E-ISSN 2149-0236

Journal of Aquaculture Engineering and Fisheries Research

FULL PAPER TAM MAKALE

INFLUENCE OF FEEDING ADMINISTRATION OF BROOD-STOCK ON BREEDING PERFORMANCE OF COMMON CARP (*CYPRINUS CARPIO* LINNAEUS, 1758)

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Cite this article as:
Yeasmin, M.Y., Rahman, H., Rahman, A., Al-Asif, A., Farid, A., Billah, M. (2018). Influence of Feeding Administration of Brood-Stock on Breeding Performance of Common Carp (*Cyprinus carpio* Linnaeus, 1758). Journal of Aquaculture Engineering and Fisheries Research 4(3), 127-137

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Submitted: 26.09.2018

Accepted: 11.10.2018

Published online: 18.10.2018

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Journal abbreviation:

J Aquacult Eng Fish Res

ABSTRACT

The aim of the experiment was to determine the effects of three types of formulated feed containing varying levels of protein, lipid on breeding performance of common carp (*Cyprinus carpio*). *C. carpio* was reared for 120 days under three dietary treatments (T1 to T3) with varying crude protein levels and crude lipid levels. Experimental diets T1, T2 and T3 were formulated from locally available feed ingredients having crude protein percentage of 23.56 ± 0.23, 28.60 ± 0.10 and 18.04 ± 0.32; crude lipid percentage of 9.50 ± 0.22, 11.06 ± 0.38 and 8.34 ± 0.19 respectively. Effect of the three diets was studied in terms of gonadosomatic index (GSI), fecundity, fertilization rate, hatching rate and deformity of fry. Fishes reared under Treatment 2 showed the highest gonadosomatic index (32.08 ± 7.24%), fecundity (355963.33 ± 77142), fertilization rate (84.00 ± 6.89%), hatching rate (87.33 ± 12.45) and lowest rate of larval deformity (11.56 ± 3.56%). Brood stock management of Treatment 2 showed significantly better results ($P<0.05$) in respect of gonadosomatic index, fecundity, fertilization rate, hatching rate and larval deformity among three selected hatcheries. Hence, it can be concluded that 28.60 ± 0.10% protein and 11.06 ± 0.38% lipid is adequate for better breeding performance of common carp (*Cyprinus carpio*).

