# Comparative Study on Fish Health Indices of Rainbow Trout (*Oncorhynchus mykiss*) Reared in Two Sites in Sulaimani Governorate, North of Iraq

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**Abstract**: This study was carried out to investigate some biological parameters related to fish health of rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792), reared in two sites (Sangasar and Penjwen) of Sulaimani governorate (North of Iraq). Both ponds were used to rear rainbow trout due to their coldwater supply. Sangasar ponds are channel shaped (raceway), with an average depth of 3.5 m from north to south direction. They were fed with river's water flowing directly from the mountains with high dissolved oxygen (DO) contents. Fishes in Sangasar ponds were manually fed. Penjwen ponds are rhombic in shape, with 2.5 m depth from north to south direction. They used special fountain as a source of DO and were directly fed with river water. Fishes in Penjwen ponds were also manually fed. Results showed that values of the condition factor of trout reared in Sangasar ponds were better than those in Penjwen ponds without significant differences; hepatosomatic index (HSI) in Sangasar ponds was slightly higher than those in Penjwen ponds but with no significant differences. Fishes sampled from Penjwen were all males while those from Sangasar ponds were females. Fish health indices were monitored and discussed as an indicator for rainbow trout welfare. Those include changes in colour, ventilation rate and swimming behavior patterns.

Keywords: Fish health, Rainbow trout, Sulaimani governorate, Iraq.

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## INTRODUCTION

Fishes of the family Salmonidae are one of the most valuable fishes in the world which include 70 species. They are mostly found in streams and cold lakes of North America and Eurasia. A large portion of sport and commercial fishery are focused on such fishes. Trouts and salmons are the most compatible species with cold water of the northern hemisphere (Fornshell, 2002). The trout is conventionally related to cold water production, although the range of comfortable temperature for its growth is quite broad. Optimal temperatures for rainbow trout are in the range from 9 to 18 °C. Fishes feed and grow at water temperatures of 4 to 20 °C is most optimal. The endemic species of trout in Iran is *Salmo trouta fario*, but by introducing the rainbow trout to Iran, farming of this species started in 1960 in Karaj farming yard (Adeli & Baghaei, 2013). Trout culture in Iran has been the source of trout reared in Sulaimani Governorate.

In the past, trout farming capacity in Iran was around 120 tons. In Jajroud trout farm, the capacity was 180 tons in 1966 and in Fars Yegandasht farm, the capacity was 300 tons in 1977. Nowadays, by governmental support and private investments, the farming area has been expanded and the integrated fish farming area including Palangan and Sirvan in Kurdistan. Gamasyab in Hamedan and also personal farming yards in Fars province and Haraz riverside in Mazandaran province has reached 230 hectare for trout farming. Since the beginning of trout culture, the activity has had great achievements with the involvement of private farming in race ways. This industry is being practiced also by other systems such as integrated fish farming, multipurpose water pool reservoirs, paddy fields, recirculating systems, earthen ponds and closed areas such as canals, cages and pen culture (Adeli & Baghaei, 2013).

Referring to people's tendency and awareness of fish nutrition, the request for fish consumption has been increased, especially for trout. So, by investment in this field and by using modern techniques in fish production, the industry can cover the local market needs. On the other hand, by considering the potential of production of farmed rainbow trout, one can go toward export to reach the level of world standards (Attia et al., 2011; Adeli & Baghaei, 2013).

Successful fish production depends on good oxygen management. Oxygen is essential to fish survival (respiration), to sustain healthy fishes and to meet the biochemical oxygen demand (BOD) within culture system (Dmitry, 2013). Dissolved oxygen levels can affect fish

respiration, as well as ammonia and nitrite toxicity. When the oxygen level is maintained near saturation or even at slightly super saturation at all times, it will increase growth rates, reduce the food conversion ratio and increase overall fish production.
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It has to be recognized that welfare is difficult to define and to measure; a useful definition can be that one suggested by Spruijt et al. (2001) "the balance between positive (reward, satisfaction) and negative (stress, aversion) expressions". The state of this balance may range from positive (good welfare) to negative (bad welfare). So, welfare of farmed fishes depends on to what extent fishes can adapt to the rearing conditions and find them rewarding (Spruijt et al., 2001).

In Sulaimani, trout rearing started in 2006, but to our knowledge there are no data about their production. So, the present study was proposed to be the first one to provide scientific recorded data about trout production characteristics in Kurdistan. Most of the cold water fish farming areas in Sulaimani are concentrated adjacent to Sangasar and Penjwen to cultivate trout in ponds and agricultural reservoirs in autumn and winter with high levels of DO. Evaluation of fish welfare in these two sites of Sulaimani governorate is being the purpose of this study. In this regards, few indices such as condition factor, hepatosomatic index, gonadosomatic index and spleenosomatic index, in addition to other behavioral and health indices were studied and discussed.

## MATERIALS AND METHODS

### Description of Ponds:

Description details of Penjwen and Sangasar ponds are shown in Table (1).

