Sjournals
Scientific Journals
Scientific Journal of Animal Science (2013) 2(8) 234-241
ISSN 2322-1704
doi: 10.14196/sjas.v2i8.937

Contents lists available at Sjournals
Scientific Journal of Animal Science
Journal homepage: www.Sjournals.com

Original article

Effects of Goldfish (*Carassius auratus*) and Roach (*Rutilus rutilus*) extracts on the growth indexes and survival rate of Beluga (*Huso huso Linnaeus* 1758) fingerlings

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ARTICLE INFO

Article history:
Received 08 July 2013
Accepted 18 July 2013
Available online 26 August 2013

Keywords:
Beluga
Nutrition
Goldfish extract
Roach extract
Growth factors

ABSTRACT

In order to investigate the effect of extracts of Goldfish and Roach extracts on the food acceptability of giant sturgeon fingerlings (Huso huso), an experiment for about a month was carried out in the Aquaculture Research Center of the School of Fisheries at the University of Agricultural Sciences and Natural Resources of Gorgan. To do this research, Goldfish and Roach extracts mixed together with three concentrations (diluted, medium and concentrated) and three replicates of each were added to the diet of fingerling giant sturgeon. Experiment was conducted within 250 liter polyethylene tanks which were half filled. 20 specimens of fingerling Beluga with an average weight of (5 ±0.2 g) were placed into storage tanks and were fed four times daily as much as full satiety. At the end of the cultivation period Growth Factors and survival were analyzed. Results showed that adding extracts of Goldfish and Roach in the diet of fingerling Beluga the growth parameters such as: Weight Gain (WG), percentage of Weight Gain (PWG), Specific Growth Rate (SGR), Condition Factor (CF), Daily Growth Rate, Daily Growth Index (GI) and Food Conversion Ratio (FCR) has been improved. Although, all treatments compared with control were significantly different, but the best indicators of growth at least in the treatment of Roach was observed. Also a significant difference in

Survival Rates between treatments were observed (P<0.05). The highest Survival Rate in treated extracts of Goldfish was observed in average concentration and minimum was observed in control treatment (P<0.05).

1. Introduction

Sturgeons (Acipenseridae) are among fish that lived 200 million years ago. About 90 percent of the world populations of sturgeons live in the Caspian Sea (Pikitch et al, 2005). Beluga (Huso huso) is one of the species of this family that its main habitats are the Caspian Sea, Black Sea, Azof Sea and surrounding areas (Berg, 1948).

Among the types of freshwater species, beluga (Huso huso) is probably the biggest species during evolution that has survived (Freedman, 1999). The main origin of beluga is the Caspian Sea which is watered with more than 100 large and small rivers. Most important river is the Volga River in Russia which about 75 percent of sturgeons catch is done in this river (Khodorevskaya et al, 1999; Artyukhin, 1997). It is suspected that illegal fishing and smuggling of sturgeons in the Caspian Sea and Volga River is reaching ten times more than allowable catch (Traffic, 2000). Since the fishermen and the poachers take away all belugas before they die naturally. The evolution of these fishes remains unknown (Raspopov, 1993).

The survival of the Caspian sturgeon totally depends on the Sturgeon hatcheries, through artificial reproduction and rearing (Khodorevskaya et al, 1999; secor et al, 2000). In recent decades many efforts by researchers around the world regarding breeding of sturgeons have taken and a number of countries started the caviar production that has marketed. Findings of scientific researchers suggest that most important factor in sturgeon breeding is feeding costs. Advances in intensive breeding methods of aquatic species need to evaluating and determining appropriate environmental factors, including nutrition and feeding. Food costs in intensive breeding system are around 40-60 percent of the executive system total costs (Anderson et al, 1997).

Economic justification depends on the chemical composition of fish meal (protein and fat content of food), energy content, pellet size, pellet shape, color and texture of palette (Hygurea, 2001), feeding frequency and feeding time that affect on the food intake and fish growth. So to have a successful breeding system having a balanced diet, proper feeding time and frequency is essential (Hasan, 2001; Akomus, 2000). Nutrition and growth performance in fish is the most important economic factors that feature Commercial production. Therefore, to make the profitable sturgeon breeding, need to care on feeding stages and the use of artificial foods (Sudagar et al, 2008).