Keywords: Feed management, Brood stock, Breeding performance, Common carp

Introduction

Brood fish is well thought-out as the foremostobligation of whichever hatchery besides brood stock administration is the crucial of superiority seed manufacture. Accomplishment of tempted breeding normally hinge on accessibility of adequate amount of excellence brood fish. So eminence of brood stock ought to be upheld methodically to acquire ready broods throughout the entire breeding period. Utmost of the regime hatcheries have individual brood stock in addition nearby 28.60 ± 0.10 percentage of brood enrollments come to pass in each year. Instead, limited private hatcheries have their particular standard and sustain them further or scarcer systematically however, around are abundant private hatcheries that do not obligate the mandatory measure of broods (Hossain et al., 2016; Samad et al., 2013; Rahman et al., 2015). Throughout breeding period they promptly acquisition broods commencing others as well as produce fry from them to accomplish their objectives (Asif et al., 2014; FAO, 2007). Brood fish are raised in ponds consuming the area of 0.5 to 1.0 acre besides water profundity flanked by 1.5-1.8 meters. Brood stock nourishment is recognized to stimulus gonadal development and productiveness of brood fish in addition it has been in general approved that superiority and magnitude of feed along with feeding administration are significant for spawning besides egg quality (Lie et al., 1993). Throughout the former epoch, accumulative consideration has been remunerated to the part of the dissimilar apparatuses of brood stock diets (Bromage, 1995). Nutritional guidance such as allowance magnitude (Tyler and Dunn, 1976;Springate et al., 1985; Shabuj et al., 2016), energy gratified (Smith et al., 1979, Takeuchi et al., 1981), lipid and fatty acid configuration (Watanable et al., 1984, Santiago and Reyes, 1993; Bhuiyan et al., 2018), protein (Santiago et al., 1983, Shim et al., 1989; Bhuiyan et al., 2018; Islam et al., 2016; Rahman et al., 2015) and protein: carbohydrate fraction (Cerda et al., 1994) in fishes have been testified by numerous researchers. Brood stock nourishment remnants single of the further most tacit in the arena of fish sustenance, besides readings are imperfect to a few types (Izquierdo et al., 2001). Conspicuously, the feasibility of fry was associated to their HUFA contented the afore mentioned accompanying to the HUFA gratified fed to brood stock (Lavens et al., 1999). Gonadal improvement and productiveness are affected by definite nutrients, predominantly for paternities with an uninterrupted level plus a petite epoch vitellogenesis. Some species of fish voluntarily integrate the dietary unsaturated fatty acids in eggs, straight throughout the breeding period. In particular fish species, LC-PUFA (Long chain polyunsaturated fatty acids) in brood stock nourishment upsurge productiveness, fertilization and egg excellence (Abrehouch et al., 2010). This has been pronounced in specie of common carp *C. carpio* (Manissery et al., 2001). Attributable to deprived administration developmental deformities or exterior malformations transpire in the hatchery (Rahman et al., 2015). These have been accredited to tetra genic possessions of environmental adulteration, scarceness of nutrient, oxygen scarcity, unexpected vicissitudes in temperature, water current, inbreeding etc. (Hore et al., 2010). Numerous influences have been conjured to enlighten skeletal malformations in fish larvae raised in hatchery eco-friendly influences such as compactness of eggs, mechanical or warm air shocks, manifestation of contaminants in the water, radiation, salinity, oxygen exhaustion and light concentration have also been conveyed to source anomalies in improvement (Haya, 1989; Wiegand et al., 1989; Caris and Rice, 1990; Andrades et al., 1996). A diversity of expected environmental features, such as temperature, salinity, pH, etc., have been recognized as accountable for persuading malformations in fish embryos and/or larvae (Kjorsvik et al., 1990). Fishes are in equipoise between impending disease organisms and their environment. Fluctuations in this symmetry such as descent in water eminence (environment) can consequence in fish fetching hassled and susceptible to disease. It is, consequently, very imperative to distinguish about the water eminence parameters besides their administration that have inspiration on development and endurance of aquatic organisms. The foremost intentions of this study were the investigation of breeding performance of common carp (*C. carpio*) such as gonadosomatic index (GSI), fecundity, ovulation success, fertilization rate, hatching rate and larval deformity.

Materials and Methods

Study location and duration of time

The experiment was conducted in a private hatchery named Treatment 1 Chanchra, Jessore coordinated 23°08'50.5"N 89°12'06.2"E and a part of that experiment was also conducted in the laboratory of Fisheries and Marine Bioscience department, Jessore University of Science and Technology (23°13'59.7"N 89°07'32.0"E) and Bangladesh Fisheries Research Institute, Bagerhat (22°38'29.7"N 89°48'23.7"E) from October 2014 to May 2015.

Experimental fish

The species that was subjected for this experiment was:

Common carp – *Cyprinus carpio* Linnaeus, 1758

Pond management of brood fish

Drying out of brood pond before stocking and dried varied from 10-15 days. The doses were found to be ranged from 1000-1200 g per decimal in the present study. Underground water was used as the main source of water in the brood pond. Fertilization schedule involving both organic and inorganic fertilizers starts 10–15 days prior to stocking and is prepared on the basis of nutrient status and chemical environment of the pond soil and water. Application rate of fertilizers differed from hatchery to hatchery. Every time TSP and oil cake were soaked in water a night before application.

Stocking management of brood fish

Complete detoxification of the liming and fertilization both organic and inorganic applied is done before stocking ponds. Absence of distress and mortality after 24 hours confirm complete detoxification and the pond is generally regarded as ready for stocking.

