Studies on Gonadosomatic Index and Hepatosomatic Index of Female Rainbow Trout Found in Laribal Hatchery, Dachigam

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Abstract

The expansion of trout culture in Kashmir valley has a significant scope and this goal can be achieved by maintaining healthy brood stock, developing artificial feed with high nutritive value and by prevention and control of various diseases. The reproductive biology of rainbow trout (*Oncorhynchus mykiss)* kept in captivity at Laribal hatchery, Dachigam National park, Jammu and Kashmir was studied from February 2018 to March 2019. This study aims to illustrate gonadosomatic and hepatosomatic indices and to correlate them with different phases of gonadal development. The ovary and liver samples were taken and were weighed for estimation of GSI and HSI. The maximum gonadosomatic index (12.33 ± 1.04%) and minimum hepatosomatic index (0.82 ± 0.08%) were observed in January, indicating that December- February was the peak spawning period for rainbow trout. It was also observed that June-August was the growing/ immature phase, September-November was the developing phase, December- February was the spawning phase and March-May was the post-spawning phase.

Keywords: Histology, gonads, oocytes, *Oncorhynchus mykiss,* biochemical composition

Introduction

Fish is one of the most essential sources of animal protein and has been generally recognized as a healthy source of protein. The physio-chemical characteristics of J&K waters, especially in the Kashmir Valley, are helpful and useful for trout fish. There are only two species of trout, brown trout (*Salmo trutta fario*) and rainbow trout (*Oncorhynchus mykiss)*. Rainbow trout are known as the most delicious, tasty as well as are considered as highly nutritious fish (Bista *et al.*, 2008). The trout varieties of Kashmir are under severe threat of being wiped out from diverse water bodies because of extensive fishing and exploitation of their habitat. Consequently, it becomes more vital to investigate these species regarding breeding biology, and the same can be achieved by understanding the changes in gonado-somatic index and hepato-somatic index. According to Arruda *et al.*, 1993, the reproductive season of fish can be estimated by observing fluctuations in gonadosomatic index (GSI). GSI value has been considered by many workers in different fishes for determining spawning season and spawning frequency (Islam *et al.*, 2008; Ghaffari *et al.*, 2011; Sadekarpawar and Parikh, 2013 and Jan *et al.*, 2014). The study of HSI is also considered imperative by many workers because the liver produces vitellogenin (yolk precursor) which plays a significant role in the maturation of oocytes and is considered as a good indicator of stored energy and feeding activity of the fish (Tyler and Dunns, 1976). So keeping these facts in view, the present study has been designed to generate the data regarding gonado-somatic index and hepato-somatic index with respect to change in reproductive parameters of farmed female rainbow trout *Oncorhynchus mykiss*, so as to establish it as a potential culturable species and to implement fisheries management measures. The aim of this study is to contribute valuable information on the reproductive biology of *Oncorhynchus mykiss* which will be fruitful for the proper management of same species.

Material and method

Study area

Specimens of female brooders of rainbow trout were collected from Laribal hatchery, Dachigam, Srinagar. The place and species were selected on the basis of its availability, popularity, local's first choice, and above all its significant share in the local fish food market.

Collection of specimens and sampling

The grown-up specimens of female rainbow trout within a range of length (24.20-39.80 cm) and weight (200-943g) were collected from Laribal trout hatchery, Dachigam which is 18.5 km away from University of Kashmir. The specimens were collected on second week of every month from February 2018 to March 2019; 8 female rainbow trout were sampled. The total length, total weight, morphological characters and phases of maturity stages were recorded for each specimen and then gonads and liver samples were weighed for recording their gonadosomatic indices as formulated by *Dias et al.,* (2005) and hepatosomatic indices formulated by Rajaguru (1992) and both were calculated as a percentage weight of ovary and liver to their total body weight.

Gonado-somatic and hepato-somatic index

All the female fishes were dissected, gutted, washed and filleted. The samples of muscle, ovary and liver was collected and weighed. The gonado- somatic index (GSI) and hepato-somatic indices (HSI) was calculated as the percentage of gonad or liver respectively to total body weight. Abbreviated as GSI, the Gonado-somatic Index calculates the gonadal weight as a proportion of the overall body weight.

