Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 25(4): 741 – 751 (2021)
www.ejabf.journals.ekb.eg

Comparative study of zootechnical parameters between two species of salmonids; *Oncorhynchus aguabonita* and *Oncorhynchus mykiss*

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ARTICLE INFO

Article History:
Received: Apr. 9, 2021
Accepted: July 17, 2021
Online: Aug. 29, 2021

Keywords:
Zootechnical parameters,
Oncorhynchus aguabonita,
Oncorhynchus mykiss
alevin period

ABSTRACT

The main objective of this study is to compare the zootechnical parameters of two species of rainbow trout; *Oncorhynchus aguabonita* (mutant trout) and *Oncorhynchus mykiss* (wild trout) subjected to the same ecological and dietary conditions during the fry phase. The results showed that the alevins of mutant trout have better growth performance compared to the alevins of the wild trout. The average weight gain, average daily growth rate, and food conversion efficiency during the experimental period are 6.67 g, 0.071 g/d, and 0.76, respectively, compared to only 3.47 g, 0.036 g/d, and 0.86 for wild trout. The results obtained during the experimental period are encouraging to give greater importance to the mutant variety *Oncorhynchus aguabonita*, which will contribute to the increased demand for animal protein and essential fatty acid for cardiovascular diseases.

INTRODUCTION

Fish production has increased dramatically in recent decades, from less than 15 million tons in 1990 to about 82.1 million tons of aquatic animals in 2018 (**FAO, 2020**), with a significant average increase estimated at 5.3% between 2001 and 2018. Fish production for human consumption is 54.3 million tons in 2018, which corresponds to approximately 66.2% of total aquaculture animal production. In comparison with the quantities produced by fishing, aquaculture is now more important in the production of fish for human consumption. At the continental level, animal aquaculture production is estimated at 51.3 million tons, which equates to 62.5% of total aquaculture production. Across Africa, aquaculture production increased significantly from 31.4 million tons to 44.3 million tons between 2006 and 2011 (**Djekota, 2020**). Freshwater fish farming far exceeds marine production with widely varying percentages for different species. Rainbow trout (*Oncorhynchus mykiss*), native to the west coast of North America (**Fuller *et al*., 1999; Quinn, 2005**) and to Russia (Quinn, 2005), is currently considered among the highest species due to its adaptive plasticity on a global scale, due to its robustness relative strength, its tolerance to a wide range of water qualities and temperatures, and

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also as a fish too desirable for recreational fishing (**Crowl *et al,* 1992; Matthews *et al.* 2005; Casal, 2006; Le François *et al.* 2010; Abba *et al* 2012**). Golden rainbow trout (*Oncorhynchus aguabonita*) (**Jordan, 1892 in GBIF Secretariat, 2019**), near rainbow trout, yellow-orange (Fig 1), originates in California where they breed in rivers (Fig.2). It is an albino variety derived by mutation of the wild-type (*Oncorhynchus mykiss*) (**Robins, 1991**).

In intensive fish farming, the golden Trout did not experience the same fate as the wild strain (*Oncorhynchus mykiss*) for unknown reasons. It is in this context that we have presented ourselves to contribute to the study of biological parameters during the early stages of its development cycle in intensive livestock farming and to compare its performance against the high wild species under the same ecological conditions and fed by the same artificial feed at the salmoniculture station of the National Center for Hydrobiology and Pisciculture in Morocco.

Figure. 1. Native distribution of golden trout (*Oncorhynchus aguabonita*; black stipple) and countries, states, or provinces into which this species has been introduced (red stipple); sources for native distribution (**Behnke 1992**)