Stocking density

Stocking density is one of the important measures for assuring good and healthy parent fish. The brood carp was stocked together at 1500-2000 kg/ha in three ponds for maintaining three treatments.

Selection of brood

The selection of brood fishes were mainly based on physical characteristics such as size, coloration and growth rate, with little recognition of the long term genetic impact that such selection imposes on the stocks. Ten female broods were collected for GSI observation from each pond (treatment) and for breeding performance observation ten female broods and twenty male broods were collected from each pond.

Feeding Management of Brood Fish

Feed formulation

Three experimental diets were formulated containing three levels of protein, lipid, fat and ass. The ingredient compositions of experimental feeds are shown in Table 1.

Determination of proximate composition

Proximate composition such as protein, lipid, moisture and ass of three formulated diets were analyzed by standard procedure named AOAC (2000) in Bangladesh Shrimp Research Institute (Table 2).

Feeding management of the experimental fish

The brood fish were fed one time a day morning and evening. In first few days, feeds were applied at the rate of 2-3 % of the body weight and increased gradually according to the feeding frequency of the fish.

Sex ratio

2:1 sex ratio of male and female was maintained for the experiment.

Body weight measurement

The weight of individual fish were taken using a measuring board (0.1 cm) and digital weighing balance (0.1 g).

Determination of gonadosomatic index (GSI)

From each treatment ten females were collected for determination of gonadosomatic index. The body weight of those females was within 0.9 kg to 4.5 kg. The ovaries were weighted (g) on an electronic balance of 0.001 g accuracy. The gonadosomatic index of female was calculated by using the following formula,

$$\text{Fecundity (no.)} = \frac{\text{total gonad weight(g)} \times \text{No. of eggs}}{\text{weight of small portion of total gonad(g)}} \times 100$$

Estimation of fecundity

Then the fecundity was measured by using the following formula,

$$\text{Fecundity (no.)}=\frac{\text{total gonad weight(g)}\times\text{No. of eggs}}{\text{weight of small portion of total gonad(g)}}\times 100$$

Hormone administration

After preparation of PG solution, it was injected in brood fish. Fish was caught carefully by net, and kept in sponge. They were covered by soft cloth; PG was then injected near the pectoral fin base. The amount of PG solution for each fish was determined before according to the body weight of the broods (Table 3).

Observation of ovulation success

After 6 hours of final hormone dose of selected females' ovulation was happened. The rate of ovulation was estimated by using the following formula:

$$\text{Ovulation rate (\%)}=\frac{\text{No.of females ovulated}}{\text{Total no. of females injected}}\times 100$$

Estimation of fertilization rate

The rate of fertilization was estimated by using the following formulas:

$$\text{Hatching rate (\%)}=\frac{\text{No. of hatchlings}}{\text{Total no. fertilized of eggs}}\times 100$$

Estimation of hatching rate

The thermostatic heater in the hatchery was set at 26°C which ensured the hatching of the eggs. Hatching started after 48 ± 2 hrs of fertilization. The yolk sac absorption took place after 96 ± 2 hrs of hatching. Then hatching rate was determined by the following formula:

$$\text{Hatching rate (\%)}=\frac{\text{No. of hatchlings}}{\text{Total no. fertilized of eggs}}\times 100$$

External Deformity of Common Carp (*C. carpio*) Larvae

Sample collection

Normally hatching was completed within 50 hours. The samples were collected immediately after hatching from three selected hatchery. Initially the larvae were collected just after hatching. 100 larvae were sampled from each hatchery for observing external deformity.

Examination of deformities

The preserved larvae were kept in Petridis and examined in the laboratory of fisheries and marine bioscience department. Any deformities in the larvae were identified with the help of electronic microscope.

Determination of deformity rate

The deformity rate was calculated by visual observation.

Table 1. Gross ingredients of formulated feed.

