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RESEARCH ARTICLE **(Open Access)**

The assessment of some performance and welfare indicators in rainbow trout. (*Oncorhynchus mykiss* Walbaum, 1792), reared under two different feeding practices

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Abstract:

Three groups of rainbow trout constituted by 100 individuals per group, with initial live weight of 50. 67±1. 954 g were kept in 5 m³ containers for 77 days. Two of them were fed on demand using mechanical equipments (Demand and Belt feeders). The feeding of the third group was done according to the traditional method, by hand. The effect of the way of feeding on condition factor values (K), specific growth rate (SGR), feed conversion ratio (FCR) and fin condition were studied. The k and SGR values have resulted higher in mechanical feeding than in hand feeding. Mechanical feeding improve also the feed conversion ratio. Lower values of pectoral and dorsal fin damage in both experimental groups compared with the control group, sampled a better situation of welfare when the feeding was provided on demand.

Keywords: rainbow trout; feeding practices; condition factor; feed conversion ratio; growth rate; welfare.

1. Introduction

"The greatness of a nation and its moral progress can be judged by the way its animals are treated [6]. In recent years growing scientific evidence has accumulated on the sentience of fish and the Council of Europe has issued a recommendation on the welfare of farmed fish [12].

Increasing scientific, political and public attention is being paid to fish welfare, especially in regard to the quality of life and state of well being of fish in commercial production systems [11, 20, 7]. Different risks to welfare (stressful husbandry practices, disease, water quality) have been extensively discussed, but establishing what is acceptable for the fish and how to quantify welfare using relevant operational indicators remains a major challenge [13, 30, 34, 20, 26, 7]. Observations of growth reduction at high stocking densities and in the case of different feeding practices were frequently associated with fin damage, though the exact process by which fin damage occurs remains poorly understood. Fin damage is commonly observed in all commercial farmed fish species. The shape and length of fins changes, and the occurrence of injuries (necrosis, splits, rot) can be used as welfare indicators both in experiments and on-farm [23, 19, 25, 27].

The purpose of our 77-day experiment was to assess the influence of different feeding practices on some welfare and performance indicators of rainbow trout (*Oncorhynchus mykiss*, Walbaum 1792) cultivated in 5m³ flow-through tanks. Initial stocking density was equal in three groups of the experiment. The fish performance was measured using a number of commonly applied production measurements (condition factor, specific growth rate and food conversion). Fish welfare was assessed using physical indicators, particularly focusing on the incidence of damage to pectoral, dorsal and caudal fins.

2. Material and Methods

The study was carried out in Lini fish plant cultivation located in Pogradec region. Rainbow Trout (*Oncorhynchus mykiss* Walbaum) were kept in containers of 5m³ capacity. The water supply of containers was 1. 5 l/min/kg fish. The water temperature was 10-11. 3ºC. Three containers (two experimental group and one control group) were used in this study. One hundred trout were put in each of the containers. The trout average individual weight and average zoological length were respectively 50. 67±1. 954 g and 16. 71±0. 210 cm. The autofeeding "Demand feeder" was installed in one of experimental container. In another experimental container the autofeeding "Belt feeder" was installed. The feed was distributed by hand in the third container that constituted the control group. The experiment started in the mid-May 2012.

During the experimental period the mechanical equipments used were: autofeeding timer Belt Feeder-BFS 12A and auto feeding Pendulum Demand Feeder tip FH. During 15 of May up to 5 of June, the 75% of

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feed ration was given by hand to trout placed in the container equipped with Demand feeder and the rest (25%) of it was given by Demand Feeder. This procedure was carried out because the trout need a time interval to get used by trigger activation. According to Alanara A. [5], the groups of 100 – 300 trout grown in containers need around 25 days to get the stabilized level of autofeeding. The experiment with Belt Feeder equipment started from 15th of May, 2012.

The fish performance was measured using a number of commonly applied production measurements :

The condition factor (K), the specific growth rate (SGR) as indicators of the general physiological condition of trout reared in two different feeding systems. The calculation of condition factor is done according to Fulton, T. W[15]; Froese R.[14];

$K = (W/L^3) *100$

K-condition factor

W-live weight fish (g)

L-zoological length (cm)

The specific growth index is calculated according to [29]

$SGR= [(\ln Wt2) - (\ln Wt1)]/ (t2-t1) \times 100$

SGR-specific growth index (% W/day)

W1-live weigh of fish at time t1

W2- live weigh of fish at time t2

(t2-t1) -the time interval or the number of days between two consecutive measurements of fish weight.

