Acta Scientific MICROBIOLOGY (ISSN: 2581-3226)

Volume 6 Issue 7 July 2023

Research Article

Physical Analysis of the Milt in Cultured and Wild Stocks of Scale carp, *Cyprinus carpio* var. *communis*

Ishrat Mohd, Farooz A Bhat*, Tasaduq H Shah and Asifa Wali

Department of Fisheries, SKUAST, India

***Corresponding Author:** Farooz A Bhat, Department of Fisheries, SKUAST, India.

DOI: 10.31080/ASMI.2023.06.1272

Received: May 25, 2023

Published: June 20, 2023

Abstract

The present study was conducted to compare the physical parameters of seminal plasma between the cultured and wild stocks of scale carp (*Cyprinus carpio* var. *communis*) during the year 2019-2020. The following physical spermatological parameters in wild conditions were found out: Mean sperm volume 2.393 ± 1.64 ml, mean sperm motility 75.038 ± 10.162%, mean movement duration 50.367 ± 13.92 sec, mean sperm density 3.534 ± .272 10^9/ml and mean pH 8.29 ± .494 whereas in farmed condition, the mean sperm volume were 1.486 ± 0.88 ml, mean sperm motility 68.9 ± 12.46%, mean movement duration 44.66 ± 13.48s, mean sperm density 3.84 ± 0.18110^9/ml, and mean pH 8.5 ± 0.311. Significantly higher sperm volume and motility percentage were found in the wild ($P < 0.05$) as compared to farmed fishes, whereas significantly higher sperm density was found in the farmed fishes ($P < 0.01$) as compared to wild fishes. It can be concluded that the sperms of wild fishes were of better quality than the sperms of farmed fishes.

Keywords: *Cyprinus carpio* var. *communis*; Sperm Motility; Wild; Farmed

Introduction

Cyprinus carpio var. *communis,* are widely cultivated around the world in tropical, subtropical, and temperate climates because of their outstanding ability to tolerate a wide range of climatic conditions. It is considered to be a completely domesticated fish and is one of the most frequently farmed fish in the world. *C. carpio* made up roughly 69.13% of the entire capture by weight in the Dal lake of Kashmir, making it the most dominating fish both in terms of population and weight [41]. According to [41] of the two fish species that live in the lake, *C.c. communis* has contributed 59.2% and *C.c. specularis* has made up 9.11% of the total capture by weight. According to [42] *C.c. communis* made up the majority of the catch from the Dal lake. Due to exploitation and contamination of water resources as well as declining catch fisheries, Kashmir's native species, particularly the Scale carp, are under extreme stress [37,38]. The lake has also seen a decline in the fecundity of *Cyprinus carpio var. communis* [40,46,47]. More consideration should be given to the opportunities presented by efficient fish aquaculture methods due to the decline in brood stock captures and, as a result, a shortage of gametes (sperm and eggs). To encourage artificial fertilisation as a means of fish species reproduction, several trials have been carried out. The most crucial element in improving the effectiveness of artificial fertilisation is the selection of high-quality sperm.

Despite the fact that the sperm quality of male brood stock affects the production of healthy larvae, the quality of eggs is prioritised in the fish farming industry. An important method for assessing the reproductive capacity of a species is milt quality evaluation in fish reproduction [24,25]. Sperm quality is a critical factor in aquaculture management because it determines the percentage of eggs fertilised and hence the number of viable larvae produced from a particular brood stock.

In fish farms, gamete management is important to achieve high fertilization [7]. Basic knowledge for managing fertilization can be provided by studying sperm physiology [2]. It is essential to have sufficient understanding of the physical and chemical features of the milt to assess the reproductive capacity of farmed fish in order to achieve controlled and successful production in aquaculture systems [45]. Fertilisation is a crucial step in achieving better productivity in aquaculture. No single predictive parameter exists to evaluate the mill quality. To predict sperm quality and fertility, we could establish a consistent picture of the sperm quality by evaluating its physical characteristics collectively. The analysis of sperm samples is crucial for identifying males with improved reproductive performance and for tracking the ideal parameters for brood stock rearing in two separate settings [44]. Spermatocrit, sperm density, osmolarity and pH of seminal plasma, chemical composition of seminal plasma, enzymatic activity, adenosine triphosphate (ATP) concentration, motility, morphology and ultrastructure, fertilising capacity, and several other biomarkers of sperm quality have all been documented [5,14,15,18]. Sperm motility and sperm density determine the fertilization capability of spermatozoa and are often used to estimate the semen quality [6,17,20,32]. To ascertain the reproductive capacity of fish species, sufficient understanding about the physical features of milt is required. In order to effectively "pinpoint" and appropriately assess elements that have a negative impact on fish semen quality qualities, physical aspects of semen must be taken into account. As a result, our primary goals were to contrast the physical semen indices of wild and domesticated brood stock.