### Fish Samples:

Fish samples collected from both sites were measured for weight (gm) and total length (cm) and were then examined for health signs. The weight and length of the investigated fishes ranged between 863.6-1727.3 gm and 39-50 cm, respectively as explained in Table (2). Fishes were then killed by a blow on the head and the abdominal cavity was soon opened to remove the liver, gonads and spleen to be weighed separately at once.

**Measured Indices**:

Hepatosomatoic index (HSI) was calculated as liver percentage to the whole fish weight by using the following equation:

HSI = {Liver weight (gm)/ Fish weight (gm)} × 100

Gonadosomatic index (GSI) was calculated as gonad percentage to the whole fish weight by using the following equation:

GSI = {Gonad weight (gm)/ Fish weight (gm)} × 100

Spleenosomatic index (SSI) was calculated as spleen percentage to the whole fish weight by using the following equation:

SSI = {Spleen weight (gm)/ Fish weight (gm)} × 100

Table 1: Characteristics of Penjwen and Sangasar ponds.

| Characteristics | Penjwen ponds | Sangasar ponds |
|---|---|---|
| Shape | Rhombic | Raceway (channel) shape |
| Depth | 2.5 m | 3.5 m |
| Direction | North- south | North- south |
| Source of water | Directly river water | Directly river water |
| Source of DO | Fountain | Running water |
| Feeding method | Manual | Manual |

Table 2: Weights and lengths of fishes used in the present study.

| Sangasar fishes | | Penjwen fishes | |
|---|---|---|---|
| Weight (gm) | Length (cm) | Weight (gm) | Length (cm) |
| 1090.9 | 43.0 | 1511.3 | 50.0 |
| 1000.0 | 45.0 | 1363.6 | 49.0 |
| 1318.2 | 44.0 | 1295.4 | 45.0 |
| 909.1 | 39.0 | 1250.0 | 48.0 |
| 1000.0 | 43.5 | 1727.3 | 47.5 |
| 863.6 | 40.0 | 1159. 1 | 47.0 |
| 1000.0 | 43.5 | 1318. 2 | 49.5 |
| 1090.9 | 46.0 | 1363.6 | 48.0 |
| 1363.6 | 45.0 | 1318. 2 | 45.0 |
| 863.6 | 40.0 | 1318. 2 | 48.0 |

**Statistical Analysis**:

Statistical analysis was performed by using the analysis of variance (ANOVA) and Duncan's multiple range tests to determine differences between means at 0.05 probability rates. The standard errors of treatment were also estimated. All statistics were carried out by using a statistical analysis program (SPSS).

## RESULTS AND DISCUSSION

The present results showed that the recorded temperature in Penjwen was between 6-12 °C against 10-15 °C in Sangasar ponds. The ranges of temperature recorded in both sites were within the ranges which have previously reported as suitable for rainbow trout (Fornshell, 2002). However, the magnitude of any effect depends mainly on the intensity of fish production, waste dispersion by currents and the environmental carrying capacity to assimilate any organic loading (Dmitry, 2013). Growth rate, feed intake and feed efficiency ratio of juvenile Atlantic salmon smolts were significantly influenced by temperature and fish size, overall growth rate was highest at 14 °C (1.53%/day). However, at 10 °C and 18 °C, growth rates were equal or only slightly lower during the later stages of the experiment, while fishes at 6 °C showed significantly lower overall growth rate (Handeland et al., 2008).

The present study indicated that trout reared in Sangasar with high stoking density had lower growth rates as compared to those in Penjwen ponds, but without any significant differences (as illustrated in Table 3). These findings agree with McKenzie et al. (2012) who found that, at a water temperature of 14 °C, high stocking density reduced growth rate in rainbow trout because fishes dissipated more energy as metabolism and fishes at high density had poor swimming performance, indicating a physiological impairment.

The data illustrated in Table (3) showed that the condition factor of rainbow trout reared in Sangasar was better than those in Penjwen ponds numerically without significance. These values agree with those reported by Barnham & Baxter (2003) for trout where 1.60 was considered as "excellent" condition, 1.40 as "good" well-proportioned fish and 1.20 as fair fish. The condition factor quantitatively allows us to compare the condition of individual fish within a population, individual fish from different populations, and two or more populations from different localities, and may also be used as an index of the productivity of water. This study revealed a relationship between weight and length independent variation in constituent body weights within the samples, when variation due to length was accounted for, variation in fat weight was not strongly reflected by variation in dry weight. Morphometric indices are frequently used to estimate fish condition under the assumption that changes in body weight track changes in physiological condition (Sutton et al., 2000).

