



Efficacy of Dry Pituitary Gland, Wet Pituitary Gland and the Synthetic Hormone Ovaprim on *Labeo catla* Breeding

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An induced breeding experiment with Indian major carp, catla (*Labeo catla*) was conducted to know the efficacies of three different doses of dry Pituitary gland and wet Pituitary gland in comparison to that of ovaprim. Intra- peritoneal injections were given at the base of the pelvic fin with dry PG low dose (DPL), 1 mg/Kg body weight for first dose of female fish and after 6 hours interval second dose (2 mg/Kg of body weight) was administered; at the same time 1 mg/Kg body weight for male. For dry PG medium dose (DPM), 2 mg/Kg body weight for first dose and after six hours interval 4 mg/Kg body weight for female and 2 mg/Kg body weight for male. For dry PG high dose (DPH), 3 mg/Kg body weight for first dose and after 6 hours interval 6 mg/Kg body weight for female and 3 mg/Kg body weight for male fish. Wet PG low dose (WPL), 7 mg/Kg body weight for first dose and after six hours interval 10 mg/Kg body weight for female and 7 mg/Kg body weight

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for male fish. For wet PG medium dose (WPM), 11 mg/Kg body weight for first dose and after 6 hours interval 15 mg/Kg body weight for female and 11 mg/Kg body weight for male fish. And for wet PG high dose (WPH), 15 mg/Kg body weight for first dose and after 6 hours interval 20 mg/Kg body weight for female and 15 mg/Kg body weight for male fish and ovaprim, 0.25ml/kg and 0.5 ml/Kg of body weight for single dose for male and female respectively. These doses were used for determination of fertilization, hatching and survival rates. The fertilization rates were $83.25 \pm 0.85\%$, $92.01 \pm 0.45\%$, $82.45 \pm 1.04\%$, $83.18 \pm 0.68\%$, $88.59 \pm 0.48\%$ and $72.85 \pm 0.43\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively. The hatching rates were $78.58 \pm 0.94\%$, $85.54 \pm 0.38\%$, $74.8 \pm 0.22\%$, $77.89 \pm 0.82\%$, $81.56 \pm 0.59\%$ and $71.54 \pm 0.48\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively and the survival rates were $77.24 \pm 0.49\%$, $87.12 \pm 0.46\%$, $73.09 \pm 0.42\%$, $75.8 \pm 0.30\%$, $80.76 \pm 0.64\%$ and $69.2 \pm 0.77\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively. Among all the doses of dry and wet PG and the synthetic hormone ovaprim, DPM gave the best result in case of fertilization, hatching and survival rate. So, the induced breeding of catla fish may use dry PG at the dose of 2 mg/Kg body weight as first dose and 4 mg/Kg of body weight as second dose.

Keywords: Fertilization; hatching; induced breeding; *Labeo catla*; ovaprim; pituitary gland; survival rate.

1. INTRODUCTION

“Fish is the second most valuable agricultural crop in Bangladesh, play a crucial role in the livelihoods and employment of 19 million of people. Bangladesh is one of the world’s leading fish producing countries with a total production of 4.621 million mt, contributing 3.57% to the GDP and over 26.50% to the agricultural GDP and 1.24% to foreign exchange earnings by exporting fish and fish products in 2021” [1]. “The culture and consumption of fish therefore has important implications for national income, food, and nutrition security. Fisheries sector being one of the most productive and dynamic sectors is playing an increasingly significant role in the economy for the last few decades [2,3]. Indian major carps are largely cultured in the country. Now, Bangladesh becomes self-sufficient fish producing country supplements about 60% (with per capita of 62.58 g/day against targeted 60 g/day) of total daily animal protein intake of her people” [1].

Catla (*Labeo catla* Hamilton, 1822) is one of the most important cultured freshwater fish species in South Asia. It is a very safe fish because it depends mostly on plankton and for surface feeder it can remain the water body environment well. Due to high market demand of both fingerlings and adult fish people rear catla for meeting protein requirement [4]. “Catla do not spawn in confined water bodies such as ponds, lakes etc., but breed in natural running water bodies as in rivers. Environmental factors such as rainfall, temperature, water velocity play an important role in stimulating the fish for reproduction [5,6]. Catla usually spawn in

inundated terrains of rivers and streams during rainy season. On the other hand, the fish seeds collected from natural spawning grounds is scanty and does not fulfill the annual requirement for inland aquaculture in the country. Henceforth, efforts have been paved to breed the catla in hatcheries” [7].