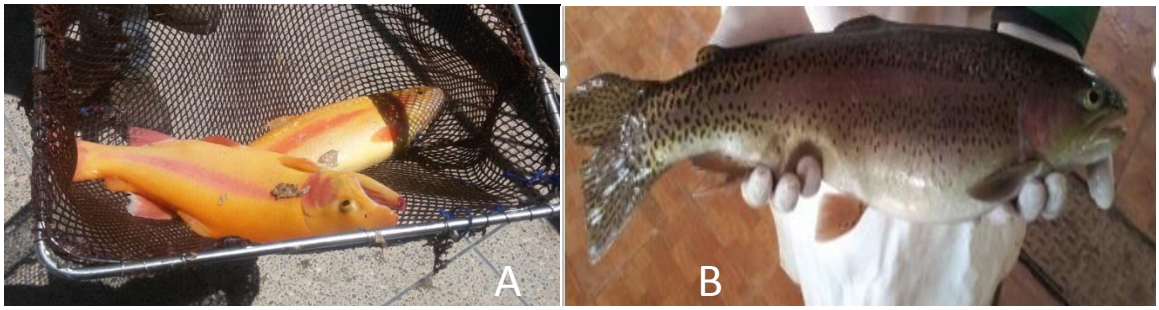

Figure.2. *Oncorhynchus aguabonita* (A) and *Oncorhynchus mykiss* (B)

MATERIALS AND METHODS

1. Presentation of Study area

The experiment was carried out in a nursery room of the National Center for Hydrobiology and Fish- Culture in Morocco, during a 94-day period that constitutes the nursery period. Fry are reared in parallel rectangular pools fed by spring water with a flow rate of 0.97 m3/h at the inlet and 1.0 m3/h at the outlet. Water quality parameters are measured daily (pH, dissolved oxygen, Temperature) with handheld devices.

2. biological Materials

Experimentations were conducted on the fry of wild trout (*Oncorhynchus mykiss*) and those of the mutant species (*Oncorhynchus aguabonita*) from egg hatching during the same period. Alevins of the two varieties were distributed in 4 rectangular basins with 500 alevins per basins (A1, A2, B1, and B2). A1 and A2 contain alevins of the *Oncorhynchus aguabonita*, and B1 and B2 contain alevins of the *Oncorhynchus mykiss*. Each day, fry receives a quantity of industrial feed (Table 1) that vary according to their average weight and water temperature. food ration is distributed in the form of 4 meals per day with variable amounts (Table 2) between 9 a.m. and 4 p.m. during the entire test period. The hygiene of the basins is ensured daily by the technique of siphoning by pipes and brushes for waste disposal and food losses. Preventive weekly treatments are used during the experimentation period with formalin 37%,

Each week 15ml of formalin is poured into each basin after the water has been stopped and the oxygen diffusers have been activated to ensure oxygenation of the basins

Table. 1: percentage of fry rationing per day

Ration rate	**Food distribution period per day**
30%	Morning
20%	Noon
20%	Afternoon
30%	Evening

3. Growth parameters

In this study, we compare the effect of a single food type on the length and weight growth performance of fry from both trout varieties. Length and weight measurements are carried out each week on a random sample consisting of 33 fries per trough during the entire experimental period. After anaesthesia, fry size and weight are determined by an ichthyometer and an electronic balance (type: Statorius: QS16000B) with the precision of 1g. These two parameters (size and weight) are important for any estimation of biomass and fish production (**Mouneimne, 1998; Abba *et al*., 2013; Dahak *et al*., 2017**).

Table. 2: Composition of the distributed feed

Feed composition	Quantity
Crude protein (%)	44
CrudLipide(%)	22
Ashes (%)	6
Fibers (%)	2.2
Phosphorus total (%)	0.6
Vit A (UI/kg)	5000
Vit D3 (UI/kg)	1000
Vit C (mg/kg)	100
Vit E (mg/kg)	180

4. Zootechnical parameters

The zootechnical parameters of the two varieties were assessed during the study period from the different formulae according to several authors (Table 3).

