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INTRODUCTION

In addition to agriculture, aquaculture is an important sector for providing the better nutrition for human population. Because it provides essential proteins and vitamins. In addition to this fish is also an important source of essential fatty acids. Of this Omega 3 fatty acid is essential polyunsaturated fatty acids (PUFA) which is mainly found in marine fishes. When compared to marine fishes freshwater fishes does not possess sufficient amount of Omega 3 fatty acids. The present study aimed to improve this essential fatty acid content in fresh water fish, Cyprinus carpio (Common carp), which in turn can be used to improve the human health. Fish is most widely accepted as a nutrient-rich food source because it is palatable, tender, and of high nutritive value. The nutrients derived from fish include vitamins, calcium, phosphorus and unsaturated fat. These nutrients when provided naturally or artificially in aquaculture enable the fish to grow adequately for the enhancement of health in humans [1]. When fishes are cultured in artificial environment, additional nutrients need to be supplied in the form of supplementary diet [2]. To meet animal protein needs in developing countries, increased efforts are being made to develop aquaculture on an intensive scale [3]. Generally, Lipids of marine fish species contain more highly unsaturated fatty acids with higher n-3/n-6 ratio than the freshwater fish species [8]. The main source of Omega 3 fatty acids are marine fishes such as salmon, tuna, mackerel etc. The availability of these marine fishes in non-coastal regions is uncommon.

ABSTRACT

The main aim of this present study is to improve the fatty acid content in freshwater fish Cyprinus carpio by means of providing manufactured feed. Four experimental diets were prepared with the use of vegetable proteins and different grades of fish oil (0%, 2.5%, 5%, 7.5%) respectively. Diet I considered as the control feed. After 30 days experimental study, fishes were analysed for fatty acid content. C18:2 *9 found as the primary monounsaturated fatty acid in all groups of experimental fishes. C18:2 *6 is the second high level fatty acid (PUFA) in all groups of fishes. PUFA show marked increase in Group II, III, IV fishes than control fishes. USFA/SFA value is above 0.35 is beneficial. Our study shows values 2.5, 2.3, 1.8 and 2.5 in four groups of fishes respectively. The present study concluded PUFA content improved in fresh water fish, C.carpio by manufactured feed.

Keywords: C.carpio, Fish oil, Manufactured feed, Fatty acid.
Inclusion of fish meal (5%) and fish oil (0.1%) in carp culture is very low [17] and therefore the substitution of fish meal and oil will be considerably easier than for carnivorous aquaculture [18]. It is a general rule that larval and juvenile fish as well as other animals, tend to have a higher requirement for n-3 LC-PUFA than later life stages [16]. The LC-PUFAs -DHA, EPA, and AA play very important physiological roles in fish larvae, although fish as all vertebrates are incapable of their de novo synthesis [16]. Fresh water fish seem to possess sufficient desaturase and elongase capability to produce AA, EPA and DHA from their shorter-chain precursors Linoleic acid (LA; 18:2n-6) and Linolenic acid (LNA; 18; 3n-3) if they are present in the diet [20].

MATERIALS AND METHODS
Preparation of manufactured feed
Manufactured artificial feeds are an important part of modern commercial aquaculture, providing the balanced nutrition needed by farmed fish. In the present study fish feeds are made by mixing together ingredients such as vegetable proteins (Soy flour 15%, Tapioca flour 4%, Maize flour 4%), vitamin, mineral mixture and binding agents such as wheat bran and rice bran. Water is added and the resulting paste is boiled for 10 minutes. Then fish oil is added and mixed well. Then it is extruded through holes in a metal plate. The diameter of the holes set the diameter of the pellets which can range from less than a millimeter to over a centimeter. As the feed is extruded in the form of nodules and it is sun dried to avoid fungal infection. The dried nodules are packed in air tight containers. By this method 4 types of feeds are prepared with different proportions of fish oil such as 0 %, 2.5 %, 5 % and 7.5 % in diet I, diet II, diet III and diet IV respectively. The experimental diets are analysed for fatty acid content as described by [4]. The fatty acid content in experimental feed is shown in Figure 1.