	Treatment 1		*Treatment 2*		*Treatment 3*	
Feed ingredients	Rice bran	55%	Rice bran	40%	Wheat bran	28.60 ± 0.10%
	Soybean cake	10%	Oil cake	15%	Cow dung	28.60 ± 0.10%
	Flour	8%	Corn	10%	Rice polish	28.60 ± 0.10%
	Fishmeal	12%	Fishmeal	15%	Oil cake	15%
	Dial calcium	4%	Soybean cake	12%	Fish meal	10%
	Oil cake	8%	Flour	3%		
	Vitamin premix	1%	Dicalcium phosphate	2%		
			Molasses	1.5%		
			Salt	1.5%		

Table 2. Proximate composition of formulated feeds (%) on dry matter content.

Treatments	*Crude protein (%)*	*Crude lipid (%)*	*Moisture (%)*	*Ash (%)*
Treatment 1	23.56 ± 0.23	9.50 ± 0.22	15.8 ± 0.09	7.50 ± 0.23
Treatment 2	28.60 ± 0.10	11.06 ± 0.38	7.50 ± 0.14	5.63 ± 0.16
Treatment 3	18.04 ± 0.32	8.34 ± 0.19	17.5 ± 0.31	8.93 ± 0.12

Table 3. Doses of PG for female and male broods.

Sex	*First dose*	*Second dose*	*Time interval (h)*
Female	2 mg/kg body wt.	4 mg/kg body wt.	6
Male	-	2 mg/kg body wt.	6

Then deformity rate was determined by the following formula,

$$\text{Deformity rate (\%)} = \frac{\text{No.of deformed hatchlings}}{\text{Total no. hatchlings}} \times 100$$

Physicochemical parameters of hatchery water

Temperature, pH and water transparency (Secchi disc depth) were estimated daily, starting on day 0 (the day of fish stocking). Dissolved oxygen (DO), total alkalinity contents of water were analyzed weekly, starting on day 7, following standard procedures (APHA, 1992). Temperature and pH were measured with a water quality analyzer (Horiba, Japan; model U10).

Statistical analysis

The results obtained in the experiment were subjected to analysis. Qualitative and quantitative analysis of all kinds of data were carried out. MS Excel and graph pad prism 7 were used for presentation of the tables and graphs obtainable from different types of data. Analysis of variance (One way), Tukey-Kramer Test for differences between means were used for analysis of the effect of brood stock management on fecundity, fertilization rate and hatching rate of common carp (*C. carpio*) using SPSS 11.5 software. The significance of the data from management effect were considered significantly different at $p<0.05$.

Results

Effect of feeding management of brood stock on breeding performance of *C. carpio*

In this experiment gonadosomatic index value was found from 18.89 ± 3.46 to 32.08 ± 7.24. Gonadosomatic index value of three treatments was significantly different from each other and highest gonadosomatic index value (32.08 ± 7.24) was found in treatment 2 (Figure 1). In the present study, the result showed that, broods of Treatment 2 showed the highest fecundity of (355963.33 ± 77142) than treatment 1 and treatment 3 (Figure 2). The ovulation success of Treatment 1 and Treatment 2 was 100% but Treatment 3 showed 80% (Figure 3). In case of fertilization rate Treatment 2 showed the highest fertilization rate (84.00 ± 6.89%) and was significantly better (*p<0.05*) from treatment 1 (70.33 ± 8.52%) and treatment 3 (61.00