Table.3 *:* Determined zootechnical parameters

Parameters	Formula	Authors
Average weight gain (AWG: g)	AWG= Final weight–initial weight	**Gaubier, 1975; Abba *et al.*, 2017**
Daily individual growth (DIG: g/day)	Average weight gain / Breeding time in days	**IGA-IGA,2008; Bamba, 2008; Berday, 2007; Abba *et al.*, 2017**
Conversion Index CI	CI = Amount of dry food ingested / Body gain corporal	**IGA-IGA, 2008; Aba, 2013; Abba *et al* 2017**
Rate Survival RS %	RS (%) = (Final number of fish / Initial number of fish) x 100	**Gaubier, 1975, Abba *et a., l* 2017**
Condition factor K (K Factor)	K= (W/L^3) 100; W: weight (g) and L: (length: mm)	**Fulton, 1902; Tesch, 1971 Gaubier, 1975 ; Lalèyè *et al.*, 1995 ; Abba *et al., 2*010**

RESULTS AND DISCUSSION

1.Water quality in livestock basins

The water physicochemical parameters were recorded in the livestock basin during the experiment period (94 days) to ensure optimal living conditions for fishes. The temperature was between 13 and 14°C. The dissolved oxygen mean value was 9,01 mg/L, and the mean pH was 7.

The results obtained are corroborated with those determined by (**Abba, 2011**) and meet the requirements of salmonid farming (**Abba *et al.*, 2011; Dahak *et al.*, 2017; M S F.W 2002**).

2. Growth and relationship between size and weight

The graphical representations (figures 3, 4) show the evolution of size and weight of alevins of *Oncorhynchus aguabonita* and *Oncorhynchus mykiss* during the experimentation period. Weight and size growth are the essential parameters in fish aquaculture production, this parameter informs on the feed quality distributed during the period of experimentation. After 14 weeks of feeding, the average final weight of Oncorhynchus aguabonita alevins during the experimentation period is 17,5 g, against only 6,67g for alevins of Oncorhynchus mykiss, Correlation coefficients r2 are very important for the two varieties and reach 0.98 and 0.97, the average size final is respectively 11,14 and 8,44mm with a standard deviation 1,91. According to the results (tables 4,5 and figures 3,4), growth is very important especially after 8 weeks given as the standard deviation is close to 1 and reaches 7 at the end of experimentation. Compared to linear growth, the results show that the fry of the mutant trout (golden) has a good linear growth performance, as the size of the fry has increased from 4.575mm to 11.44 mm during the experimental period. This difference in growth may be explained by higher ingestion and better food efficiency in the fry of mutant trout compared to fry of *Oncorhynchus mykiss*.

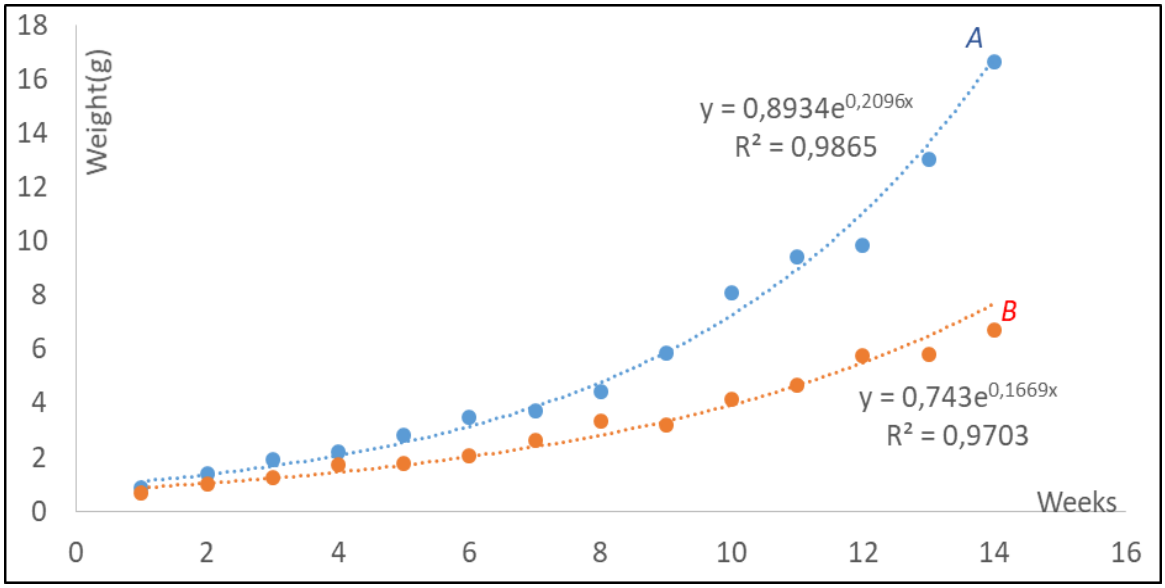

Figure. 3. Evolution of weight growth during the experimental period
(A: *Oncorhynchus aguabonita;* B*: Oncorhynchus mykiss*)