Kasumyan (2002) suggest that sturgeon larvae attracted to food by smell and taste of it. Food containing fish mill as the main source of protein which are used in most starter foods of trout is repelled and does not be eaten by larvae. Added extracts of organisms in the diet can cause chemical receptor stimulation (smell and taste) and the ingestion of food is affected (Dongmeza et al, 2006; Kasumyan and Daving, 2003; Car et al, 1996).

Present study examines and deals with the effect of the extracts of Roach and Goldfish on nutrition of fingerling Beluga. In recent decades many efforts by researchers in other countries have been taken regarding breeding of sturgeons and a number of countries produced caviar which has been marketed. Researcher's scientific findings indicate that the best operating factor in sturgeon breeding is feeding sturgeon and its related costs. Having information on the Desirability of food could reflect the basic knowledge of fish nutrition physiology that is precious (Jobling, 2001).

2. Materials and methods

This experiment was performed in the beginning of May to the early June at the Research Center of the Fisheries Department, University of Agricultural and Natural Resources, Gorgan, Iran. Beluga fingerlings supplied by Marjani Public Hatchery were kept in rearing tanks (250 m3) for a week and maintained with food rations without extracts for adapting to new environment. After adaptation and biometry, 20 fingerlings were assigned

randomly in each tank with average weight of 5.01±0.20 g. Experiment was designed in a roofed hall and a completely randomized method in the form of nine treatments and one control with three replications.

2.1. Extract preparation

Goldfish and Roach required for extract preparation were gathered from Shahid Marjani hatchery Center and Center for artificial propagation and rearing of bony fishes of Sijowal, Gorgan, Iran. Fishes separately poured in the mortar and then smashed as much as possible. After that the mixture pressed and passed through paper. Then obtained solutions poured into Test tube and then were centrifuged with centrifugal machine 5000 rpm for ten minutes (Velez et al, 2007). After centrifuge the liquid part was separated to be used for feeding the fry. For maintenance, the produced extract was maintained in freezer (-21° C) until use. All treatments concentrated, medium and diluted are presented in Table 1. The food used in this study was from the Coppens International Company. The levels of extract of 2% ration was sprayed before fry to be fed Approximate dietary compounds, fatty acid profiles and amino acid profiles are given in Tables 2, 3 and 4.

Table 1
Treatments of added extract to the diets.

Extract treatments	Water: extract
Concentrated roach	25:1
Average roach	50:1
Diluted roach	100:1
Concentrated goldfish	25:1
Average goldfish	50:1
Diluted goldfish	100:1
Control	diet without the extract

Table 2
Approximate dietary ingredients.

Approximate dietary compounds	percentage
Crude protein	51.9
Crude Fat	24.45
Humidity	10
Ash	9.3

Table 3
Fatty acid profiles of diets.

Type of fatty acid	Percentage	Type fatty acid	Percentage
C18: 1n7	1.4	C14: 0	5.57
C18: 2n6-t	6.63	C14: 1n5	0.78
C18: 3n3	1.26	C15: 0	0.45
C20: 1n9	3.59	C16: 0	16.97
C20: 04n6	5.49	C16: 1n7	5.56
C20: 5n3(EPA)	11.65	C17: 0	0.46
C22: 6n3 (DHA)	7.8	C17: 1n7	0.55
C18: 1n9	12.27	C18: 0	3.29

Table 4
Amino acid profiles of diets.

type of amino acid	Levels (micro mol ml-1)	type of amino acid	levels (micro mol ml-1)
Asp	23.246	Tyr	10.643
Glu	111.931	Val	27.707
Gly	71.146	Met	11.873
His	58.062	Thr	31.401

Arg	6.870	Ala	15.332
Cys	1.641	Phe	8.291
Ile	51.530	Lys	15.076

2.2. Fish feeding

During the experiment, fingerlings of great sturgeon were fed four times daily until satiety (hours 8, 11, 16 and 20). Water was exchanged 15-20 percent one hour before the feeding. Bioassay of fingerlings has been conducted once every ten days, for this purpose, all fingerlings were taken out of the tanks and with a biometric boards (precision 1 mm) and a digital scale (precision 0.01 g) lengths and weights were recorded. When a fingerling was taken out of the tank, tanks and air stones were thoroughly washed and cleaned. Measuring water quality parameters such as temperature, oxygen, pH and salinity were carried out every day.