Materials and Methods

Two groups of male brood stocks of Scale carp were taken for experiment: Group A (n = 30, TW = 293 ± 270.84), the cultured fishes: these brooders were reared under captivity conditions in the hatchery of Faculty of Fisheries and Pandach fish farm (J&K state Govt. owned farm). Group B (n = 30, 462.5 ± 393.06) the wild fish: these brooders were captured from the Dal Lake during the spawning season.

Milt collection

For use as semen donors, 30 mature wild and 30 farmed male brooders were chosen at random. One time only, every male was stripped, and the whole amount of expressible milt was collected by gently pressing the abdomen. Directly into clean 15 ml graded centrifuge tubes were used to collect the semen. Semen was carefully protected from contamination by water, urine, blood, or faeces. The tubes were covered and sent directly to the lab for analysis on ice (4°C).

Estimation of physical parameters

- **Sperm motility:** Motility was calculated as a percentage of motile spermatozoa using a 40X light microscope (Olympus CX31). An activating solution containing 0.3 percent NaCl was used to measure the motility. For assessing semen motility, 10 µl of semen and 100 µl of activation solution were combined on a glass microscope slide [21].
- **Volume and pH:** The milt was collected in a 15 ml graduated centrifuge tube to compute the volume, and the pH was measured using a digital pH metre (pH ep® Hanna instruments, Italy).
- **Spermatozoa density**: At a magnification of 40 X, sperm was diluted in Hayem solution (5g Na_2SO_4, 1g NaCl, 0.5g $HgCl_2$, and 200 ml double distilled water) at a ratio of 1:1000, and For each fish, the average spermatozoa count was calculated from three replicate samples. A haemocytometer counting chamber (Gem Industrial Corporation, Noida, India) was used to measure the spermatozoa density. On a haemocytometer slide (depth 0.1 mm) with a cover slip, a droplet of diluted milt was counted using light microscopy. After three to five minutes (to allow for sperm sedimentation), the quantity of spermatozoa was counted [27].

Results

Physical parameters

Biology of scale carp and summary of brood size sperm in wild and farmed conditions was determined as sperm volume (ml),motility (%), density ($\times 10^9$/ml) and pH (Table 1 and Table 2). The mean values and standard deviation of the physical parameters of the milt of *Cyprinus carpio* var. *communis* in wild and farmed conditions is presented in Table 3 and Figures1-5 In case of wild conditions, sperm volume, motility rate, duration, sperm density and pH were 2.393 ± 1.64 ml, 75.038 ± 10.162 percent, 50.367 ± 13.92 sec, 3.53 ± 0.272 $\times 10^9$/ml and 8.29 ± 0.494 respectively. Further, in case of farmed condition mean ± std of sperm volume,

motility rate, duration, sperm density and pH were 1.486 ± 0.88, 68.9 ± 12.46, 44.66 ± 13.48 sec, 3.84 ± 0.181×10^9 and 8.5 ± 0.311 respectively. Statistical analysis revealed non significant difference in motility duration and pH between the two environments. The level of sperm volume, and motility % between the two ecotypes of the fish were significantly ($P < 0.05$) different. The wild fish was having higher sperm volume and motility percentage than that of farmed fish. In addition, the Sperm density in the cultured population was significantly higher ($P < 0.01$) than that in the wild type.

Parameter	Range	Mean	Standard error
Length (mm)	200-422	311.1	14.08
Weight (gm)	133-1350	462.5	71.76
Sperm volume (ml)	0.3-5.6	2.39	0.29
Motility (%)	61.2-94	75.03	1.85
Motility duration (seconds)	20-85	50.36	2.54
Sperm density (×10^9/ml)	3.16-3.98	3.53	0.04
pH	7.2-8.9	8.29	0.09

Table 1: Summary of brood size and sperm biology of Scale carp in wild conditions.