Experimental fish
Cyprinus carpio (Common carp) was selected as an experimental fish. C. carpio belongs to the family cyprinidae, is commonly found fresh water fish. Because of their easy availability, and tolerance to low oxygen levels, C. carpio is mostly preferred rearing fish in pond culture. Fingerlings length from 3 to 5 cm was collected from Tamil Nadu Fisheries Development Corporation, Aliyar, Pollachi and Coimbatore District. Tamil Nadu, India. They were allowed to acclimatization for 2 weeks. Thereafter, they were divided in to 4 groups as I, II, III, IV each group containing 50 fishes. The group I maintained as the control. The duplicate of four groups of fishes fed experimental diet I, II, III, IV respectively. They were fed with 2 gm of manufactured feed daily at 8 a.m. This experiment was carried out for 30 days. After 30 days fish muscle were analysed for fatty acid content by Gas chromatographic analysis [4]. Fatty acid content in muscle of fishes shown in Figure 2.
Figure 3. Fatty acid content in four groups of experimental fishes

**RESULTS**

Feed analysis showed the different composition of fatty acids. There are 11 fatty acids found in the experimental diets. They are shown in the following Figure 1. The composition of fatty acids in four experimental feed found to be varied according to the ingredients used for preparation. Muscles of *C. carpio* found to have saturated fatty acids Myristic acid (C14: 0), Palmitic acid (C16: 0), and Stearic acid (C18: 0) found in *C. carpio* muscles. The principal fatty acid is Palmitic acid (C16: 0) in SFA. Their content are 18.33 %, 21.07 % 24.51 % and 19.85 % in four groups of experimental fishes respectively. Highest level of Palmitic acid (C16: 0) is found in fishes fed with diet III. Stearic acid (C18: 0) was the second highest SFA in experimental fishes (1.58 % - 2.88 %), high level found in fishes fed with diet II. Kalyoncu et al., [10] studied the fatty acid profile in *C. carpio* captured in Ivriz dam lake, Turkey and found Stearic acid (C18: 0) was the second high saturated fatty acid in *C. carpio* muscles and found the same results in *C. carpio* muscles (4.30- 5.66 %). Myristic acid (C14: 0) is the third SFA present in carp. (1.09-2.45 %). In our experiment fishes fed with artificial diet the SFA content is 24.11 %, 26.56 % , 33.01 %, 26.59 % in four groups of experimental fishes respectively. Fatty acid content in muscles of *C. carpio* shown in Figure 2.

**DISCUSSION**

In the present study (MUFA) Oleic acid (C18: 1 *9) is the predominant fatty acid found in the muscles in all groups of experimental fishes. In the case of all freshwater fish, the major fatty acid among MUFA group was Oleic acid (20.7 – 42.7 %) [9]. This is in accordance with the result of Ugoala et al., [18], Kolakowska et al., [13] and Kminova et al., [12]. The content of Oleic acid was significantly higher in carp than in other fish species [9]. Oleic acid (C18:1 *9) 35.83 % is the highest level found in fishes fed with diet I. According to Kalyoncu et al., [10], Oleic acid (C18:1 *9) was identified as a primary monounsaturated fatty acid in the carp for all seasons. The highest level of Oleic acid was found in summer 29.28 % [7]. Kolakowska et al., [13] found similar results in carp. Guler et al., [7] identified Oleic acid as the major fatty acid (15.1-20.3%) in carp. In our study MUFA Oleic acid (29.65% -35.83 %) content improved by providing artificial diet. Palmitoleic acid (C16:1 *9) is another MUFA found in carp muscles (5.36 – 9.05 %). Fishes fed with diet IV contain highest percentage of MUFA (42.23 %). PUFAs (Polyunsaturated fatty acids) n-3 and n-6 fatty acids found in fishes fed artificial diet. N-6 fatty acid include Linoleic acid (C18:2 * 6) and Arachidonic acid (20:4 *6) and N-3 fatty acid include Linolenic acid (C18:3 *3), EPA (C20:5 *3) and DHA (C22:6 *3). The percentage contents of n-6 PUFA in bream and carp were similar (10.5 % and 10.8 % respectively) [9,14]. Ozogul et al., [14] found that n-6 PUFA values in tench (16.8 %) and carp (16.5 %), Greka and Dudek [5] reported n-6 PUFA for carp was 17.09 %. Our present study results showed that 20.86 – 25.89 %. Fishes fed with diet IV contain higher percentage of n-6 PUFA (25.89 %). C18:2 *6 is the second highest level of PUFA found in 4 groups of experimental fishes, (i.e.) 20.91 %, 21.53 %, 20.18 %, 25.24 %, 22.18 % in fishes fed with diet I; diet II, diet III and Diet IV respectively. C18:2 *9 is found high level in fishes fed with diet IV. AA is another PUFA identified (0.36 – 0.68 %) and found high level in fishes fed with diet III. The main fatty acids of n-3 PUFA in muscle lipids of fish were DHA (0.60-0.85 %) and EPA (0.69 – 1.04 %). High content of EPA and DHA was found in carp fed with diet III 1.04 % and 0.85 % respectively. Fishes fed with diet IV contain high PUFAs (28.78 %). N-3 PUFA contents varied from 2.89 – 3.74 %. High levels of n-3 PUFA present in fishes (3.74 %) fed with diet III. There were no significant differences between the four groups of fishes at 0.05 levels. Joanna Lucznska et al., [9] found that...
than 1 in the wild carp and less than 0.5 in the farmed carp.