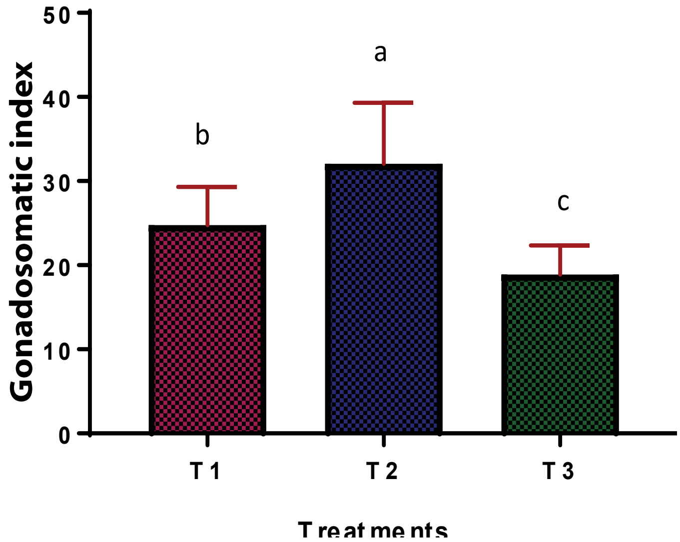

Figure 1. Gonadosomatic index of *C. carpio* in three treatments.

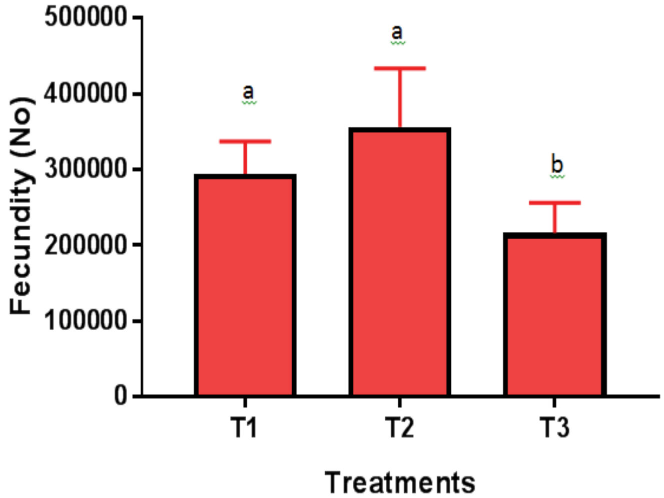

Figure 2. Fecundity of *C. carpio* in three treatments.

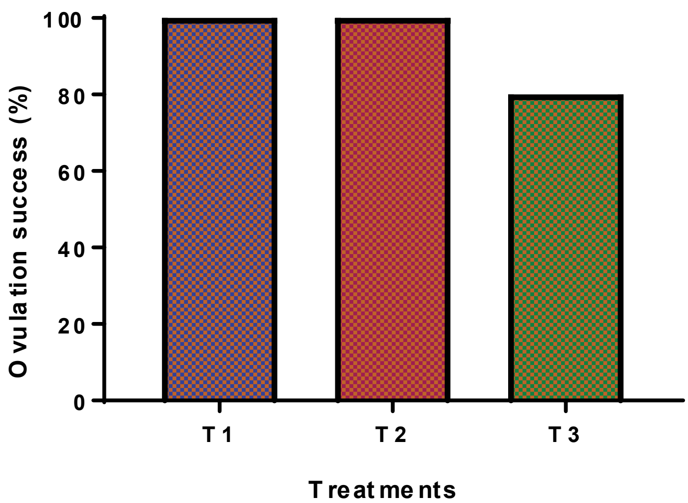

Figure 3. Ovulation success of *C. carpio* in three treatments.

± 9.23%) (Figure 4). In the experiment hatching rate was 73.33 ± 9.1%, 87.33 ± 12.45% and 65.66 ± 6.66 in treatment 1, treatment 2 and treatment 3 respectively. Hatching rate of three treatments was significantly different from each other and highest was in treatment 2 (87.33 ± 12.45%) (Figures 5 and 6).

Deformity rate of C. carpio larvae

The deformity rate of *C. carpio* in three treatments was observed after 4th day of hatching. The deformity rate was ranged from 11.56 ± 3.56% to 23.33 ± 6.66%. The highest rate (23.33 ± 6.66%) of deformity was observed in Treatment 3 and the lowest rate of deformity was observed in Treatment 2. Treatment 3 showed significant different ($P<0.05$) with two other treatments.