Parameter	Range	Mean	Standard error
Length (mm)	190-420	254.1	11.72
Weight (gm)	90-1180	293.1	49.44
Sperm volume (ml)	0.1-3	1.48	0.17
Motility %	44-89	68.9	2.27
Motility duration (sec)	20-69	44.66	2.46
Sperm density (×10^9 ml)	3.27-4.21	3.84	0.03
pH	7.9-8.9	8.5	0.05

Table 2: Summary of brood size and sperm biology of Scale carp in farmed conditions.

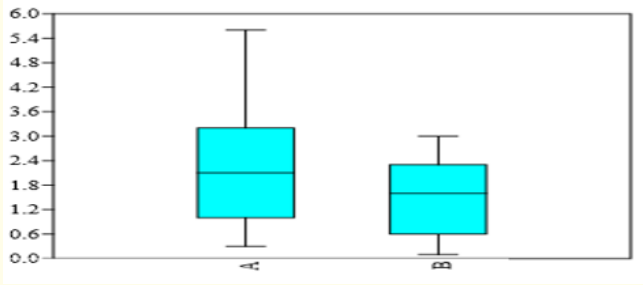

Figure 1: Sperm volume of Wild (A) and Farmed (B) Scale carp.

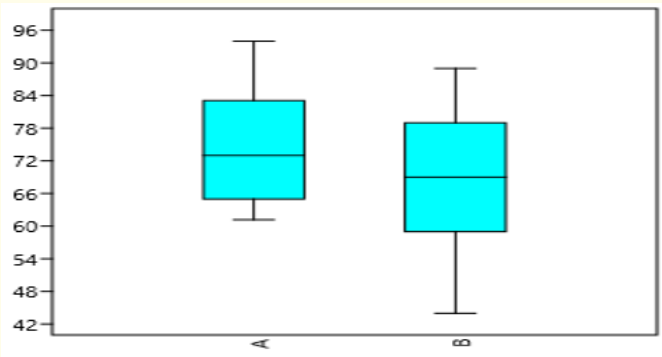

Figure 2: Motility % Wild (A) and Farmed (B) Scale carp.

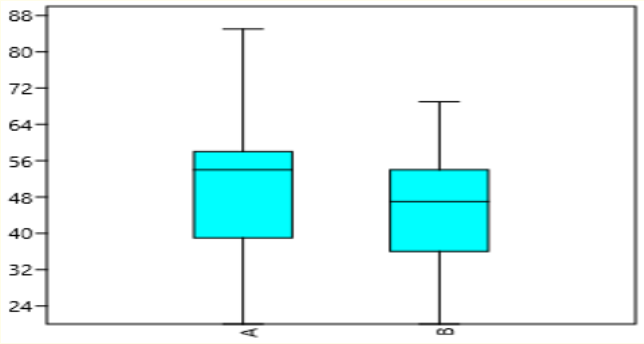

Figure 3: Motility duration of Wild (A) and Farmed Scale carp (B).

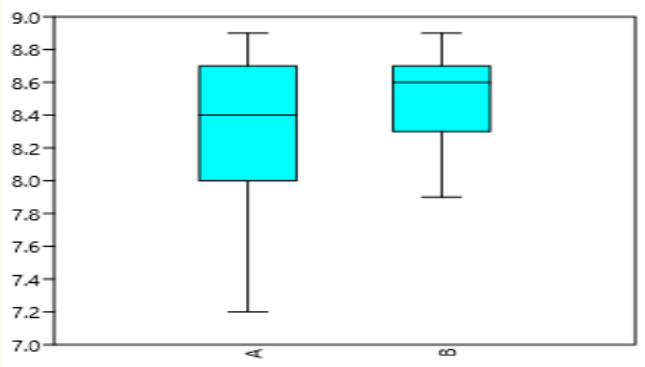

Figure 5: pH of Wild (A) Farmed Scale carp (B).

