meal in rainbow trout with two different sizes (*Oncorhynchus mykiss*). Pak. J. Biol. Sci., 10: 3722-3725.

Anonymous, 1993. Nutrient Requirements of Fish. National Academy Press, Washington, DC., USA.

Anonymous, 1995. Association of Official Analytical Chemists. 15th Edn., Official Methods of Analysis of the Association of Official Analytical Chemists, Arlington, Virginia, USA.

Anonymous, 2005. Fishstat Plus: Universal software for fishery statistical time series. Aquaculture production: quantities 1950-2003; aquaculture production: values 1984-2003; capture production: 1950-2003; Commodities production and trade: 1950-2003; Total production: 1970-2003, Vers. 2.30. FAO Fisheries Department, Fishery Information, Data and Statistics Unit, FAO, Rome, Italy.

Anonymous, 2008. SPSS Inc.: SPSS (v17) for window. SPSS Inc., Chicago, USA.

Brown, M.E., 1957. Experimental Studies on Growth. In: The Physiology of Fishes, Volume 1, Varley, M.E. (Ed.). Academic Press, New York, pp: 361-400.

Cho, C.Y., H.S. Bayley and S.J., Slinger, 1974. Partial requirement of herring fish meal and other changes in a diet for rainbow trout (*Salmo gairdneri*). J. Fish. Res. Board Can., 31: 1523-1528.

Gropp, J., 1976. Replacement of Fish Meal in Trout Feeds By Other Feedstuffs. FAO Technical Conference on Aquaculture, Kyoto, Japan.

Hepher, B., 1988. Nutrition of Pond Fishes. Cambridge University Press, Cambridge, UK., pp: 388.

Hlophe, S.N., N.A.G. Moyo and J.R. Sara, 2011. Use of kikuyu grass as a fishmeal substitute in practical diets for *Tilapia rendalli*. Asian J. Anim. Vet. Adv., 6: 1076-1083.

Kim, K., 1993. Requirement for phenylalanine and replacement value of tyrosine for phenylalanine in rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 113: 243-250.

Lovell, R.T., 1980. Using heat treated fullfat soybean meal in fishfeeds. Aquacult. Mag., 6: 39-48.

Olli, J.J., A. Krogdahl and A. Vabeno, 1995. Dehulled solvent-extracted soybean meal as a protein source in diets for Atlantic salmon (*Salmo salar* L.) Aquacult. Res., 26: 167-174.

Ozkan, C.O., A.I. Atalay, I. Guven, E. Kaya and A. Sagocak, 2011. Crude protein and amino acid compositions of some protein sources used livestock production in south of Turkey. Asian J. Anim. Vet. Adv., 6: 750-753.

Refstie, S., O.J. Korsoen, T. Storebakken, G. Baeverfjord, I. Lein and A.J. Roem, 2000. Differing nutritional responses to dietary soybean meal in rainbow trout, *Oncorhynchus mykiss* and Atlantic salmon (*Salmo salar*). Aquaculture, 190: 49-63.

Refstie, S., S.J. Helland and T. Storebakken, 1997. Adaptation to soybean meal in diets for rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 153: 263-272.

Smith, R.R., 1977. Recent research involving fullfat soybean in salmonid diets. Salmonid, 1: 8-18.

Steffens, W., 1989. Principles of Fish Nutrition. Ellis Horwood Limited Press, NY, USA., Pages: 363.

Takeshi, Y., T. Unuma and T. Akiyama, 1995. The effect of combined use of several alternative protein sources in fingerling rainbow trout diets. Fish. Sci., 61: 915-920.

Tiews, K., J. Gropp and H. Koops, 1976. On the development of optimal rainbow trout pellet feeds. Arch. Fish. Wiss., 27: 1-29.

Wilson, R.P., 1989. Amino Acids and Proteins. In: Fish Nutrition, Halver, J.E. (Ed.). Academic Press Inc., San Diego, CA, USA., pp: 119-147.