World Journal of Fish and Marine Sciences 4 (4): 422-425, 2012
ISSN 2078-4589
© IDOSI Publications, 2012

# Effects of Replacing Fish Meal with Plant Protein (Sesame Oil Cake and Corn Gluten) on Growth Performance, Survival and Carcass Quality of Juvenile Beluga (*Huso huso*)

*Abdolreza Jahanbakhshi, Mohamadreza Imanpuor, Vahid Taghizadeh and Ali Shabani*

Department of Fishery, Faculty of Fisheries and Environment,
Gorgan University of Agricultural Science and Natural Resources, Gorgan, Iran

**Abstract:** Studies were carried out on the possibility of replacing fish meal in the feeds for beluga with protein sources of plant (sesame oil cake and corn gluten). Experimental feeds with 47.5% of crude protein, GE: 4.75 Kal gG$^{1}$ in three replacement levels 160, 320 and 480 gkg$^{1}$ respectively accompanied with a control diet (0 gkg$^{1}$) were prepared and fish were fed for 60 days. At the end of growth tests, significant differences were not found in growth performance ($P$>0.05). Biomass gain, specific growth rate, feed conversion rate and protein efficiency ratio have not significantly different ($P$>0.05). Also Protein, fat, moisture and ash have not significantly different too ($P$>0.05). According to the obtained results in the present experiment, maximum recommended levels of fish meal substitution by CGM (corn gluten meal) and sesame oil cake in diets for Beluga (*Huso huso*) can be established at 16-48% of total protein.

**Key words:** Great Sturgeon % Diet % Growth % Fish Meal % Plant Protein

## INTRODUCTION

In the recent years, the intensive culture of certain sturgeon species has been advanced as an option to other more traditional fish species such as trout and carp. The Beluga sturgeon (*Huso huso*) is an increasingly prominent aquaculture species in Russia, Eastern Europe, Turkey, Japan and Iran because of the decreasing natural sources for its caviar and meat. This fish is a commercially important fish and is usually processed into frozen fillets [1].

One of the main needful to increase aquaculture development is the attainability and cost of feed [2, 3]. Fish meals supply dietary protein with essential amino acid profiles like to dietary requirements. However, much work is being done to reduce its portion in commercial diets by partial replacement with individual alternative beast and plant protein sources, in order to guarantee the reserve of high quality diets to fish farmers, prevent availability, quality and costs oscillations associated with fish meal [4].

Over the years, it has been substantiated that cautiously formulated and well-presented fish diet plays an extremely significant function in fish culture [5]. Fish meal is quiet considered the most prominent protein source for aquaculture industry because of its high biological estimate, but this is a limited food stock and there is important concern on the long-term accessibility of this feed stuff for use in fish diets [6, 7]. Fish meal reserve in the world market is changeable and its value is ever increasing. In recent years, the higher price of fish meal has produce renewed interest in the use of plenty of the alternative protein sources for fish feed. For two economic and practical cause, fish feed should be prepared using locally attainable protein sources, preferentially those unsuitable for human consumption [8]. Among the plant protein sources, oil cakes are considered as kind protein sources for fish diet and are attainable in large amount as by-products of the edible oil industry.

Reviews on alternative protein sources have been advertised by Tacon and Jackson [4] and Kaushik [9] Among plant protein sources, some studies report that partial replacement of dietary fish meal with corn gluten meal (12 to 26% of the diet) has lead to sufficient results of growth rates and feed employment in diets for the *Oncorhynchus mykiss* [10-13]. Alliot *et al.* [14] found that replacement of fish meal by corn gluten meal at levels up to 20% did not affect growth or feed efficiency ratios in sea bass *(Dicentrurchus labrux)* juveniles.

**Corresponding Author:** Abdolreza Jahanbakhshi, Department of Fishery, Faculty of Fisheries and Environment, Gorgan University of Agricultural Science and Natural Resources, Gorgan, Iran.

While the plant protein source can influence several physiological parameters, the main purpose of the present study was to conclude the effect of plant protein diet on growth performance and carcass quality of beluga (*Huso huso*) Juvenile, as a valuable species for production of flesh and caviar and one of the best candidate species for sturgeon culture, mainly in Russia, Eastern Europe and Iran.