Types of deformities of *C. carpio* larvae

Deformities were recorded at three categories those are absences of eye, slightly curved body shape and completely curved body shape. Among three hatcheries the highest rate of absent eye deformity was observed in Treatment 3. Highest rate of slightly curved body shape deformity was observed Treatment 1 and the highest rate of completely curved body shape deformity was observed Treatment 3.

Water quality parameters

The water quality parameters such as, surface temperature, dissolve oxygen, pH, transparency and alkalinity of three treatments are shown in Tables 4 and 5.

Discussion

Brood pond management relating to fertilization and feeding is the prime consideration for producing quality broods and that in turn allows the availability of good seed for successful aquaculture in the country. A high seed production demands particular nutrition of brood stock which significantly affects fecundity and survival (Bromage et al., 1992; Islam et al., 2017).

Studies on the natural environment, show direct link between diet and fertility, similar studies were conducted on trout rainbow, *Oncorhynchus mykiss*, in captivity. These experiments have shown that reducing the required amount of food will cause a reduction in fertility and in some cases, the proportion of females reaching sexual

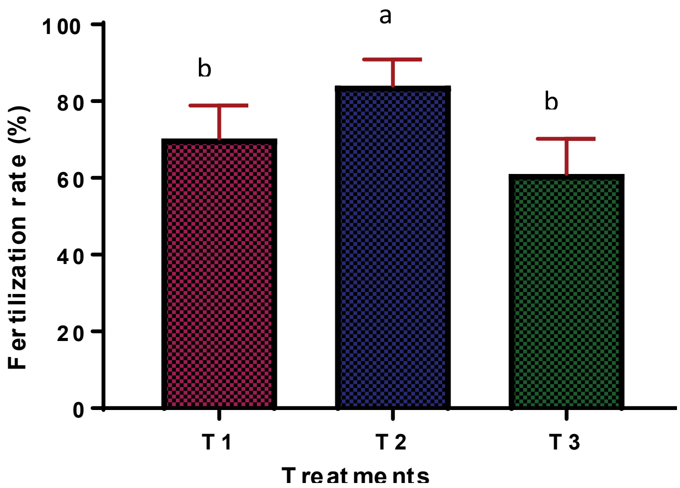

Figure 4. Fertilization rate of *C. carpio* in three treatments.

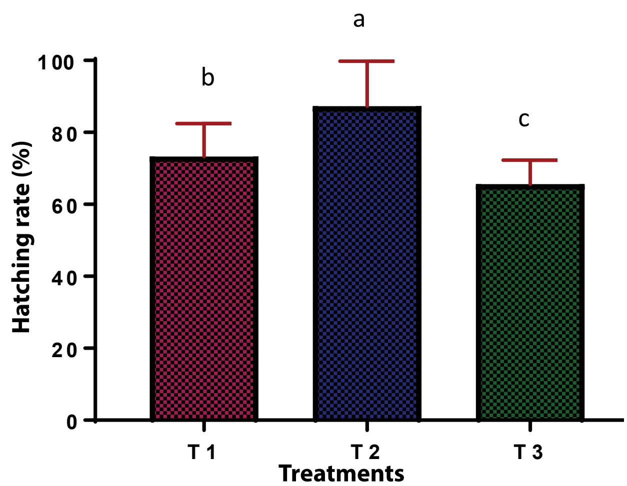

Figure 5. Hatching rate of *C. carpio* in three treatments.