Sakineh Yeganeh

0.5 and 3.8, whereas with marine fishes it is 4.7-14.4 [7].

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Koalkowska

(Tench) and 0.4 (carp) respectively [9]. According to

accounted for 3.3 (Rainbow trout), 2.6 (Bream), 1.6

and to reduce cancer risk [11]. The ratio of n-3/n-6

prevent coronary heart disease by reducing plasma lipids

dietary n-3/n-6 fatty acid ratio is essential in the diet to help

n-3 PUFA in C. carpio is 4.7%. An increase in the human
dietary n-3/n-6 fatty acid ratio is essential in the diet to help
prevent coronary heart disease by reducing plasma lipids

and to reduce cancer risk [11]. The ratio of n-3/n-6
accounted for 3.3 (Rainbow trout), 2.6 (Bream), 1.6
(Tench) and 0.4 (carp) respectively [9]. According to

References et al., [13] the value in carp was 0.1, whereas

in the case of Rainbow trout the n-3/n-6 ratio was 4.9. The

present study reported the n-3/n-6 ratio 0.11 – 0.18 in four
groups of experimental fishes. A high level of n-6 fatty

acids lowered the n-3/n-6 ratio in summer in S. luciperca

which was the freshwater fish [6]. Our present study

coincides with the above study. The ratio of n-3/n-6 PUFAs

in total lipids of freshwater fishes changes mostly between

0.5 and 3.8, whereas with marine fishes it is 4.7-14.4 [7].

Sakineh Yeganeh et al., [15] reported this ratio was more

than 1 in the wild carp and less than 0.5 in the farmed carp.

CONCLUSION

MUFAs found higher level in all experimental

fishes. C18:1*n*9 is the predominant MUFAs in all groups of

fishes. C18:2 *n*6 (PUFA) was the second higher level of

fatty acid in all groups of fishes. MUFAs and PUFAs found

high level in fishes fed with diet IV. At the same time
group IV fish contain higher n-6 PUFA than other fish
groups whereas n-3 PUFA level increased in group III

fishes. The ratio of unsaturated (USFA) Vs. saturated fatty

acids is of great importance in edible fat. The value of more

than 0.35 is usually believed to be beneficial [12]. In our

study USFA Vs SFA values 2.6, 2.3, 1.7, 2.5 in four groups

of experimental fishes respectively. The present study

revealed the improvement of fatty acid contents in the

muscles of C. carpio fed with artificial diet.

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A Study of Interrelationship between Physico-Chemical Characteristics of Water and Spermatological Qualities of *Cyprinus Carpio*

N. Thamizhselvi and K. Thirimathal

**Abstract**

The main aim of this work was to study the effect of environmental factors on the spermatological characteristics of *C. carpio*. The temperature, pH, alkalinity, total hardness, ammonia and nitrate negatively correlated with all sperm quality parameters of *C. carpio*. But dissolved oxygen exhibit positive relationship with all sperm quality parameters (semen volume, semen pH, duration of sperm motility, motility %, motility score, sperm density, live and dead cell %) of *C. carpio* and showed significant positive relationship with spermatocrit (*r* = 0.994, *P* < 0.05). The water pH showed negative correlation with all sperm quality parameters of *C. Carpio*. Alkalinity showed significant negative correlation with volume of semen (*r* = -0.994) at *P* < 0.05 level. Total hardness exhibit significant negative relationship with duration of motility (*r* = -0.989), % motility (*r* = -0.999), motility score (*r* = -0.989) and live cell percentage (*r* = -0.995) at *P* < 0.05 level. Ammonia showed significant negative relationship at *P* < 0.05 level with spermatocrit. Nitrate exhibit perfect negative correlation with motility score at *P* < 0.01 level and showed significant correlation with live cell percentage at *P* < 0.05 level.