“In 1967, first induced breeding technology of carp fish was developed in Chandpur, Bangladesh. From the beginning the natural sources of rivers were the major source of carp seed production in Bangladesh” [8]. “Due to the destruction of natural habitats and increased demand, carp seed availability in nature has largely declined and the aquaculture venture are gradually replaced by the hatchery bred fry since early 80’s when artificial fish breeding techniques and low-cost hatchery designs have been successfully adapted in Bangladesh” [9]. Private fish hatcheries produced about 6,68,801 kg hatchling of 5-6 days old fry while the public sector farms produced about 12,193 kg hatchling [1]. “The availability of fish fry is an essential prerequisite for aquaculture. Pituitary gland (PG) hormone usually used for induced breeding of different fish like Indian major carp. The hormone secreted from pituitary gland stimulates growth, development, maturity, and ovulation of eggs thus it is important as the production of Indian major carp including catla” [10].

“The poor breeding response, coupled with a relatively shorter spawning season, results in an inadequate production of hatchery-reared seed, which often fails to cover the entire needs of the farmers. While carp pituitary extract has been the common inducing agent used since the

development of the induced breeding technology. Also, several synthetic hormones such as Ovaprim, Ovotide and Wova-FH are used" [11].

There is a lack of literature on comparative efficacy of dry and wet PG in induced breeding of catla. To investigate the comparative efficacy of the above mentioned two PGs is the need of time. So, the present study was conducted to determine the effect of dry PG and wet PG with their different doses on fertilization rate, hatching rate and survival rate of catla and to compare their efficacy with that of the widely used synthetic hormone, ovaprim.

2. MATERIALS AND METHODS

2.1 Study Site and Duration

The experiment was carried out in the brood ponds and hatchery complex of the Fisheries Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh from February to July 2020.

2.2 Collection and Selection of Brood Fish for Breeding

For the present study, mature and healthy catla brood were collected for inducing hormone. Fish of almost equal size and weight range 2 Kg/fish were collected during the experiment. Main criteria for selection of male and female are given in Table 1.

2.3 Preparation of PG and Ovaprim

The amount to be used was calculated using the following formula

$$\text{Weight of PG (mg)} = \text{Wt (g)} \times \text{Pt (ms)}/1000$$

Where, Wt represents total body weight (g) of the fish to be injected and Pt, represent rate of mg PG to be injected/Kg body weight.

The weighed PG was homogenized with a small volume of distilled water and the homogenate was carefully transferred to a centrifuge tube by using water to ensure complete transfer.

2.4 Doses of PG and Ovaprim Used for Induced Breeding

Doses and dosages of PG and ovaprim injected in male and female fish, is shown in Table 2 and Table 3, respectively.

2.5 Hormone Injection Administration

Intra- peritoneal injections of hormone were given at the base of the pelvic fin according to the experimental design shown in Tables 2 and 3. For confirmation of getting enough ovulated eggs, in each case, 15 females and 15 males fish were injected. During injection, brood fish were covered by soft cloth and handled smoothly. Females brood were given two doses of PG injection. The males were given only one dose at the time of the second dose given to female. Intra- peritoneal injections were given at the base of the pelvic fin [12]. Injections were given to the carps at an angle of 45° of the body. After injection both male and female breeders were released immediately in the same circular tank with showering of water.

2.6 Collection and Mixing of Eggs and Milt

Stripping method was followed for collecting eggs. After 6 hours of 2nd dose, eggs and milt were collected from the ovulated females and males by stripping the abdomen of the fish with a gentle pressure. Eggs were collected at first into a dish and immediately it was weighed. Then milt of the males were stripped over the eggs. The eggs and milts in the dish were mixed with a soft feather for two minutes and distilled water was added to the mixture to reduce the stickiness of the eggs and prolong the fertilizing capacity of the milt. The egg-sperm ratio 12000:1 and Male and female ratio 1:1 was maintained. Unfertilized eggs were washed away by water. Fertilized and unfertilized egg sample were taken in a vial for counting. After well mixing for two minutes the fertilized eggs were poured into hatching jar or circular hatching tank with care with continuous water flow for aeration and circulation.