The formula represents it:

GSI = [Total ovary weight/ total body weight] x 100

It is a method to measure animal sexual maturity in relation to the growth of ovaries.

The HSI is classified as the ratio of liver weight to the body weight. It shows the state of an animal's energy reserve. It can be used to access the animal's health status as it decreases with unfavourable environmental requirements.

HSI = [Total liver weight/ total body weight] x 100

Results

On the basis of changes in gonadosomatic index, hepatosomatic index and morpho-histological characteristics of oogenetic cells, the reproductive cycle was divided into four different phases which include:- immature phase, developing phase, spawning phase and post-spawning phase (**Table 1**).

Changes in gonado-somatic and hepato-somatic indices with respect to four different gonadal phase

Immature Phase (June to August)

In this phase slight percentage increment of mean gonadosomatic index was perceived (3.22 ± 0.40%). The mean hepatosomatic index value calculated was (2.49 ± 0.20%). In this phase, the average gonadosomatic index increased to 3.22 ± 0.40% and the calculated value of hepatosomatic index was 2.49 ± 0.20%.

Developing Phase (September to November)

For the duration of developing phase (September- November), the mean gonadosomatic index gradually amplified from (3.22 ± 0.40%) to (8.13 ± 0.61%) However, the mean hepatosomatic index attained maximum value (1.76 ± 0.25%).

Spawning phase (December to February)

Throughout spawning phase ovaries were full of mature follicles and thus the mean gonadosomatic index attained maximum value (12.33 ±1.04%). In contrast to that, during spawning phase, the significant decrease in hepatosomatic index was observed (0.82 ± 0.08%).

Post-spawning phase (March to May)

During this phase the follicles full of yolk were reabsorbed. The mean gonadosomatic index was calculated as (2.12 ± 0.13%). The mean hepatosomatic index was found to be (1.74± 0.10%).

Table 1: Comparison of GSI and HSI of ovary and liver in female rainbow trout with respect to four different reproductive phases

Phase	Month	Sample Size (n)	Weight (g)	Length (cm	Ovary Weight (g)	GSI	Liver weight (g)	HSI
Immature phase	Jun-Aug	34	337.37[a] ± 12.67	28.69[a] ± 0.48	10.32[a] ± 1.17	3.22[a] ± 0.40	8.31[a] ± 0.70	2.49[a] ± 0.20
Developing phase	Sep-Nov	27	363.51[a] ± 10.39	31.06[b] ± 0.38	30.09[b] ± 2.78	8.13[b] ± 0.61	6.30[b] ± 0.88	1.76[b] ± 0.25
Spawning Phase	Dec-Feb	18	547.92[b] ± 26.40	35.15[c] ± 0.84	68.25[c] ± 6.60	12.33[c] ± 1.04	4.56[cb] ± 0.58	0.82[c] ± 0.08
Post- spawning	Mar-May	19	468.15[c] ± 40.55	33.20[d] ± 0.68	9.53[a] ± 0.72	2.12[a] ± 0.133	7.90[ab] ± 0.81	1.74[b] ± 0.10

The values shown are the mean ± standard deviation of triplicates. Values in the same columns with different superscripts differ significantly (*$P < 0.05$*). [The superscript a, b, c & d on mean values of different phases signifies that the mean values differ significantly ($p < 0.05$) while as same alphabetical superscript signifies that the mean values of two phases are non-significant ($p > 0.05$)to each other]