**Keywords**: *C. carpio*, sperm, temperature, Dissolved oxygen, semen pH, sperm motility, alkalinity, hardness.

1. **Introduction**

The global aquaculture production in the world was 90.43 million tons in the year 2012 [31]. According to the report of FAO [16] the food fish production in 2010 was 59.9 million tons and it as increased to 66.63 million tons in 2012. The food demand will be increased in forthcoming years due to population explosion and capture fisheries alone can’t meet this requirement. China holds first place in aquaculture production from 1970 to 2012 and India has the second level next to China [7]. It is important to analyse the factors affecting fish reproduction and enhance the aquaculture production. A perceptive knowledge about gamete biology is very essential for improving aquaculture industry. At the same time evaluating gamete quality is also an important one to increase the reproductive success in aquaculture *C. carpio* is mostly preferred for pond culture for its fast growing and omnivorous feeding habit. *C. carpio* is included as exotic species in India. Seasonal changes greatly influence the spawning behaviour of *C. carpio* [29, 30]. The growth and survival of aquatic organisms are greatly influenced by the physico-chemical characteristics of water. Seasonal changes influence the fish reproduction [32, 33]. The main aim of the present study is to understand the relationship between physico-chemical characteristics of water and sperm qualities of *C. carpio*, this will helpful for successful reproduction and increase in the *C. carpio* population.

2. **Materials and methods**

2.1. **Experimental fish**

The experimental fish *C. carpio* size ranged from 300 ± 50 g collected from Tamil Nadu Fisheries Development Corporation, Aliyar Nagar, Pollachi, Tamil Nadu, India. The fishes were stocked in cultured tanks for 10 days of acclimatization. Then they were divided into two groups of 100 fishes each. These were fed with traditional feed. This experiment was carried out for 90 days. The physico-chemical factors such as temperature, pH, Dissolved oxygen (DO), alkalinity, total hardness, ammonia and nitrate was noted every week of experimental period. Sperm quality parameters were analysed bimonthly.
2.2. Collection of fish milt
Ten mature Common carp males were randomly selected from the stock and were used as semen donors. The semen was collected first week of every month. The fish were not fed 48 hrs prior to the semen collection. Each male was stripped only once and the total amount of expressible milt was collected individually by gently pressing the abdomen. The semen was collected directly into clean and dry glass tubes. Care was taken to avoid the contamination of semen with water, urine, blood or faecal matter. The tubes were covered and immediately transported to the laboratory for analyses.

2.3. Evaluation of water quality parameters
Water temperature was noted by using mercury thermometer and dissolved oxygen was estimated by winkle’s iodometric method. pH was measured by using digital pH meter. Alkalinity and total hardness, ammonia and nitrate were evaluated by APHA [1].

2.4. Evaluation of milt quality
2.4.1. Semen volume and pH
Sperm was sampled into 20 ml calibrated glass tubes and the volume was expressed as ml. Sperm pH was measured using digital pH meter within 30 minutes of sampling.

2.4.2. Spermatozoa motility
Semen sample was collected by abdominal stripping of male fish. Semen was diluted with medium water in ratio of 1: 100. Then 10µl of semen sample was placed on a glass microscopic slide and observed under a light microscope. Duration of spermatozoa motility was noted by using stopwatch. Duration was noted from the time of water dilution and expressed as seconds. Each motility determination was performed in triplicate [2].

2.4.3. Determination of motility score and motility percentage
The motility score was determined arbitrarily on a 0 to 5 point scale [4]. The percentage of motility was determined based on the motility score, 0 denoting 0% motility and 5 denoting 100% motility. Motility percentage was calculated by the percentage of actively moving spermatozoa. Forward moving sperm were considered as motile others considered as non-motile. Observations were made within 2 hrs of semen collection.