2.7 Incubation, Hatching and Hatchling Monitoring and Sampling

After transferring eggs into circular or bottle hatching tanks numbers of hatched or unhatched eggs were sampled after 1,6,18,32,42, and 72 hours. In the spawning tank (Picture 1) after 24 hours the fertilized eggs were hatched. Hatched larvae were not supplied with any type of food up to 72 hours. After the yolk sac absorption was completed around 72 hours of hatching, the hatchlings were observed for the total absorption of their yolk sac. All that time, boiled egg yolk diluted in water was provided as the first food for the hatchlings at ambient temperature of 26 to 30°C. At that time, they were little bit of blackish

and transparent in color. After 72 hours fries were transferred into hapa placed in a brood pond. Catla fries at 4 days, 7 days, 10 days, 13 days, and 15 days were sampled and preserved in well written vial with 10% formalin for observation of their successful breeding efficacies.

The following variables were calculated by using the formula [8]

$$\text{Fertilization rate \%} = \frac{\text{No. of fertilized eggs}}{\text{Total no. of eggs}} \times 100$$

$$\text{Hatching rate \%} = \frac{\text{No. of spawn}}{\text{Total no. of eggs}} \times 100$$

$$\text{Survival rate \%} = \frac{\text{No. of survived eggs}}{\text{Total no. of eggs}} \times 100$$

2.8 Data Analysis

Data analysis was done using Analysis of Variance (ANOVA). The data obtained from the trial were subjected to one-way analysis of variance (ANOVA) (using SPSS 16.0 program) to test for effects of various type of hormone. When ANOVA identified significant difference among groups, multiple comparison tests among means were performed using Duncan's new multiple range test. For each comparison, statistically significant differences were determined by setting the aggregate type I error at 5% ($p < 0.05$).

Table 1. Criteria followed to select broods of catla [8]

Characteristics	Male	Female
1. Scale, Operculum and pectoral fins	Rough touch, particularly the dorsal surface of pectoral fins	Pectoral fins smooth to lubricious
2. Abdomen	Round and firm	Swollen and soft
3. Genital opening	Elongated slit, white in color	Rounded and pink in color
4. When pressure applied on abdomen	Milky white fluid oozes through genital opening	A few ova may ooze through genital pore
5. Shape of body and size	Body linear, smaller	Body stouter, slightly larger

Table 2. Doses and dosages of PG and ovaprim injected in male catla

SI No.	Hormone	Doses and dosages	Description of the dose	Designation
1 and 2	Dry PG	1 mg/Kg	dry PG low dose	DPL
3 and 4	Dry PG	2 mg/Kg	dry PG medium dose	DPM
5 and 6	Dry PG	3 mg/Kg	dry PG high dose	DPH
7 and 8	Wet PG	7 mg/Kg	wet PG low dose	WPL
9 and 10	Wet PG	11 mg/Kg	wet PG medium dose	WPM
11 and 12	Wet PG	15 mg/Kg	wet PG high dose	WPH
13, 14 and 15	Ovaprim	0.25 ml/Kg	Ovaprim	Ovaprim

Table 3. Doses and dosages of PG or ovaprim injected in female catla

Fish No.	Hormone	Doses and dosages (mg or ml/Kg body weight)	
		1 st dose	2 nd dose
1 and 2	Dry PG	1 mg PG/Kg (DPL)*	2 mg PG/Kg (DPL)
3 and 4	Dry PG	2 mg PG/Kg (DPM)*	4 mg PG/Kg (DPM)
5 and 6	Dry PG	3 mg PG/Kg (DPH)*	6 mg PG/Kg (DPH)
7 and 8	Wet PG	7 mg PG/Kg (WPL)*	10 mg PG/Kg (WPL)
9 and 10	Wet PG	11 mg PG/Kg (WPM)*	15 mg PG/Kg (WPM)
11 and 12	Wet PG	15 mg PG/Kg (WPH)*	20 mg PG/Kg (WPH)
13, 14 and 15	Ovaprim		0.5 ml/Kg

*DPL: dry PG low dose; DPM: dry PG medium dose; DPH: dry PG high dose; WPL: wet PG low dose; WPM: wet PG medium dose; WPH: wet PG high dose



Picture 1. Breeding in spawning tank

3. RESULTS

3.1 Amount of Ovulated Egg

Total amounts of eggs that could be collected from female breeders were different by using different amounts of dry or wet PG or ovaprim induction. The highest number of eggs could be collected from the dry PG medium dose induced fish, 460 g and the lowest amount, 113 g, from dry PG high dose induced fish and from wet PG high dose induced fish did not lay egg Table 4.