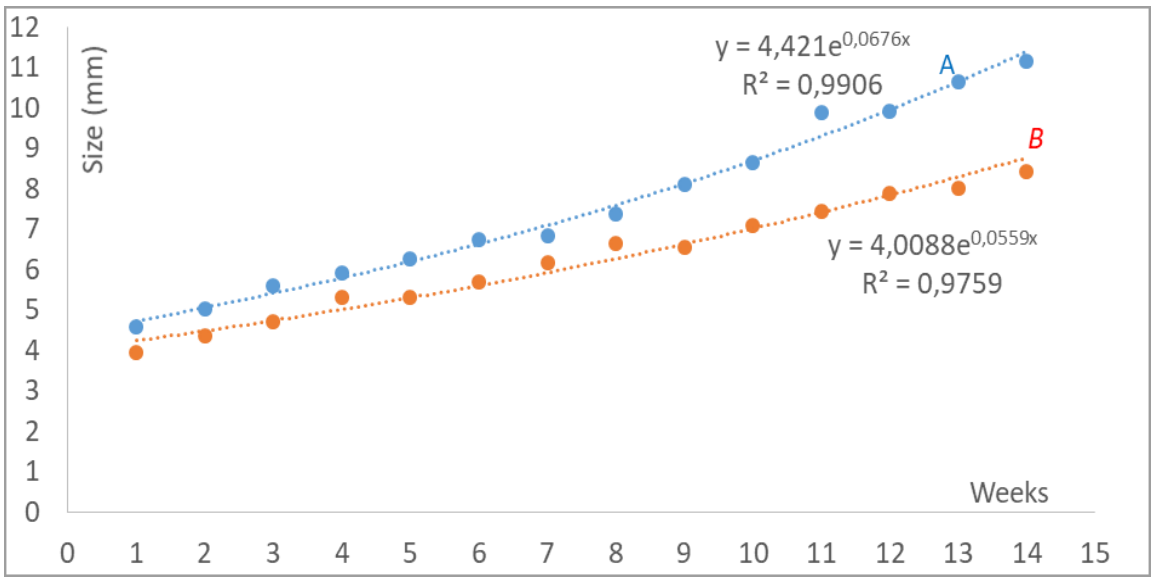

Figure. 4. Evolution of growth in length during the period of experimentation (A: *Oncorhynchus aguabonita;* B*: Oncorhynchus mykiss*)

Table 4. Effective, average size and weight of alevins of *Oncorhynchus aguabonita* (A1 A2) *and Oncorhynchus mykiss* (B1, B2)

Weeks	Average weight (g) A1+A2/2	Average weight (g) B1+B2/2	Standard **d**eviation
1	0,85	0,66	0,13435029
2	1,37	0,995	0,26516504
3	1,97	1,26	0,50204581
4	2,195	1,74	0,32173359
5	2,765	1,76	0,71064232
6	3,53	2,075	1,02884037
7	3,675	2,625	0,74246212
8	4,685	3,34	0,95105862
9	5,87	3,19	1,89504617
10	7,52	4,135	2,39355645
11	9,76	4,645	3,61685119
12	10,215	5,77	3,14308964
13	13,17	5,83	5,19016377
14	17,05	6,69	7,32562625

3 Zootechnical parameters

The experimental test shows that the performance of zootechnical parameters varies significantly between the two varieties of rainbow trout (Table 6). With an average weight gain of 6.67 g in 94 days, individual daily growth of 0.071g/day, and a specific growth rate of 2.31% /day, the mutant (golden) TAC fry showed better growth performance compared to the wild (normal) TAC fry with parameters of only 3.47g for average weight gain, 0.036 g/day for individual daily growth and 1.95 %/day for specific growth rate.