Daily feeding ratio : percentage of average daily feed ration per kg live weight of fish. The daily feeding ration is determined based on the value of ichthyic-biomass and water temperature according to Haskell, D. C. [16]: Hinshaf J. [18]; Alnara A. [4]. To correct and determine the daily feed ration the standard tables are used according to McDowell L. R. [24];

Feed conversation ratio (FCR):

Feed conversation ratio (FCR) is determined through giving feed quantity (kg) and weight gain of ichthyic biomass (kg) ratio according to JhingranV. G [21]; Aderolu Z. A. [1]:

$FCR = F/(Wf-Wo)$,

Where:

F-the given feed quantity during the test period.

Wo-fish live weight at the beginning of the test.

Wf-fish live weight at the end of the test.

The correction is done in every 15 days that was the interval between two progressive measures of individual weight.

The differences between average values are compared using Duncan's Multiple Range Test[31]. The statistical analyzes of the obtained data from a differential study of FCR values is done by MSTATS program.

The evaluation of fins condition :

Ten fish of each group were examined at intervals of 15, 30 and 60 days after the beginning of the experiment. The fish drawn from the containers were inserted into a 20 liter bucket filled with water. The water temperature was the same with that in the container. The general profile of fins was evaluated considering five levels of erosion according to the scheme proposed by Person Le Ruyet J. [27]. The 0 level for the perfect fins and the 4 level when all fins rays had eroded. The erosion frequency is expressed in percentage and its average value was calculated from obtained data.

The classification into three groups referring to the market index was done through examination of the caudal fin: (A) there are not visible changes of the profile in comparison with the perfect caudal fin, except for some small cracks that are common in plants of cultivation ; (B) moderate erosion associated with the shift to the general profile (erosion to the edges of the rays) and (C) large erosion with bleeding edge or damaged (the fish is not sold as whole).

3. Results and Discussion

3. 1. The condition factor (K) and the specific growth index (SGR)

The average values of condition factor (K) and the specific growth index (SGR), of the trouts of the three groups are presented in figure 1.

Higher values of both indexes result when the trout received feeds from Demand Feeder. The lower level of these indexes is obtained in the control group where the feed is distributed by hand. These differences are small between two experimental groups. There are not significative differences between the average values of this indicator of experimental groups and control one.

The values of ΔWkg, or biomass gain, in the three groups were ; 13. 23kg (control group); 14. 74kg (Demand feeder group); 14. 27kg (Beld Feeder group). There were not significant statistical differences between experimental groups and control one of both average values of K and SGR ($P \leq 0. 95$). T-test values for average K and SGR between Demand feeder group and control one resulted respectively 0. 83 and 0. 31 ($P \leq 0. 95$). In the case of comparisons between Beld feeder group and control one the corresponding t-test values for K and SGR resulted t=0. 66 (P≤0. 95) and t=0. 25 (P≤0. 95).

3. 2 Feed conversation index (FCR)

The values of some performance parameters of the control group trout (hand feeding) and experimental ones (mechanical self-feeders) are presented in Table 1.

There were not significant statistical differences of average values of the daily feed ratio between control group and experimental one where trout were fed by Demand feeder (t = 0. 16; P≤0. 95) as well as between control group and other experimental one, where the trout were fed by Belt Feeder (t = 0. 12; P≤0. 95).

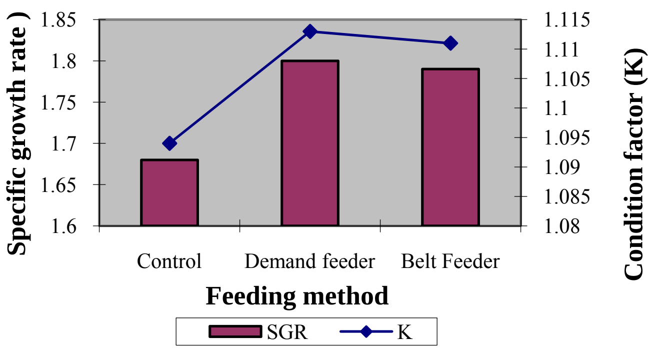

Figure 1. Values of condition factor (K) and specific growth rate (SGR) in three experimental groups of rainbow trout for the period from 15 May to 30 July.

The average values (M±m) of daily feed quantity (g) per fish during the whole experimental period of control, Demand feeder and Belt feeder groups were respectively: 2. 1±0. 202 g, 2. 2±0. 250 g and 2. 28±0. 231 g. There were not statistical differences between average given daily feed quantity between control group and respectively experimental ones (P≤0. 95).

Daily feed quantity and feed conversation ratio (FCR) of each group are presented in Fig. No. 2. Average values of feed conversation ratios were 1. 20±0. 130 for the control group, 1. 11±0. 125 for Demand Feeder group and 1. 18±0. 117 for Belt Feeder group. The feed conversation ratio was lower (0.1 kg feed per 1 kg gained fish) for trout fed by Demand feeder than hand feeding trout.