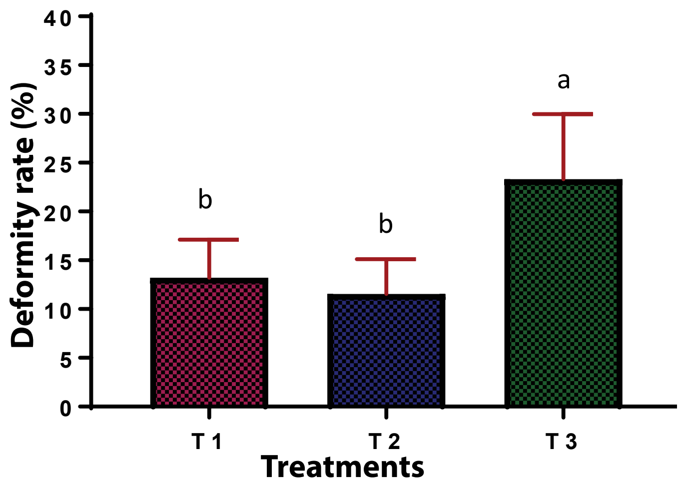

Figure 6. Deformity rate of *C. carpio* larvae in three treatments.

Table 4. Water quality parameters in three treatments.

Treatment	*Surface temperature (°C)*		*DO (mgL^{-1})*		*pH*		*Transparency (cm)*		*Alkalinity (mgL^{-1})*	
	Average	S.E.	Average	S.E.	Average	S.E.	Average	S.E.	Average	S.E.
Treatment 1	27.065	2.150	5.994	0.145	7.710	0.515	73.561	0.354	125.321	8.804
Treatment 2	26.315	3.071	5.230	0.339	7.709	0.313	71.857	0.319	139.975	15.630
Treatment 3	26.520	2.143	5.658	0.242	7.734	0.715	74.430	0.580	143.867	13.321

Table 5. Types of deformities of *C. carpio* larvae.

Name of treatment	*Percentage of different types of deformity into the total deformed larvae*		
	Mean rate of absence of eye (%)	*Mean rate of slightly curved body shape (%)*	*Mean rate of completely curved body shape (%)*
Treatment 1	20	50	30
Treatment 2	26	55	19
Treatment 3	15	63	22

maturity (Baiz, 1978). For some fish species like sea bream (*Sparus aurata*), or Japanese sea bream (*Pagrus major*) the composition of the egg is quickly affected by diet in a few weeks of feeding brood stock (Watanabe et al., 1985, and Tandleretal, 1995). The egg quality composition of porgy was affected by the levels of essential fatty acids in experimental diets. Similarly, the viable eggs percentage increases with higher levels of n-3 Highly Unsaturated Fatty Acid (HUFA) in the diet and the incorporation of these fatty acids in eggs, which indicates the importance of these essential fatty acids for eggs and embryos normal development (Abrehouch et al., 2010). The present study showed the similar result that the higher percentage of protein (28.60 ± 0.10%) containing feed results the highest number of eggs (355963.33 ± 77142). Dietary protein level influence relative fecundity (De Silva and Radampola, 1990; Chong et al., 2003 and Khan et al., 2004). The elevation of dietary lipid levels from 12% to 18% in brood-stock diets for rabbit fish (*Siganus guttatus)* resulted in an increase in fecundity and hatching (Duray et al., 1994), although this effect could also be related to a gradual increase in the dietary essential fatty acid content. The present study also shows the similar result that the highest lipid (11.06 ± 0.38%) containing feed provided by the Treatment 2 showed the highest fecundity (355963.33 ± 77142). The result showed that the fertilization rate (84.00 ± 5.29%) and hatching rate (87.33 ± 2.51%) were observed in fish fed with highest percentage (28.60 ± 0.10%) protein containing feed. This result is similar to the work of (Marimuthu et al., 2009; Islam et al., 2016). This observation was in line with the reports of Chong et al. (2003) and they seem to confirm the assertions of Izquierdo et al. (2001), that it is desirable to ensure that nutritional requirements of brood stock must be fulfilled to optimize reproductive performance. Low quality feed reduced gonadal development and quality of the hatchlings (high deformed larva and mortality). Studies with tilapia and grass carp showed relationship between dietary protein and egg size according to Gunasekara et al. (1997) and Khan et al. (2004) but the reports of Manissery et al. (2001) showed that dietary protein level affects common carp egg quality. The present study showed the similar result.