## MATERIALS AND METHODS

The experiments conducted on juvenile Great sturgeon (average weight: 51±2 g) produced at the Institute of Aquaculture of the Marjani for Sturgeon, Golestan, Iran. Fish were acclimated to laboratory conditions for 30 days before being randomly distributed into the fiberglass tanks of 400 L capacity. Fish with 51±2 g initial body weights were distributed into 12 experimental tanks in four groups of 120 fish each (10 fish per tank). Fiberglass tanks supplied with freshwater from an urban system. 120 fish were individually measured for weight and length. The tanks were individually aerated and water temperature was controlled at 23 °C. Dissolved oxygen, pH and water temperature were continuously monitored. Photoperiod was maintained at 12-h light: 12-h dark cycle. Four groups were fed by hand twice a day to 2% whole body weight. Each group was weighed every 2 weeks to follow growth and feed utilization.

Four experimental diets were formulated to contain 47.5% crude protein (Table 1).

Nine fish from each treatment were used for whole body chemical analysis. The fish were anaesthetized (with clove oil at 100 mg $L^{-1}$), killed with a blow to the head and weights of the whole fish body were recorded. The samples were stored at-20°C.

The whole fish and diet samples were ground and then analyzed for dry matter after desiccation in an oven (105°C for 24h), ash (550°C, overnight), crude protein (6.25× nitrogen (N); Kjeltec Auto System), lipid (Soxtec HT6 after hydrolysis with HCl) and energy (adiabatic bomb calorimeter).

Whole-body specific growth rates (SGR), expressed as a percentage of the body weight, were calculated using the growth rate equation of [16]: SGR (%/day)={[ln(*Wf*)-ln(*Wi*)].100}/*t*.

Where *Wi* and *Wf* are the initial and final wet weights (g) of the experimental beluga, respectively and *t* is the length of the experimental period (in days).

The feed conversion ratio (FCR) was calculated in terms of wet weight as:

FCR= wet weight of feed consumed/change in wet weight

Total feed consumption was estimated from the amount of feed that was not eaten and was collected from the strainer at the bottom of the tank every hour. The pellets remained intact prior to collection and uneaten feed was estimated from the number of pellets using the average weight of a pellet for each feed [17].

The protein efficiency ratio (PER) and per cent survival rate was calculated in terms of wet weight as:

PER = Live wt. gain (g)/ Protein intake (g)

Survival (%) = Total live fish (No.) after t/ Total fish at 0 day (No.).100

All data were analyzed with one-way analysis of variance (ANOVA) by using SPSS16.0 for windows. Differences between means were determined using Duncan's multiple test (significance P<0.05).

Table 1: Formulation and chemical composition of the diets

| | Experimental diets | | | |
|---|---|---|---|---|
| Nutrient material | Treatment 1 (%) | Treatment 2 (%) | Treatment 3 (%) | Treatment 4 (%) |
| Fish meal | 55 | 45.33 | 34.35 | 23.27 |
| Corn gluten | 0 | 8 | 16 | 24 |
| Sesame oil cake | 0 | 8 | 16 | 24 |
| Wheat flour | 20.25 | 15.03 | 10.05 | 6.48 |
| Gelatin | 8 | 8 | 8 | 9 |
| Fish oil | 5.750 | 5.195 | 5.175 | 4 |
| Soybean oil | 5.750 | 5.195 | 5.175 | 4 |
| Lysine | 1.5 | 1.5 | 1.5 | 1.5 |
| Methionin | 1.5 | 1.5 | 1.5 | 1.5 |
| antioxidant | 0.25 | 0.25 | 0.25 | 0.25 |
| Vitamins and minerals* | 2 | 2 | 2 | 1.75 |
| Chemical composition (% or cal.$g^{-1}$) | | | | |
| Crude protein | 48.08 | 48.00 | 47.00 | 47.00 |
| Lipid | 16.30 | 15.90 | 16.66 | 15.16 |
| Energy crude | 4.80 | 4.78 | 4.81 | 4.73 |

*Vitamins and minerals were supplied according to NRC [15].