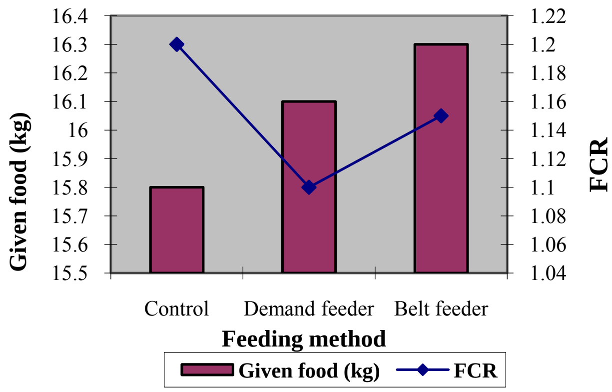

Figure 2. Quantity of giving food (kg) and the values of feed conversion ratio (FCR) in three groups of rainbow trout (*Oncorhynchus mykiss*) feeds by hand and by self-feeders.

Table 1: Some performance data for the three groups of rainbow trout (*Oncorhynchus mykiss*)

Feeding method	*Daily feeding ratio*	*Weight gain (kg) (ΔW = Wf-Wo)*	*Total quantity of giving food (kg)*
Hand feeding	1. 982±0. 178	13. 23	15. 8
Demand feeder	1. 940±0. 172	14. 74	16. 1
Belt feeder	1. 953±0. 175	14. 27	16. 3

3. 3. The results of fins damage as an indicator of trout welfare.

The erosion frequencies of pectoral (P) and dorsal (D) fins are given in Fig. No. 3. The control group had the highest average value of pectoral and dorsal fin erosion respectively 6. 7 % and 9. 2 % of individuals. The frequency of individuals with pectoral and dorsal fin erosion of Demand Feeder group was respectively 4. 0 % and 6. 7 % . In the case of Belt Feeder group the frequency of individuals with pectoral and dorsal fin erosion was 6. 3% and 5. 8%. The frequency of individuals with visible erosion of both fins was rare (4. 5% of analyzing samples).

In total fish samples (90 individuals) from both groups (control and experimental) were noticed 18 individuals (20%) with pectoral fin erosion and 26 individuals (28. 9%) with dorsal fin erosion. In general an increased frequency of fin erosion was noticed by the first sampling up to the third one.

The average of dorsal fin erosion values of both three groups was 4. 2 % in May. In June this figure amounted to 8. 3 % and the highest value 9. 2 % was noticed in July. The same situation was also at the pectoral fin erosion. This phenomena has been more expressed in the control group (a=3. 75; r=0. 98) and slower in experimental groups where the trout used mechanical autofeeder. (a=1. 25; r=0. 89). There were significant differences (P≥0. 95) in the dynamic of fin erosion between the group of trout fed according to the traditional way and the group of trout that received feed from mechanical feeder.

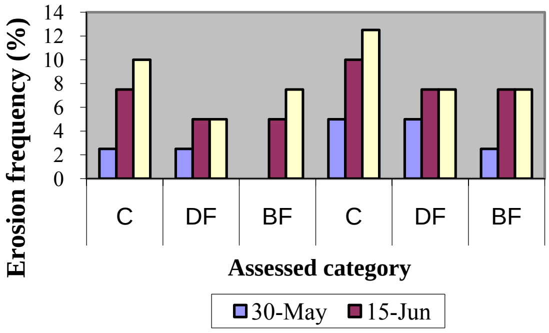

Figure 3. Frequency (%) of pectoral (P) and dorsal (D) fin erosion in rainbow trout (*O. mykiss*) fed under three different feeding practices

The frequency levels of erosion gravity of the pectoral (P) and dorsal (D) fin determined according to Person Le Ruyet J.[27] schemes are presented in Fig. No 4.

In about 55 % of cases the erosion has affected the ends of 3-5 rays of the pectoral fin and the ends of 9-11 rays of dorsal fin (first level of erosion.).

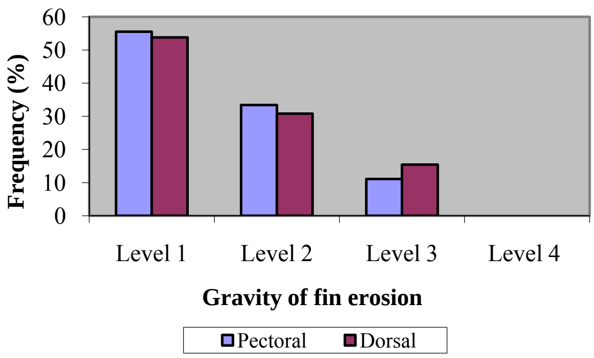

Figure 4: Frequency (%) of different levels of fins damage in pectoral (P) and dorsal (D) fins (%) of the number of individuals that demonstrate fin erosion.