2.4.4. Sperm density
Sperm density was determined according to the haemocytometric method [3]. Semen sample was diluted in medium water at a ratio of 1: 100 (semen: medium water). The diluted semen sample (10µl) was placed on the haemocytometer slide (depth 0.1 mm) with a coverslip, the sperm were allowed to settle for 3-5 minutes, then the number of spermatozoa was counted in 16 cells and calculated according to Caille et al [3] using compound microscope (40X), spermatozoa density was expressed as x10⁶ cells/ml. This process was carried out in triplicate.

2.4.5. Spermatoocrit
Spermatoocrit is defined as the percentage volume of white packed cells to the total volume of semen. Measurements were done in triplicate for each sample and the average of three measurements was used in subsequent statistical analysis. Spermatoocrit was measured within 1hr of the semen collection. For spermatoocrit measurement, the volume (length) of semen in capillaries was measured by meter scale in mm and centrifuged for 3min at 1000g [24]. The volume of white packed cells was measured in mm.

\[
\text{Spermatoocrit} = \frac{\text{Volume of white packed cells}}{\text{Total Volume of semen}} \times 100
\]

2.4.6. Live and dead cells
Live and dead sperm cells were counted by using eosin-nigrosin staining method [25]. The live-dead ratio was calculated by counting the number of live cells (without color) and dead cells (pink) using optical microscopy (400X), after combining 1µl of semen with 1µl of eosin-nigrosin.

3. Results
The physico-chemical characteristics of water in the experimental tank showed significant difference during the study period from January to March, 2013 (Table 1). The high temperature of 28°C was observed in March, 2013 compared to January, 2013 (25.5°C) and February, 2013 (26.6°C). The DO content in fish culture tank was high in January, 2013 (6.37) and low level of DO was found in March, 2013. The other physico-chemical characteristics of water included pH, alkalinity, total hardness, ammonia and nitrate was found high in March, 2013 compared to January, 2013 and February, 2013.

The spermatological properties of C. carpio showed significant differences. The sperm quality parameters were high in January 2013 and gradually decreased in February and March, 2013 shown in Table 2. Correlation analysis indicated that physico-chemical characteristics of water in experimental tank (Temperature, pH, alkalinity, total hardness, ammonia and nitrate) showed negative relationship with all sperm quality parameters of experimental fishes (Table 3). Temperature showed significant negative relationship with % motility (r = -0.999), motility score (r = -0.988) and live cell percentage (r = -0.995) at P<0.05 level. The DO showed positive correlation with all sperm quality parameters of C. carpio and showed significant positive relationship with spermatoctrit (r = 0.994, P<0.05). The water pH showed negative correlation with all sperm quality parameters of C. carpio. Alkalinity showed negative relationship with all sperm quality parameters and exhibit significant correlation with volume of semen (-0.994). Total hardness exhibit significant negative relationship with duration of motility (r = -0.989), % motility (r = -0.999), motility score (r = -0.989) and live cell percentage (r = -0.995) at P<0.05 level. Ammonia showed significant negative relationship at P<0.05 level with spermatoctrit (r = -0.992). Nitrate exhibit perfect negative correlation with motility score (r = -1.000, P<0.01) and significant with live cell percentage (r = -0.997) at P<0.05 level.

Table 1: Physico-chemical characteristics of water observed during the experimental period.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>January, 2013</th>
<th>February, 2013</th>
<th>March, 2013</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>25.5</td>
<td>26.6</td>
<td>28</td>
<td>26.68±1.26</td>
</tr>
<tr>
<td>DO</td>
<td>6.37</td>
<td>6.35</td>
<td>5.55</td>
<td>6.09±0.47</td>
</tr>
<tr>
<td>pH</td>
<td>8.47</td>
<td>8.42</td>
<td>8.87</td>
<td>8.59±0.25</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>44.17</td>
<td>54.33</td>
<td>57.5</td>
<td>52±6.96</td>
</tr>
<tr>
<td>Total hardness</td>
<td>36</td>
<td>39.67</td>
<td>44.67</td>
<td>40.11±4.35</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.75</td>
<td>0.75</td>
<td>0.92</td>
<td>0.81±0.1</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.043</td>
<td>0.047</td>
<td>0.05</td>
<td>0.047±0.004</td>
</tr>
</tbody>
</table>