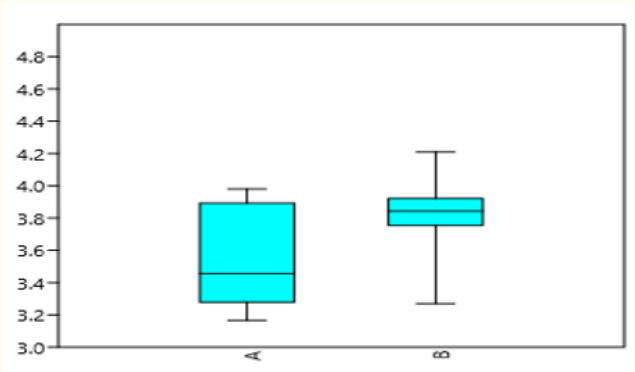

Figure 4: Sperm density (A) Wild and Farmed (B) Scale carp.

Parameters	Mean ± std (Wild)	Mean ± std (Farmed)	t value	P value
Sperm volume (ml)	2.393 ± 1.64	1.486 ± 0.88	2.625	<0.05
Motility (%)	75.038 ± 10.162	68.9 ± 12.46	2.0899	<0.05
Duration (sec)	50.367 ± 13.92	44.66 ± 13.48	1.61	>0.05
Sperm density ($\times 10^9$/ml)	3.534 ± .272	3.84 ± 0.181	-5.148	<0.01
Ph	8.29 ± .494	8.5 ± 0.311	-1.905	>0.05

Table 3: Statistical analysis of physical parameters of the milt of *Cyprinus carpio* var. *communis* in wild and farmed conditions.

Discussion

In the present study, the differences in semen quality of wild and farmed Scale carp were examined. The present results showed higher sperm volume, motility% and duration of wild compared to cultured fish. Mean sperm volume was higher in wild brooder (2.393 ± 1.64 ml) than in farmed individual (1.486 ± 0.88 ml).

Comparison of wild Scale carp with farmed fishes reveals the significant difference in sperm volume ($P < 0.05$). Mean sperm volume in farmed and wild fish was found similar with the finding of [4] that recorded the sperm volume ranged from 1-9 ml. Mean seminal volume was also similar with the results reported by [23] they reported the sperm volume of Scale carp as 2 ml during the spawning season. [8] also reported the volume of milt in scaly carp as 2.75 ml. [36] also reported the volume of milt in the *Cyprinus carpio* as 1.83 to 1.98 ml. Higher sperm volume of wild fish than farmed has also been reported by [16]. [22] reported the cultured Caspian brown trout produced higher milt volume which is contrary to the present results. It is likely that cultured males of Scale carp with the application of an efficient osmoregulation, excrete the excess water of the body in response to hypotonicity of freshwater environment as reported by [22] in Caspian brown trout while studying the milt quality in the cultured and wild stocks on comparative basis. It is essential to say that the weight of wild males was higher than cultured individuals during the present study. [32,33] have reported that milt volume increases with increase of weight in Turbot (*Scophthalmus maximus*). Thus the higher weight of wild fish seems to be one of the reason for the higher milt volume of wild males than cultured fishes. The sperm volume has also been found higher in wild European flounder (0.7 ml; 29) than in cultured ones (0.2 ml; 3). [12] has found a low sperm quality and volume of stocked animals.

An important factor that determines the sperm quality is the sperm density [32] (Suquet., *et al*. 1992). It is important for the fertilization of spermatozoa [1,26]. In the present study, the average sperm density of 3.534 ± 0.27 $x10^9$ mL^{-1} in wild and 3.8415×10^9 ± 0.18 ml^{-l} in farm was recorded for the fish which are in conformity with the results of [10] for grass carp (2.87-33.914 $x10^9$ mL^{-1} in). [13] have reported the sperm density of $6.6x10^9$ sperm cells/ml in *C. carpio*. [36] recorded the average sperm density of $2.25x10^9$ sperm cells/ml in *C. carpio* from January to March, 2013. [19] found that the sperm density of *C. carpio* as 0.5 to 1.0×10^{11} cells per mL of milt. Comparison of farmed fish with wild revealed that sperm density of farmed fish was higher than wild individual. Similar results have been reported by [16]. Contrary to the present results [22] reported higher sperm density in wild than farmed fishes. Our results showed that the mean sperm density were higher in cultured males than in wild fish.