Table 2: Growth performance in fish fed the experimental diets

| Experimental diets | Treatment1 | Treatment2 | Treatment3 | Treatment4 |
|---|---|---|---|---|
| Mean initial body weight (g) | 52.40 ± 2.00 | 53.22 ± 2.00 | 52.87 ± 2.00 | 52.50 ± 2.00 |
| Mean final body weight (g) | 240.87 ± 2.20 | 253.77 ± 2.15 | 224.94 ± 2.35 | 230.71 ± 2.45 |
| Weight gain(g) | 188.38±2.4 | 200.55±1.5 | 172.22±1.2 | 184.84±1.7 |
| SGR (%)* | 2.51 ± 0.18 | 2.64 ± 0.09 | 2.45 ± 0.10 | 2.43 ± 0.04 |
| PER | 3.14 ± 0.07 | 3.15 ± 0.02 | 3.11 ± 0.10 | 3.15 ± 0.06 |
| FCR | 0.6 ± 0.07 | 0.6 ± 0.02 | 0.6 ± 0.02 | 0.6 ± 0.01 |
| Survival (%) | 100 | 100 | 100 | 100 |

Tank average values of fish weight (Mean±SE) were used as experimental units for the statistical analysis of growth performance.

*Specific growth rate = {[ln(*Wf*)-ln(*Wi*)].100}/*t*

Table 3: Fish composition of whole fish fed the experimental diets

| | Proximate composition (%) | | | |
|---|---|---|---|---|
| Experimental diets | Treatment1 | Treatment2 | Treatment3 | Treatment4 |
| Protein | 14.80 ± 0.26 | 14.60 ± 0.21 | 14.00 ± 0.25 | 14.40 ± 0.81 |
| lipid | 4.09 ± 0.08 | 4.60 ± 0.60 | 4.60 ± 0.03 | 4.60 ± 0.05 |
| Ash | 4.10 ± 0.10 | 4.53 ± 0.30 | 4.56 ± 0.55 | 4.23 ± 0.32 |
| Moisture | 77.98 ± 0.51 | 77.76 ± 0.72 | 77.82 ± 0.46 | 77.31 ± 0.42 |

## RESULTS

Data on growth performance of fish fed with the four different diets are shown in Table 2. Weight gain, specific growth rate, feed conversion rate and protein efficiency ratio have not significant different. However, at the end of the trial, specific growth rates (SGR) were reduced only in the third and the fourth treatments. There was no mortality in the experiment.

Protein, lipid, ash and moisture contents of fish were not influenced by the level or type of alternative ingredient in diets (Table 3). Fish fed the fish meal diet showed the highest protein and lower lipid levels, but with no significant differences with the rest of the treatments.

## DISCUSSION

In recent years, a significant numbers of researches have been directed on the substitution of fish meal with plant protein source. The suitability of this substitution in terms of growth performance has resulted to be generously variable among fish species and experimental situation. Thus, specific experiments have to be performed for each species. In fish, protein digestibility is usually high ranging from 75% to 95% [9]. Diet containing 20% of CGM (Corn Gluten Meal) had a very good digestibility, in agreement with the results of Gomes [18] in rainbow trout fed diets including about 20% CGM. In general, proteins from CGM are measured to have a kind digestibility [15]. It is then surprising that incorporation of CGM in substitution of fish meal led to a significant reduce in protein digestibility.

Sesame oil cake is also a pompous plant protein source, having a justly good level of methionine and the absence of any known toxic factor [19]. Hasan *et al.* [20] shown that sesame oil cake could be used at 25-50% in the diet of *Cyprinus Carpio*. Many scientists used sesame oil cake as a dietary protein source at levels ranging from 4.0% to 70% in distinctive carp species [8, 20, 21]. In the present examination, sesame oil cake and corn gluten meal was used at 16-48% in different diets, which was within the range used by different scientists. However the growth performance of Beluga-fed sesame oil cake and corn gluten in this study was excellent in compared with the other fish species reported by previously scientists as cited above.

In summary, according to the obtained results in the present experiment, maximum proposed levels of fish meal replacement by CGM and sesame oil cake in diets for Beluga (*Huso huso*) can be recognized at 16-48% of total protein.

## ACKNOWLEDGMENTS

The authors thank the Aquaculture Research Center and Fishery group for the supply of research material. This work was supported by the Gorgan University of Agricultural Sciences and Natural Resources. The authors are also grateful to Dr. Hedayati which deeply contributed with valuable comments and suggestions.