Table. 5. Average weight of alevins of *Oncorhynchus aguabonita* (A1 A2) *and Oncorhynchus mykiss* (B1, B2)

Weeks	Number of fries				Average length (mm)				Average weight (g)			
	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2
1	500	500	500	500	4,60	4,55	3,95	3,95	0,84	0,86	0,67	0,65
2	500	500	500	500	4,87	5,16	4,45	4,28	1,37	1,37	1,10	0,89
3	500	499	499	500	5,77	5,45	4,75	4,67	2,05	1,89	1,35	1,17
4	500	499	496	499	5,89	5,96	5,32	5,33	2,20	2,19	1,85	1,63
5	499	498	496	499	6,32	6,24	5,23	5,40	2,72	2,81	1,83	1,69
6	499	498	496	498	6,75	6,75	5,75	5,63	3,58	3,48	2,11	2,04
7	499	497	496	498	6,64	7,00	6,04	6,28	3,65	3,70	2,42	2,83
8	498	496	496	495	7,39	7,37	6,67	6,62	4,93	4,44	3,39	3,29
9	496	495	489	485	8,06	8,12	6,51	6,56	5,86	5,88	3,32	3,06
10	496	493	486	481	8,48	8,79	6,95	7,23	6,95	8,09	3,92	4,35
11	490	491	481	476	10,06	9,68	7,23	7,67	10,11	9,41	4,18	5,11
12	490	490	478	470	10,01	9,84	7,86	7,90	10,60	9,83	5,79	5,75
13	485	487	473	454	10,56	10,72	7,97	8,04	13,31	13,03	5,94	5,72
14	481	481	459	438	11,03	11,25	8,53	8,34	17,46	16,64	6,90	6,48

At the end of the experiment, taking into account the biomass produced and the total amount of feed distributed, the feed conversion ratio of each pond was calculated. It is 1.29 and 0.85 for mutant and wild TAC fry, respectively. The Conversion Index (CI= Amount of dry food ingested / Body gain corporal) of mutant TAC (CI= 0.79) is better compared to that of wild trout (CI= 0.86). The survival rate between the two varieties was 96.2% for Oncorhynchus aguabonita, against only 89% for Oncorhynchus mykiss with a standard deviation of 5.1.

For the condition factor k, which is influenced by several parameters, the values obtained are greater than 1 for both varieties of trout. This value of K higher than 1, shows that the common trout studied adapts well to its habitat and that the conditions of the environment including the distributed food are favorable to the development of the alevins of the two varieties (**Abba, 2012, Farid, *et al*., 2017; Nazeef *and al*. 2018**).

Table.6. Zootechnical parameters used during experimentation period

Index	A1+A2/2	B1+B2/2	Standard deviation
Initial weight(g)	0,85	0,66	0,13435029
Finalweight(g)	17,05	6,69	7,32562625
Initial total biomass (Kg)	0,425	0,330	0,06717514
Final total biomass (Kg)	8,20	2,98	3,6910974
Weight Gain(g)	16,2	6,03	7,19127596
Daily individual growth (DIG) (g/j)	0,174	0,064	0,07778175
Specific growth rate (SGR) (% /j)	3,19	2,46	0,51618795
Consumption Index (CI)	0,79	0,86	0,04949747
Survival rate (%)	96,2	89,0	5,09116882
Condition factor K	1,09	1,13	0,02828427

CONCLUSION

The comparison of zootechnical parameters between two varieties of rainbow trout *Oncorhynchus aguabonita* and *Oncorhynchus mykiss* under the same ecological conditions and fed with the same type of feed during the 94-day rearing phase. The results obtained clearly show that the fry of the mutant trout provided better growth

performance compared to the fry of the wild trout. The highest values of final average weight, average daily growth, and feed conversion efficiency were obtained with *Oncorhynchus aguabonita* fry. From a perspective, a study should be done for the other growth stages to conclude the growth of *Oncorhynchus aguabonita.*

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