Motility is an important parameter to decide the quality of the spermatozoa [35]. Sperm motility is a key factor that determines fertilization success [7]. In the present study, the value of mean motility percentage and mean motility duration in case of wild fish was 75.03% and 50.36 sec respectively and in farmed fish the value was 68.9% and 44.6 sec respectively. Significant difference in motility percent was found between the groups but difference in motility duration was found non significant. [10] reported the mean sperm motility as 63.18 ± 7.1% and mean motility duration was found 56.81 ± 20.3 sec for Scale carp. [9] reported that motility percentage ranges from 70-95% and duration ranges from 35-117 sec in Grass carp. These results are in conformity with the present results for both farmed and wild fish. From the present study mean sperm/motility and mean motility duration were higher in wild brooder than in farmed individual. Similar results have been reported by [16]. [30] reported the wild males of Cod had higher sperm velocity, percentages of motile and progressive cells than their farmed counterparts. However many workers reported no difference in sperm motility between wild and cultured brooders [3,28,29]. Wild males with higher motility rate may be due to higher secretion of spermatic duct epithelium compared to the farmed ones. It is likely that with lower seminal fluid secretion by spermatic duct epithelium in farmed fishes, the quantity of materials involved in sperm motility decreases as well. This seems to be one of the reason for lower sperm motility rate in farmed Scale carp.

One of the sperm-activating factors in aquatic animals is a change in the external medium's pH [31]. In both of the fish conditions, the pH of the milt was found to be alkaline. Between wild and farmed fish, no discernible pH change was found. The pH of wild fish was 8.20.49 while that of farmed fish was 8.560.3 in the current study. The pH of the milt recorded in the present study is in the conformity with [10] who reported that pH of the milt of Scale carp from 6.9-9.2. [39] recorded pH of 7.8 ± 0.07 in catla, 7.3 ± 0.06 in rohu, 7.9 ± in mrigal, 8.1 ± 0.09 in kalbasu, 7.8 ± 0.03 in silver carp, 7.9 ± 0.06 in grass carp.

The social dynamics between cultivated and natural circumstances are different, which may explain the variation in sperm features. High stocking densities are frequently used for fish rearing in ponds. They are dependent on artificial nutrition

and aren't given full exposure to the natural environment. Additionally, they experience physical stress during management rather regularly. While farmed fish are fed a diet of pellets, wild fish subsist on zooplankton and phytoplankton. Pellet diet reportedly has the potential to influence sperm characteristics (Bell., *et al*. 1996). Therefore, as proposed by Skjaeraasen (2009), a lack of social dynamics and differences in nutrition may account for the decreased sperm volume, motility, and longevity in Cod species.

Conclusion

In a successful fish breeding, the quality of sperm is very essential. The present study revealed the higher sperm performance in wild fishes than farmed ones as wild fishes were found with higher sperm volume, motility % and duration but their sperm density was found lower than farmed fishes. The present results suggested that the type of environment has an effect on sperm quality.

Acknowledgements

The authors acknowledge the facilities provided by Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir for carrying out this research work.

Bibliography

1. Aas GH., *et al*. "Evaluation of milt quality of Atlantic salmon". *Aquaculture* 95 (1991): 125-132.

2. Alavi S M H and Cosson J. "Sperm motility and fertilizing ability in the Persian sturgeon (*Acipenser persicus*)". *Aquaculture Research* 36 (2005): 841-850.

3. Aydin I., *et al*. "A study on the spermatological characteristics of hatchery-reared flounder (*Platichthys flesus luscus* Pallas, 1814)". *Journal of Fisheries Sciences.com* 5.4 (2011): 270-278.

4. Belova NV. "The ecological and physiological peculiarities of sperm in pond cyprinids. Communication I. Production and ecological and physiological peculiarities of the sperm of cyprinids". *Journal of Ichthyology* 21 (1981): 90-102.

5. Billard R and Cosson M P. "Some problems related to the assessment of sperm motility in freshwater fish". *Journal of Experimental Zoology* 261 (1992): 122-131.

6. Billard R., *et al*. "Motility of fresh and aged halibut sperm". *Aquatic Living Resources* 6 (1993): 67-75.

7. Billard R., *et al*. "Biology of sperm and artificial reproduction in carp". *Aquaculture* 124 (1995): 95-112.

8. Bozkurt Y. "Relationship between body condition and spermatological properties in scaly carp (*Cyprinus carpio*) semen". *Journal of Animal and Veterinary Advance* 5.5 (2006): 412-414.