**REFERENCES**

1. Dragoev, S.G., D.D. Kiosev, S.A. Danchev, N.I. Ioncheva and N.S. Genov, 1998. Study on the oxidative processes in frozen fish. Bulgarian Journal of Agricultural Science, 4: 55-65.
2. FAO, 1983. Fish Feeds and Feeding in Developing Countries. UNDPL FAO, ADCP REP, pp: 18-83.
3. James, D., 1992. Seafood technology in the 1990: The needs of developing countries. in: E. Graham Bligh (Ed.), Seafood Science and Technology. Fishing News Books, pp: 12-23.
4. Tacon, A.G.J. and A.J. Jackson, 1985. Utilization of conventional and unconventional protein sources in practical fish feed. Nutrition and Feeding in Fish, 1: 18-145.
5. Omoregie, E., 2001. Utilization and nutrient digestibility of mango seeds and palm kernel meal by juvenile *Labeo senegalensis* (Antheriniformes: Cyprinidae). Aquaculture Research, 32: 681-687.
6. Hardy, R.W., 1996. Alternative protein source for salmon and trout diets. Animal Feed Science and Technology, 59: 71-80.
7. Sargent, J.R. and A.G. Tacon, 1999. Development of farmed fish: A nutritionally alternative to meat. Proceedings of the Nutritional Society, 58: 377-383.
8. Hossain, M.A. and K. Jauncey, 1989. Studies on the protein, energy and amino acid digestibility of fish meal, mustard oil cake, linseed and sesame for common carp (*Cyprinus carpio* L.). Aquaculture, 83: 59-72.
9. Kaushik, S.J., J.P. Cravedi, J.P. Lalle`s, J. Sumpter, B. Fauconneau and M. Laroche, 1995. Partial or total replacement of fish meal by soya protein on growth, protein utilization, potential estrogenic or antigenic effects, cholesterolemia and flesh quality in rainbow trout. Aquaculture, 133: 257-274.
10. Robaina, L., M.S. Izquierdo, F.J. Moyano, J. Socorro, J.M. Vergara, D. Montero and H. FernCndea-Palacios, 1995. Soybean and lupin seed meals as protein sources in diets for gilthead seabream (*Sparus aurata*): Nutritional and histological implications. Aquaculture, 130: 219-233.
11. Gropp, J., H. Koops, K. Tiews and H. Beck, 1979. Replacement of fish meal in trout feeds by other feedstuffs. Aquaculture, 64: 596-601.
12. Alexis, M.N., E. Papaparaskeva and V. Theochari, 1985. Formulation of practical diets for rainbow trout (*Salvo gairdneri*) made by partial or complete substitution of fish meal by poultry by-products and certain plant by-products, Aquaculture, 50: 61-73.
13. Moyano, F.J., G. Cardenete and M. de la Higuera, 1992. Nutritive value of diets containing a high percentage of vegetable proteins for trout, *Oncorhynchus mykiss*. Aquatic Living Resources, 5: 23-29.
14. Alliot, E., A. Pastoreaud, J. Pelaez and R. Metailler, 1979. Partial substitution of fish meal with corn gluten meal products in diets for sea bass (*Dicentrurchus labrax*), pp: 229-238.
15. National Research Council (NRC), 1993. Nutrient requirements of fish. National Academy Press, Washington, DC, pp: 114.
16. Ricker, W.E., 1979. Growth rates and models. Fish Physiology, 8: 677-743.
17. Carter, C.G. and R.C. Hauler, 2000. Fish meal replacement by plant meals in extruded feeds for Atlantic salmon (*Salmo salar* L.), Aquaculture, 185: 299-311.
18. Gomes, E.F., P. Rema and S.J. Kaushik, 1995. Replacement of fish meal by plant proteins in the diet of rainbow trout (*Oncorhynchus mykiss*): digestibility and growth performance. Aquaculture, 130: 177-186.
19. Liener, I.E., 1980. Toxic Constituents of Plant Foodstuffs. Academic press, NewYork, USA, pp: 502.
20. Hasan, M.R., D.J. Macintosh and K. Jauncey, 1997. Evaluation of some plant ingredients as dietary protein sources for common carp (*Cyprinus carpio* L.) fry. Aquaculture, 151: 55-70.
21. Mohanty, S.N. and S.P. Dash, 1995. Evaluation of *Azolla caroliniana* for inclusion in carp diet. Journal of Aquaculture in the Tropics, 10: 343-353.