2.3. Analysis of growth parameters

After each repetition of growing period based on length and weight, the rate SGR (percentage) increase in body weight (g), percentage of body weight gained, food conversion ratio (FCR), condition factor (CF), percentage of daily growth and of survival rate in percent were calculated by the following formula (Takon, 1997):

BWI= BWf - BWi

PBWI= (BWf - BWi) 100/BWi

CF =100 * BW/ L3

DGI= (W1/3f - Wi1/3) ×100/ day

SGR= (LnWf - LnWi) ×100/ day

DGR= Wi × (Wf - Wi) ×100/ day

Wi= initial weight Wf = final weight DGI = Daily growth index

BWI = Increase in body weight PBWI= percentage of increase in body weight

SGR = specific growth rate DGR = daily growth rate

CF= condition factor Feed Conversion Ratio= given food/weight gain

Price index= Feed Conversion Ratio × Food Price per kg

2.4. Statistical analysis

Data analysis was done using Excel and SPSS software packages. For comparing means of treatments in a completely randomized design analysis of one way ANOVA and Duncan (One-Way ANOVA) were used. Presence or absence of significant difference on 5 percent probability level ($P < 0.05$) were determined. First to establish completely random design, normal distributed data with Anderson-Darling test was used at the 5 percent level of confidence ($P<0.05$) and the uniformity of environment of data was evaluated with Bartlet-Leven test.

3. Results

3.1. Physicochemical factors of water

During the entire experimental period temperature changed from 19.1 to 24.02 degrees Celsius, changes in water oxygen was from 5.7 to 7.7 mg/l, changes in pH was from 7.5 to 8.2, and salinity changed only 0.1ppt.

3.2. Growth indices

At the end of experiment after the final fish biometry, growth indicators have been tested and the results are given in Table 5.

3.3. Weight gain

Maximum body weight gain was observed in treated with diluted Roach extract. Weight gain in this treatment was rated as 16.30±0.15 g. while increase in body weight of the control treatment was obtained as 9.71±0.827 g. Moreover, between different treatments of fish extracts of Roach and Goldfish (Diluted, medium and concentrated) in comparison with control treatments no significant difference was observed ($P>0.05$), but, all

extract treatments (thin, medium and thick) compared with control treatments (no extracts) and Goldfish extract treatments (thin, medium and thick) demonstrated significant differences (P< 0.05) (Table 5).

Table 5
Analysis of growth factors in the different roach extract treatments.

Growth Indicators	Diluted extract	Medium extract	Concentrated extract	Control
Initial length (cm)	10.57±0.3[a]	10.37±0.2[a]	10.37±0.15[a]	10.46±0.22[a]
Initial weight (g)	5.51±0.14[a]	5.54±0.10[a]	5.74±0.30[a]	5.61±0.25[a]
Final length (cm)	21.91±0.30[b]	16.67±0.70[a]	16.45±0.30[a]	15.28±0.36[a]
Final weight (g)	21.91±0.20[b]	19.27±0.73[b]	19.70±0.1[b]	15.32±0.33[a]
Weight gain	16.40±0.15[b]	13.73±0.30[b]	13.95±0.40[b]	9.71±0.27[a]
Percentage of weight gain	297.7±5.4[b]	248.3±17.4[b]	244.3±24.5[b]	174.32±12.1[a]
Initial condition factor	0.47±0.05[a]	0.49±0.03[a]	0.51±0.03[a]	0.49±0.01[a]
Final condition factor	0.43±0.01[a]	0.42±0.05[a]	0.44±0.05[a]	0.43±0.02[a]
Specific growth rate (%/day)	4.93±0.04[b]	4.45±0.10[b]	4.40±0.20[b]	3.59±0.16[a]
Daily growth rates (%)	10.63±0.2[b]	8.87±0.6[b]	8.72±0.8[b]	6.22±0.4[a]
Daily growth index (%)	3.68±0.02[b]	3.25±0.10[b]	3.24±0.20[b]	2.53±0.09[a]
Food conversion rate (%)	0.86±0.02[b]	0.93±0.05[b]	0.92±0.07[b]	1.30±0.03[a]
Price index (Rials)	15432±480[b]	18551±205[b]	18356±346[b]	26092±751[a]

Mean±S.D.,numbers in a row with different letters is significantly different (P≤0.05).

Table 5
Analysis of growth factors in the different goldfish extract treatments.