9. Bozkurt Y and Ogretmen F. "Sperm quality, egg size, fecundity and their relationships with fertilization rate of grass carp (*Ctenopharyngodon idella*)". *Iranian Journal of Fisheries Sciences* 11.4 (2012): 755-764.

10. Bozkurt Y., *et al*. "Effect of different extenders and storage periods on motility and fertilization success of Grass Carp (*Ctenopharyngoden idella*) sperm during spawning season". *Journal of Agricultural Sciences* 15.3 (2009): 277-284.

11. Bozkurt Y., *et al*. "Relationship between seminal plasma composition and spermatological parameters in scaly carp (*Cyprinus carpio*)". *Journal of Animal and Veterinary Advances* 8 (2009b): 2745-2749.

12. Cabrita E., *et al*. "Characterization of *Senegalese sole*, *Solea senegalensis*, male broodstock in terms of sperm production and quality". *Aquaculture* 261 (2006): 967-975.

13. Chutia I P., *et al*. in: Ponniah A G, P Das, S R Verma (Eds.), Fish genetics and Biodiversity conservation, Nature conservators, Muzaffarnager (1998): 205-213.

14. Ciereszko A and Dabrowski K. "Estimation of sperm density of rainbow trout, whitefish and yellow perch using a sperctrophotometric technique". *Aquaculture* 109 (1993): 367-373.

15. Geffen AJ and J Evans. "Sperm traits and fertilization success of male and sex reversed female rainbow trout". *Aquaculture* 182 (2000): 61-72.

16. Hajirezaee S., *et al*. "Comparative analysis of milt quality and steroid levels in blood and seminal fluid of Persian sturgeon males, *Acipenser persicus* during final maturation induced by hormonal treatment". *Biologia* 66.1 (2011): 160-169.

17. Krol J., *et al*. "Quality of semen and histological analysis of testes in Eurasian perch *Perca luviatilis L*. during a spawning period". *Czech Journal of Animal Science* 5 (2006): 220-226.

18. Lahnsteiner F., *et al*. "Determination of semen quality of the rainbow trout, *Oncorhynchus mykiss*, by sperm motility, seminal plasma parameters, and spermatozoa metabolism". *Aquaculture* 16 (1998): 163-181.

19. Lahnsteiner F., *et al*. "Cryoperservation of spermatozoa in cyprinid fishes". *Theriogenology* 54 (2000): 1477-1498.

20. Linhart O., *et al*. "Cryopreservation of European catfish (*Silurus glanis* L.) spermatozoa". *Aquaculture* 115 (1994): 340-359.

21. Mims S D. "Evaluation of activator solutions, motility duration and short term storage of paddle fish spermatozoa". *Journal of the World Aquaculture Society* 22 (1991): 224-229.

22. Morisawa M., *et al*. "Changes in blood and seminal plasma composition of the mature salmon (*Oncorhynchus keta*) during adaptation to freshwater". *Comparative Biochemistry and Physiology* 64 (1979): 325-329.

23. Nahiduzzaman M., *et al*. "Sperm biology of artificially induced Common carp, *Cyprinus carpio* (Linnaeus, 1758)". *International Journal of Fisheries and Aquatic Studies* 1.6 (2014): 27-31.

24. Najar A M and Qadri MY. "Progesterone levels and ovarian development in *Schizothorax niger* (Heckel)". *Oriented Science* 4 (1999): 31-43.

25. Najar AM., *et al*. "Estradoil 17-βlevels in relationship with various events of ovarian development in *Schizothorax niger* (Heckel)". *Applied Biological Research* 2.1 (2000): 7-13.

26. Poole W R and Dillane M G. "Estimation of sperm concentration of wild and reconditioned trout. *Salmo trutta* L". *Aquaculture Research* 29 (1998): 439-445.

27. Rainis S., *et al*. "Enhancement of spermiation in European sea bass (*Dicentrachus labrax*) at the end of reproductive season using GnRHa implants". *Aquaculture* 219 (2003): 873-890.

28. Rideout RM., *et al*. "Relationship between sperm density, spermatocrit, sperm motility and spawning date in wild and cultured haddock". *Journal of Fish Biology* 65 (2004): 319-332.