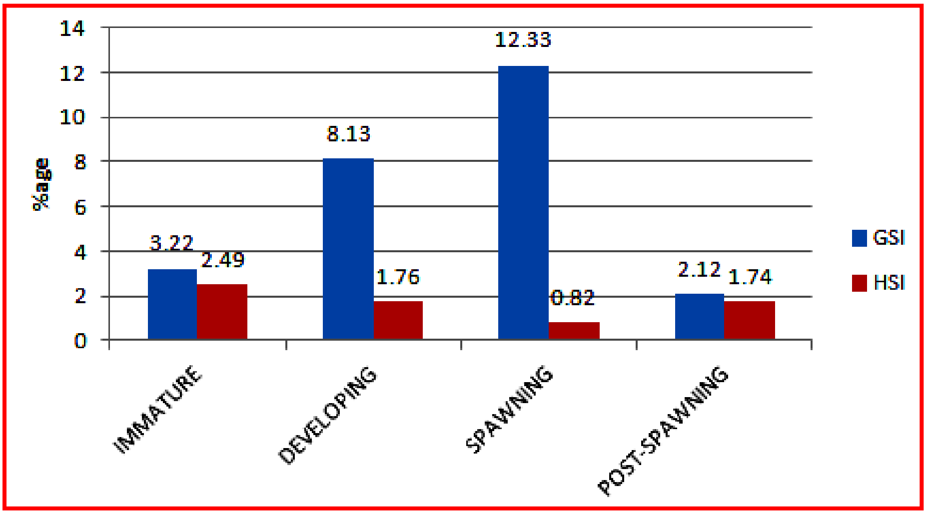

Figure 1: Graph depicting corresponding change in GSI and HSI with respect to different developmental stages

Discussion

The reproductive condition of rainbow trout was accessed by calculating the gonadosomatic (GSI) and hepatosomatic (HSI) indices (**Figure 1**). Changes in the gonadosomatic index assist in determining the reproductive season by calculating the spawning season and spawning frequency of fish (Jan *et al.,* 2014). In rainbow trout, the low gonadosomatic indices were detected during the immature phase of reproduction (June to August) and the post-spawning phase (March to May). The significant decrease in the gonadosomatic Index from March onwards was due to the expulsion or reabsorption of mature oocytes. However, due to the slow accumulation of yolk granules, the gonadosomatic index increased slightly from November to February indicating the spawning period and the maximum GSI value was found in January pointing out maximum gonadal growth. The maximum value of GSI corresponds to the maximum spawning period. Thus, it verifies the close relationship between the two. Similarly, the study of the hepatosomatic index is also considered imperative by many researchers, because the liver produces vitellogenin (yolk precursor) which plays a significant role in the maturation of oocytes and is also a well-thought-out indicator of the amount of energy stored (Tyler and Dunns, 1976). The value of hepatosomatic index was lowest in the early spawning phase (December) possibly due to the transportation and accumulation of diverse nutrients and the yolk precursor (vitellogenin) from the liver to mature oocytes. The hepatosomatic index increased steadily during the growth phase and then reached its maximum value at the beginning of the developing phase (September). According to Christensen *et al.,* 1999, , hepatic metabolism increases due to the production of vitellogenin, that ultimately leads to an increase in the hepatosomatic index, possibly due to an increase in the size of the liver. Thus, this study confirms the inverse relationship between gonadosomatic index and hepatosomatic index, which means that the peak of the gonadosomatic index corresponds to the lowest value of the hepatosomatic index. This condition led to the assumption that vitellogenin mobilization and increased gonadal weight due to vitellogenin transport from the liver during gonadal maturation, resulted in liver weight loss (Zin *et al.,* 2011). The ANOVA test revealed that the female rainbow trout showed significant weight change $(P < 0.05)$ in the ovary and liver during the four different phases of reproduction. However multiple comparisons by post hoc tests reveal significant mean GSI values $(P < 0.05)$ between different phases but the comparison between the immature phase and the post-spawning phase illustrated in-significant mean GSI values $(P = 0.18)$. Similarly, post-hoc tests applied on mean HSI values illustrate significant values ($P < 0.05$) between different phases but the comparison between developing phase and post-spawning phase exemplify in-significant mean HSI values $(P = 0.95)$.

Conclusion

The present study contributes valuable knowledge in the field of fisheries for their proper management by providing the information about breeding biology of female rainbow trout.

Acknowledgement

The authors acknowledge and express sincere thanks and deep sense of appreciation to all faculty members of the Centre of Research and Development, University of Kashmir and to all my colleagues for their constant support and their cheerful company. The departmental fellowship granted to the PhD program of the first author is gratefully acknowledged.

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