In about 34% of cases the erosion was spread among 3-8 rays of the pectoral fin and 6-11 rays of dorsal fin (second level of erosion). The third level of erosion was found in 11 % of individuals with pectoral fin erosion (the damage lay between 3-11 rays) and in 15% of individuals with dorsal fin erosion (the damage affected the fin between 2-11 rays). There were not found individuals with a fourth level of pectoral and dorsal fin damage.

In no case were found caudal fin erosion classified in C group. About 12. 2 % of fish samples had small cracks in the lateral part of caudal fin. Only 4 individuals (4. 4%) were found with slight erosion in the ends of caudal fin rays, but even in this case the profile of the organ didn't change.

Quantitative estimation of the condition factor (K), specific growth rate (SGR) and feed conversation ratio (FCR) for each rainbow trout group (*Oncorhynchus mykiss* Walbaum) cultivated in different feeding practices during the 77 day period, showed that these performance indicators were characterized by different levels of variability. The variability of these indicators between groups was not in all cases statistically significant. In general the use of mechanical distributors of feed like as Demand Feeder as well as Belt Feeder resulted in higher values of condition factor and specific growth rate and lower values of feed conversation ratios in comparison with traditional way of hand distribution of feed. Similar results are obtained in studies where are analyzed the growth performances and special indicators of effectively feed use of rainbow trout during mechanical or automatically feeding equipments [5, 10, 35, 36, 32, 3]. In the view of Ashley P. J. [7] any feeding practices in addition of uncontrolled cultivation densities and inadequate feed ration result in stress situations that worsen the growth indicators.

The condition factor (K) values were in all cases higher than 1.0 [33], by studying the condition factor of rainbow trout reared in cultivating plants have confirmed that fish is in good condition when condition factor value is higher than 1. 0, and in worst condition when the “K” value is lower than 1. The above author's have calculated an average “K” value (M±σ) 1. 15 ± 0. 111 for female rainbow trout. The obtained values from our study are approximate with.

The average values of the specific growth ratio (SGR) were 1. 80±0. 290 of Demand Feeder group, 1. 79±0. 338 for Belt Feeder group and 1. 68±0. 267 for control one. There were not significant differences between experimental groups and control one of the average values of this indicator.

Different interval values of SGR for Rainbow trout are found in literature. These values are affected by age of individuals analyzed, environment conditions and cultivation practices relating to feeding protocols applied. SGR values that lie in the interval 1. 47÷4. 19 are calculated for rainbow trout fingerlings [22], while values of 0. 40 up to 4. 8 are found in the trout cultivated in fattening plants [28, 3]. SGR value was equal 1. 11 for trout with initial weight 52. 1 g. [2]. This is 35% lower than our values of the trout with the same live weight at the beginning of cultivation. The differences are due to experimental condition of the trout rearing.

The fins condition has been considered as a reference feature of fish life quality. [13, 34, 20, 27]. The caudal fin condition is used to divide the fish according to the quality before selling in farms. .

Relating to fin erosion of rainbow trout, different studies confirm that pectoral and dorsal fin are more sensitive to the cultivation conditions compared with other fins. This fact could be used as a barometer of fish welfare according to Bosakowski Th.[9]; Baldwin L.[8]. Higher values of dorsal fin damage in comparison with other fins are reported by Hernán Alberto Cañon Jones [17], in their study on Atlantic salmon (*Salmo salar*). According above authors restricted feeding affects fin damage.

Different opinions exist regarding the factors causing fin erosion. According to North B. P. [26], the causes of fin damage are unclear. Person-Le [27], confirms that fin abrasion is firstly caused by the contact of fish with each other and with a sharp surface of rearing units. The same authors add that fin damage happens also in cases of con-specific attacks caused by inappropriate feeding procedures specially at high stocking densities.

There is a general opinion which recognizes that partial implementation of cultivation protocols especially in the case of intensive rearing may lead to the development of social stress. In species where aggression is common, social stress can increase competition for food between individuals, accompanied by deteriorating of growth performances and damage to welfare indicators.

4. Conclusions

The feeding practice is an important element of cultivation technology of rainbow trout (*Oncorhynchus mykiss*) that effects on growth performances as well as feed use efficiency and welfare indicators.

Feeding on demand using Demand feeder and Belt feeder resulted in higher values of condition factor (K), specific growth ratio (SGR) as well as lower values of feed conversation ratios (FCR) in trout of the experimental groups in comparison with traditional manual feeding.

Fin condition could be used as a welfare indicator for trout cultivated in intensive rearing units. The fin damage frequency was higher in trout manually feeding. The frequency of pectoral and dorsal fin damage was higher in manually feeding trout than in mechanical feeding trout. Implementing special feeding practices can lead to social stress in cultivated fish resulting in deterioration of their growth.

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