Growth Indicators	Diluted extract	Medium extract	Concentrated extract	Control
Initial Length (cm)	10.67±0.4[a]	10.63±0.5[a]	10.60±0.2[a]	10.46±0.22[a]
Initial Weight (g)	5.76±0.3 [a]	5.77±0.3 [a]	5.47±0.2[a]	5.61±0.25[a]
Final Length (cm)	16.50±0.20 [a]	16.40±0.30 [a]	16.40±0.20[a]	15.28±0.36[a]
Final Weight (g)	21.83±0.30 [b]	21.64±0.50 [b]	20.17±0.20[b]	15.32±0.33[a]
Weight Gain	16.07±0.60 [b]	15.88±0.40 [b]	14.71±0.70[b]	9.71±0.27[a]
Percentage of Weight Gain	280.3±17 [b]	275.6±6 [b]	269.3±4.7[b]	174.32±12.1[a]
Initial Condition Factor	0.48±0.02 [a]	0.48±0.04 [a]	0.47±0.02[a]	0.49±0.01[a]
Final Condition Factor	0.48±0.01 [a]	0.49±0.03 [a]	0.45±0.08[a]	0.43±0.02[a]
Specific Growth Rate (%/day)	4.76±0.20 [b]	4.72±0.05 [b]	4.66±0.40[b]	3.59±0.16[a]
Daily Growth Rates (%)	10.01±0.2 [b]	9.84±0.2 [b]	9.61±0.2[b]	6.22±0.4[a]
Daily Growth Index (%)	3.58±0.1 [b]	3.55±0.04 [b]	3.43±0. 2[b]	2.53±0.09[a]
Food Conversion Rate (%)	0.81±0.02 [b]	0.88±0.02 [b]	0. 91±0.03[b]	1.30±0.03[a]
Price Index (Rials)	15784±532 [b]	15974±413 [b]	17304±102[b]	26092±751[a]

Mean S. D.±, numbers in a row with different letters are significantly different (P ≤0.05).

2.4. Percentage of body weight gain

Percent of body weight gain in Roach extract treatments (diluted, medium and concentrated) and Goldfish extract (diluted, medium and concentrated) was significant when compared with controls (P<0.05).

2.5. Specific growth rate

Maximum Specific Growth Rate treatment was observed in diluted Roach extract (4.93±0.04%) and least Specific Growth Rate was observed in the control treatment (3.59±0.16). The maximum daily index was observed in Roach diluted treatments (10.63±0.2) and the minimum of it was observed in control treatment (6.22±0.43). Finally the maximum Daily Growth Index was observed in the Roach diluted extract treatments (3.68±0.02) and the least was recorded in control treatment.

2.6. Condition factor

There were not significant differences between the values obtained for the different treatments when compared with control. Although maximum Condition Factor was observed in Goldfish diluted and medium treatments (0.43±0.01) and minimum was observed in Roach medium treatment (0.42±0.05).

2.7. FCR

The highest Food Conversion Ratio was observed in the control treatment (no extract) and the lowest Food Conversion Ratio was observed in the Goldfish diluted treatment (0.79±0.02). Food Conversion Ratio in food rations containing extracts of Goldfish and Roach (diluted, medium and concentrated) in comparison with the control treatments (no absorbent material) has shown significant difference ($P < 0.05$). Whiles, there is not any significant difference between different levels of treatments with extracts of Goldfish and Roach (diluted, medium and concentrated).

2.8. Price Index

In observation of Price Index in this study, the least price index was observed in the diluted treatment of Roach (480 ± 15432 RLS) and its maximum was recorded in control (no absorbent material) treatment (751 ± 26092 RLS). Food Price index in the diets containing extracts of Goldfish and Roach (diluted, medium and concentrated) comparing with the control treatments (no absorbent material) is shown significant difference ($P <0.05$). Wiles, between different levels of treatments with extracts Goldfish and Roach (diluted, medium and concentrated) was not significant differences ($P>0.05$).

2.9. Daily Growth Index

In the study, the minimum Daily Growth Index was observed in the control treatment (2.53±0.09) and the maximum has been recorded in the diluted Roach treatment (3.68±0.02). Daily Growth Index diets containing extracts of Goldfish and Roach (diluted, medium and concentrated) in comparison with the control treatments (no absorbent material) is shown significant difference ($P < 0.05$). Whiles between different levels of treatments with extracts of Goldfish and Roach (diluted, medium and concentrated) there is no significant differences ($P>0.05$).