Thus, it is possible that the requirement of nutrients during spawning season vary with species. Embryonic and larval malformations are recognized as a recurring problem in fish aquaculture and represent both ethical and economic challenges for the industry (Takle et al., 2005). A variety of natural environmental factors, such as temperature, salinity, pH, etc. have been identified as responsible for inducing deformities in fish embryos and/or larvae (Kjorsvik et al., 1990). In addition to these, poor brood stock management, nutritional problem and inbreeding problem in hatcheries added a series of new parameters that may exert considerable impact on developing fish (Westernhagen et al., 1988). The ambient environmental temperature is an all-pervasive regulator of physiological processes of fish. In addition to temperature, salinity and pH also directly affect the fish physiology as well as influence the physical nature of water. A study on hatch rate of Australian bass larvae (*Macquaria novemaculeata*) showed retarding and accelerating effects of low and high temperatures respectively across the studied temperature range of 12 to 24°C (Van Der Wal, 1985; Ali et al., 2016a; Ali et al., 2016c; Shabuj et al., 2016; Islam et al., 2016; Hossain et al., 2016; Faruk et al., 2018; Zafar et al., 2017). In the present study temperature in all three treatments was more or less same. Fluctuations in pH away from the neutral range are known to have various negative effects on fish development and physiology. These include effects of low pH on oogenesis (*Oncorhynchus mykiss*) (Zelennikov, 1997), fertilization rate (*Coregonus lavaretus*) (Keinänen et al., 2003). In the present study pH fluctuation was poor. A desirable range of dissolved oxygen in water has been described for carp eggs as 5-7 mg/l (Bromage, 1988). The minimum necessary DO apparently varies among species and it is important to ensure that the incubator provides adequate oxygen to allow normal development of larvae. In the experiments DO range was within 6-7 mg/l in three treatments.

The water parameters such as temperature was from 26.315 ± 3.071°C to 27.065 ± 2.143°C, pH ranged from 7.709 ± 0.313 to 7.734 ± 0.715, DO ranged from 5.230 ± 0.339 mg/L to 55.994 ± 0.145 mg/L and alkalinity from 125.321 ± 8.804 mg/L to 143.867 ± 13.321 mg/L which is more or less similar with the study of Shajib et al. (2017); Ali et al. (2016a); Ali et al. (2016b); Ali et al. (2016c); Shabuj et al. (2016); Islam et al. (2016); Hossain et al. (2016) and Zaman et al. (2017).

Furthermore, there is evidence that the relative composition of the diet of parent fish in terms of its protein, lipid and carbohydrate content may have a significant impact on the reproductive performance and egg quality of the fish (*Dicentrarchus*labrax) (Cerdá et al., 1994). This leads to significant loss of money for the commercial industries.

Conclusion

Bangladesh is one of the densely populated countries in the third world. They can only be met their protein requirement through aquaculture. To fulfill this requirement, fish farmers have to be ensured with good quality seed through production of quality broods. Carp brood management is the prime consideration for producing quality broods as well as quality seed for successful aquaculture in the country. Jessore is the most important region which has got recognition as the most promising areas for hatchery technology of carps. In the present study the first experiment showed that the brood stock management especially the feeding management where the formulated feed contain the highest level of protein (28.60 ± 0.10%) and lipid (11.06 ± 0.38%) in Treatment 2 showed highest correlation and coefficient in length-weight relationship. Treatment 2 showed significant result ($P<0.05$) in respect of gonadosomatic index, ovulation success, fecundity, fertilization rate, hatching rate and larval deformity of *C. carpio*.

Compliance with Ethical Standards

The authors declare that they have no conflict of interest.

Funding

This research did not receive any specific grant from any funding agency.

Statement of Human and Animal Rights

The research team did not violate any kind of human and animal rights intentionally during conducting this research.

Author contribution

SMY conceived, designed and performed the experiments. MAR conceived, designed the experiment and supervised the research. MHR and AAA analyzed the data set and revised the manuscript and improved the English language. MAF revised the manuscript. MMB revised the manuscript and improved the English language.

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