29. Sahin T., *et al*. "Sperm Characteristics of Wild European Flounder (*Platichthys flesus luscus*)". *The Israeli Journal of Aquaculture - Bamidgeh*, IJA: 64.2012.796, 5 (2012).

30. Skjaeraasen JE., *et al*. "Sperm characteristics and competitive ability in farmed and wild cod". *Marine Ecology Progress Series* 375 (2009): 219-228.

31. Stoss J. "Fish gamete preservation and spermatozoan physiology". In: Hoar WS, Randall DJ, Donaldson EM, eds. Fish physiology. NewYork: Academic Press; pp. 305-350.

32. Suquet M., *et al*. "Sperm features in turbot (*Scophthalmus maximus*): a comparison with other freshwater and marine fish species". *Aquatic Living Resources* 7 (1994): 283-294.

33. Suquet M., *et al*. "The ageing phenomenon of turbot spermatozoa: effects on morphology, motility and concentration, intracellular ATP content, fertilization, and storage capacities". *Journal of Fish Biol*ogy 52.1 (1998): 31-41.

34. Suquet M., *et al*. "Rapid assessment of sperm quality in Turbut". *Scophtalmus maximus.Aqualulture* 101 (1982): 177-185.

35. Terner C. "Evaluation of salmonid sperm motility for cryopreservation". *Progressive Fish-Culturist* 48: 230-232.

36. Thamizhselvi N and Thirumathal K. "A Study of Interrelationship between Physico-Chemical Characteristics of Water and Spermatological Qualities of *Cyprinus Carpio". International Journal of Fisheries and Aquatic Studies* 4.3 (2016): 621-625.

37. Yousuf AR. "Fisheries Resources of Kashmir". In: Ecology, Environment and Energy (Ed, A.H. Khan and A.K. Pandit). University of Kashmir (1996): 75-120.

38. Bhat F A., *et al*. "Conservation of Schizothoracid *(Schizothorax ecosinus* Heckel) in aquatic environments of Kashmir Himalaya study viz a viz study on its various biological parameters". In: National conference on status and conservation of biodiversity in India with special reference to Himalaya, October 4-5, (2013).

39. Verma DK., *et al*. "Physical and biochemical characteristics of semen and ultrastructure of spermatozoa in six carp species. *Turkish Journal of Fisheries and Aquatic Sciences* 9 (2009): 67-76.

40. Shafi S., *et al*. "Study of fecundity of *Cyprinus carpio* var. *communis". International Journal of Scientific and Research Publications* 2 (2012): 1-5.

41. Shafi S., *et al*. "Catch composition of fishes from Dal lake, Kashmir". *Journal of Research and Development* 5 (2005): 111-114.

42. Sunder S., *et al*. "Fishing methods and fish catch composition of Dal lake, Srinagar (J&K) during 1969-1972". *Inland Fish Society India* 10 (1978): 9-18.

43. Bell MV., *et al*. "Decreased 20:4n-6/20:5n-3 ratio in sperm from cultured sea bass, *Dicentrarchus labrax*, brood stock compared with wild fish". *Aquaculture* 144 (1996): 189-199.

44. Mohamad I Bhat., *et al*. "Physical and biochemical analysis of seminal plasma of common carp (*Cyprinus carpio* var. *communis* Linneus, 1758) under captive aquaculture conditions of Kashmir". *SKUAST Journal of Research* 21.1 (2019): 27-32.

45. Ishrat Mohd., *et al*. "Relationships Between Seminal Plasma Composition And Sperm Quality Parameters Of The Scale Carp In Kashmir : With Emphasis On Sperm Motility". *Journal of Experimental Zoology India* 24.1 (2020): 337-341.

46. Ishrat Mohamad., *et al*. "Assessment of Fecundity and Its Relation with Body Parameters of Common Carp, [*Cyprinus carpio (var.) communis*] in DalLake, Kashmir". *Agricultural Science Digestion* (2021).

47. Ishrat Mohamad, ., *et al*. "Relationship among body weight, body length, ovary weight and the fecundity of *Cyprinus carpio* Var. *communis* in Kashmir Himalaya". *Journal of Pharmacognosy and Phytochemistry* 7.6 (2018): 2018-2020.