From January to March, 2013 Values are mean ± SD.
4. Discussion

In the present study the physico-chemical characteristics of water in the experimental tank showed significant differences during the period of the study. The *C. carpio* is able to tolerate temperature ranged between 25°C to 35°C. But the optimum temperature required for spawning in *C. carpio* is 18°C to 23°C [8]. The intensity and duration of motility changes during spermiation period and also depends on the species and temperature of the water medium [9]. The temperature observed during the present study ranged from 25.5°C to 28°C. The DO level below 4mg/l reduced the growth rate in lake trout, *Salvelinus namaycush*. The oxygen requirement in rainbow trout *O. mykiss* ranged from 1.0 to 5.0mg/l [10]. Similar reports were observed in the present study DO level ranged from 5.55 to 6.37mg/l. The pH ranged from 5 to 10 is essential for activation of sperm motility in all species of fish especially in *C. carpio* [11]. Similar findings were recorded in the present study that the alkalinity ranged from 44.17ppm to 57.5ppm. The total hardness in the present study was ranged from 36ppm to 44.67ppm. This is agreement with the report of Santhosh and Singh [13]. They observed that 0.1mg/l to 4.0mg/l is the suitable range of nitrate in fish culture tank and the similar reports were recorded in the present study. Bieniarz et al. [14] have reported that nitrate level in water bodies increased by the use of fertilizers in agriculture activities and the combustion of fossil fuels. The *C. carpio* reproduction was greatly affected by such eutrophic pond conditions and lowers the sperm quality. Generally freshwater fishes are more tolerant to ammonia toxicity compared to marine fish. The NH3-N concentrations below 0.05mg/l and Total Ammonia Nitrogen (TAN) below 1.0mg/l should be maintained for long-term exposure of fish [10]. This was supported by the present study the NH3 level ranged between 0.75mg/l to 0.92mg/l.

The sperm quality parameters of *C. carpio* also showed significant differences during the period of this study from January to March, 2013. Bozkurt [15] have reported that the volume of milt in scaly carp was 2.75ml. The volume of milt observed in the present study ranged from 1.83 to 1.98ml. The milt pH is one of the essential factors to induce sperm motility. The milt pH of *Oreochromis* varied from 6.2 to 8.2 [17]. Similar findings were recorded in the present study the pH of milt varied from 7.32 to 8.32. Alkaline pH of 8.0 to 8.2 increased the fertilization success in *O. mykiss* [18]. Sperm motility behaviour used to analyse the semen quality of fishes [19]. The sperm motility duration is significant due to the time required by the sperm to reach the egg for fertilization. Generally externally fertilizing fish species exhibit very brief period of motility duration usually ranged from 30s to 60s. Verma et al. [20] have investigated the motility duration in different species of carp and he reported that mrigal species showed high duration of motility (110s) and short duration of motility noted in silver carp (80s) and catla (85s). This was supported by the present study that the duration of sperm motility was high (127s) in January, 2013 and slowly decreased (113.67s) in February, 2013 and short duration of motility (81.33s) noted in March, 2013. The percentage of motility in grass carp was 77.0±8.89% [26]. But in the present study the percentage of motility in January, 2013 was 53% and it was gradually decreased in February, 2013 (47.67%) and March, 2013 (39.17%). The motility score were recorded in the present study ranged from 2 to 2.67. The motility score observed in *Prochilodus lineatus* varied from 4 to 5 [21]. Sperm density is an important parameter to evaluate the milt quality [28]. Chutia et al. [21] have found out the sperm density of 6.6x10⁸ sperm cells/ml in *C. carpio*. In the present study the average sperm density of 2.25x10⁸ sperm cells/ml was recorded in *C. carpio* during the period of study from January to March, 2013. Tekin et al. [21] have reported that spermatocrit value decreased with increasing age of fish. The spermatocrit value observed in the present study ranged from 53% to 70.83%. The spermatocrit value was higher in January, 2013 and low value noted in March, 2013. Live cell percentage determine the success of animal production [22]. The live cell percentage was high (76.33%) in January, 2013 and low (63.5%) in March, 2013.
5. **Conclusion**

In the present study it was clearly understood that the sperm quality parameters was high in January, 2013 compared to February and March, 2013. Statistical analysis determined the relationship between physico-chemical characteristics of water and sperm qualities of *C. carpio*. The water temperature, pH, alkalinity, total hardness, ammonia and nitrate showed negative correlation with all sperm quality parameters but DO exhibit positive relationship with all sperm quality parameters of *C. carpio*.

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