2.10. Daily Growth Rate

In the study of Daily Growth Rate the minimum daily growth was in control treatments (6.22±0.43) and the maximum was recorded in the diluted Roach treatment (10.63±0.2). Daily Growth Rate in the diets containing extracts of Goldfish and Roach (diluted, medium and concentrated) comparing with the control treatments (no absorbent material) is shown significant difference ($P < 0.05$). Whiles between different levels of treatments with extracts of Goldfish and Roach (diluted, medium and concentrated) there is no significant difference ($P>0.05$).

2.11. Survival Rate

Survival Rate in diets containing fish extracts from Roach (diluted, medium and concentrated) and diluted extract from Goldfish in comparison with control treatments (no absorbent material) is not shown any significant difference. Whiles, between different levels of treatment with extracts from Goldfish (medium and concentrated) with control and Roach treatments (diluted, medium and concentrated) shows a significant difference. Maximum survival rate was recorded in Goldfish medium treatment (59 ± 4) and the least survival rate was recorded in the control treatment (49 ± 3).

4. Discussion

Having the necessary information regarding the palatability in aquaculture could give us cognition on nutrition physiology that could have great influence on the success of a fish breeder. In recent years, many materials are used as feed attractant in aquatic diet such as amino acids, amines, alcohols, classic tasting materials, nucleotides and nucleosides, sugar and other hydrocarbons, the organic acid and a mixture of these materials (Kasomyan, 2002).

Utility of Attractants in the diet to increase desirability of aquatic food as an essential aspect in reduction of related costs of nutrition are well known especially in the larval stage of marine fishes that the denial of artificial food by them is considered as a major problem in the aquaculture (De La Higuera, 2001).

Attractants are those that help fish to take the food items through taste receptors both inside and outside of fish mouth. Also these materials encourage the fish to use that food by provoking its appetite. Moreover, there are another group of substances that has no effect on fish feeding behavior and doses not provoke taste system in and out of fish mouth. These are considered as ineffective materials.

Adding nutritional stimulators to the diet of fishes give the possibility to use undesirable and cheap protein resources which make the aquaculture meaningful (Jobling et al., 2001). The use of Attractants reduces the feeding waste to the minimum because of two reasons: firstly the economic value of the food and secondly preventing and avoiding extreme changes in water quality.

One of the other possibilities that are provided through using the feeding stimulus is that it has covering effect on materials that reduce desirability of food rations. So we can use plant proteins instead of fish meal protein in commercial diets. Also with adding stimulating materials to the diet that cause palatability of food, most of the food will be consumed in the minutes after starting feeding the fish. By using the natural food which is available in the natural habitat the stimulus materials were prepared to be effective (Velez et al, 2007).

Oikawa and March, 1997 reported that a fish diet were fed with low desirability diet were satiated earlier than fish that fed with a diet with high desirability. If the fish which is fed with a diet with low desirability until satiety then re-fed with a diet with high desirability will start again feeding until reaching a new level of satiety. Takeda et al, 1984 showed in another study that if the artificial food which is fed by fish has good desirability will be effectively digested.

Mearns et al (1987) tested aqueous extract of shrimp on two salmonid species and reported that different materials contained in this aqueous extract including amino acids, nucleotides and organic compounds have stimulated the fish under investigation. Carr et al., (1996) with 30 different extracts from fish species and crustaceans reported that glycine and Alanyn in 22 species of fish increased the food intake. Moreover, proline, arginine, betanine hystedyn in 20 percent of species under investigation have increased the food catchability. Aqueous extract from a kind of sea lettuce on Tilapia stimulates the food intake. Investigation showed that the amino acids glutamic acid, aspartic acid, Serine, lysine and alanine increase the food catchability (Kasumyan and Daving, 2003).

In a study in 1999 by Kasumyan shows that extract from larvae of daphnia and extract from larvae of chironomid on a group of sturgeon under investigation will improve food intake and growth indicators. These results which are obtained in this research are in agreement with the results obtained by Kasomyan. Hidaka et al., in 2000 by using muscle tissue extracts of mackerel, in the diet of yellow tail fish (Seriola quinqueradiata) could increase the food intake and improve fish growth indexes which the results of our study is in conformity with their results.

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