Table 3: Values of condition factor, hepatosomatic index and spleenosomatic index in Sangasar and Penjwen fish ponds.

| Indices | Sangasar ponds | Penjwen ponds |
|---|---|---|
| Condition factor | 1.330[a] | 1.262[a] |
| Hepatosomatic index | 1.466[a] | 1.261[a] |
| Spleenosomatic index | 0.118[b] | 0.345[a] |

Data of Table (3) showed that HSI in Sangasar ponds was numerically higher than those in Penjwen ponds, but without significant difference. Tibbetts et al. (2005) found that cultured haddock *Melanogrammus aeglefinus* with enlarged livers have lower somatic tissue growth (as a percentage of whole body weight) than fishes with smaller livers, so minimizing the HSI which is of economic importance. Poli et al. (2005) indicated that high stocking density produced a reduction in liver weight and hence in HSI. The reduction of HSI by high stocking density has been described for rainbow trout and for brook trout *Salvelinus fontinalis*. This reduction seems to be related to higher hepatic lipid utilization, associated with an increased lipid mobilization.

From data of splenosomatic index (Table 3), it was obvious that SSI in Penjwen ponds was significantly higher than those in Sangasar ponds ($p<0.05$). The spleen is a major storage organ for blood cells and is known to contract in teleost fish during acute stress. Hemre et al. (2005) illustrated that spleen was the only organ, besides the distal intestine, that varied in size in Atlantic salmon *Salmo salar* between three nutritional treatments. The size of the spleen recorded in their study was, however, within the normal ranges given for healthy salmonids.

Results observed in Table (4) showed GSI values for fishes collected from Sangasar ponds which were all females. Values varied between 0.13-9.12 reflecting different stages of sexual maturity. Fishes sampled from Penjwen, however, were all males with small gonads which were not easy to be measured.

Table 4: Gonadosomatic index values of fishes sampled from Sangasar ponds.

| Sangasar ponds | Penjwen ponds |
|---|---|
| 9.12 | All samples were males. |
| 0.68 | |
| 5.67 | |
| 0.13 | |
| 1.33 | |

Notes concerning fish health indices including swimming behavior, colour, ventilation rate, condition, growth, morphological abnormalities, injuries and disease status are all described and discussed in Table (5).

Table 5: The direct observations of fish health indices in Penjwen and Sangasar ponds.

| Index | Observations |
|---|---|
| Changes in colour | Stress-induced changes in skin or eye colour (which have a complex neural and hormonal background) have been reported in a number of fish in Sangasar ponds, but not in Penjwen ponds. This could be a sign of exposure to adverse events. |
| Ventilation rate | A high oxygen demand is reflected by rapid irrigation of the gills and high ventilation rate in fishes of Sangasar ponds. This, together with a visual assessment of gill status, is used as a sign of incipient problems in fishes of Sangasar ponds, but not in Penjwen ponds. |
| Swimming and general behavior | Fishes may respond to unfavorable conditions by changing swimming speed and space used. Abnormal swimming has been used as a sign of poor welfare in farmed fishes in Sangasar ponds. Behavioral responses to adverse conditions (or lack of responsiveness to specific stimuli) are signs of both general and specific trouble. These include excessive activity or immobility, body positions that protect injured fins, escape attempts and rubbing to dislodge ectoparasites and fungal infections. All these were not observed in Penjwen ponds. |
| Condition | Fishes change shape and/or lose weight for many reasons, but because reduced feeding and mobilization of reserves are secondary stress responses, where body shape can be assessed by eye (for example by the visibility of the vertebrae), loss of condition can indicate possibly impaired welfare in Sangasar ponds only. |
| Growth | Growth rates in fishes are flexible and naturally variable. In Sangasar ponds, an estimate of expected prolonged growth and low rates of growth are noticed, which may be an indication of chronic stress. |

| | |
|---|---|
| Morphological abnormalities | Because adverse conditions can interfere with normal development, the occurrence of morphological abnormalities can be used as an indicator of poor rearing conditions, although whether this represents a problem for fish welfare depends on the degree of sentience of the stock concerned as seen in fishes of Sangasar ponds. |
| Injury and fin damage | Injury may be a direct consequence of an adverse event, in which case, a high frequency of such injuries is a sign of poor welfare. Dorsal fin injury in salmonids is often caused by attacks from conspecifics and scales that are dislodged with blood visible rather than lying flat are a sign of poor welfare in fishes. In addition, because immune responses can be suppressed by cortisol, slow recovery from injury (or a high incidence of injury) may be a sign of generally poor conditions. As well as acute damage, healed injuries may result in long-term abnormalities (e.g. in salmon healed fin, injuries may cause permanently short fins). All these were obviously observed in Sangasar pond fishes. |
| Disease status | Since the causes of most aquatic diseases are complex and dependent on environmental conditions, the presence of disease can indicate an underlying problem with the environment or management. However, interpreting the welfare implications of an observed disease requires a detailed understanding of the natural history of the disease such as fungal and bacterial infections that observed in fishes of Sangasar ponds. |

According to the present data, it can be conclude that coldwater rainbow trout has a good performance in regards to welfare aspects parameters in Penjwen as compared to those reared in Sangasar and all these proved that the limited factor for rainbow trout well-being is the DO concentration. Due to the absent of any scientific information about rainbow trout rearing in Kurdistan especially in Sulaimani, more studies and details are badly required to cover all aspects of rainbow trout rearing in Kurdistan.

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