Numbers of eggs were counted at unfertilized state and at different hours after fertilization is shown in Table 5.

3.2 Hatching Condition

It was found that the best result was achieved by the medium dose of dry PG Table 6.

Table 4. Amount of ovulated egg of PG or ovaprim injected in female catla

Fish No.	Hormone	Average total egg (gram)
1 and 2	DPL	417g
3 and 4	DPM	460g
5 and 6	DPH	113g
7 and 8	WPL	403 g
9 and 10	WPM	227g
11 and 12	WPH	Didn't lay egg
13, 14 and 15	Ovaprim	475g

3.3 Fry Sampling after Transferred into Hapa

After transferring into hapa, fries were counted at different day's interval are shown in Table 7.

3.4 Fertilization, Hatching and Survival Rate

Variations of fertilization rate, hatching rate and survival rate of catla fry in different doses of hormones are shown in Table 8.

3.4.1 Fertilization rate

It was observed from this study that the fertilization rates were $83.25 \pm 0.85\%$, $92.01 \pm 0.45\%$, $82.45 \pm 1.04\%$, $83.18 \pm 0.68\%$ and $72.85 \pm 0.43\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively (Fig. 1). According to the above calculated result of ANOVA 1% level of significance, the fertilization rate was the best at dry PG medium dose $92.01 \pm 0.45\%$ followed by low dose ($83.25 \pm 0.85\%$) and high dose ($82.45 \pm 1.04\%$). The fertilization rate by wet PG was the highest ($83.18 \pm 0.68\%$) at medium dose followed by low dose ($82.45 \pm 1.04\%$) and ovaprim ($72.85 \pm 0.43\%$).

3.4.2 Hatching rate

The hatching rates were achieved from this study @ $78.58 \pm 0.94\%$, $85.54 \pm 0.38\%$, $74.8 \pm 0.22\%$, $77.89 \pm 0.82\%$, $81.56 \pm 0.59\%$, $71.54 \pm 0.48\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively (Fig. 2). According to the above calculated result of ANOVA 1% level of significance, the hatching rate was the best at dry PG medium dose $85.54 \pm 0.38\%$ followed by low dose ($78.58 \pm 0.94\%$) and high dose ($74.8 \pm 0.22\%$). The hatching rate by wet PG was the highest ($81.56 \pm 0.59\%$) at medium dose followed by low dose ($77.89 \pm 0.82\%$) and ovaprim ($71.54 \pm 0.48\%$).

Table 5. Number of eggs at unfertilized state and at different hours after fertilization

Condition of Egg/hr	Dry PG 1mg/Kg	Dry PG 2mg/Kg	Dry PG 3mg/Kg	Wet PG 7 mg/Kg	Wet PG 11 mg/Kg	Ovaprim 0.5 ml/Kg
Unfertilized	821	856	805	751	790	712
Fertilized (0)	690	708	697	682	700	653
Fertilized (6)	25	28	26	27	24	24
Fertilized (12)	23	24	22	24	22	23
Fertilized (18)	21	22	22	23	21	19

Table 6. Number of hatched and unhatched eggs/gram

Time (hr)	Dry PG 1 mg/Kg		Dry PG 2 mg/Kg		Dry PG 3 mg/Kg		Wet PG 7 mg/Kg		Wet PG 11 mg/Kg		Ovaprim 0.5ml/Kg	
	UH**	H**	UH	H	UH	H	UH	H	UH	H	UH	H
1	6	21	8	42	7	21	9	28	5	24	9	21
6	7	23	8	45	9	27	11	33	7	27	11	26
18	9	30	10	60	13	37	12	45	8	34	13	35
32	23	79	15	96	21	65	18	71	19	79	24	61
42	21	85	18	112	24	70	21	78	21	91	25	64
72	19	90	19	117	27	80	24	91	23	112	27	71

**UH= Unhatched; H=Hatched

Table 7. Number of fry/grams after transferred into hapa

Day	Number of Fries					
	Dry PG 1 mg/Kg	Dry PG 2 mg/Kg	Dry PG 3 mg/Kg	Wet PG 7 mg/Kg	Wet PG 11 mg/Kg	Ovaprim 0.5ml/Kg
1	418	445	400	431	446	404
4	307	313	278	301	297	293
7	204	218	199	196	199	189
10	184	186	147	158	161	154
13	143	151	107	131	143	139
15	127	138	87	113	129	123

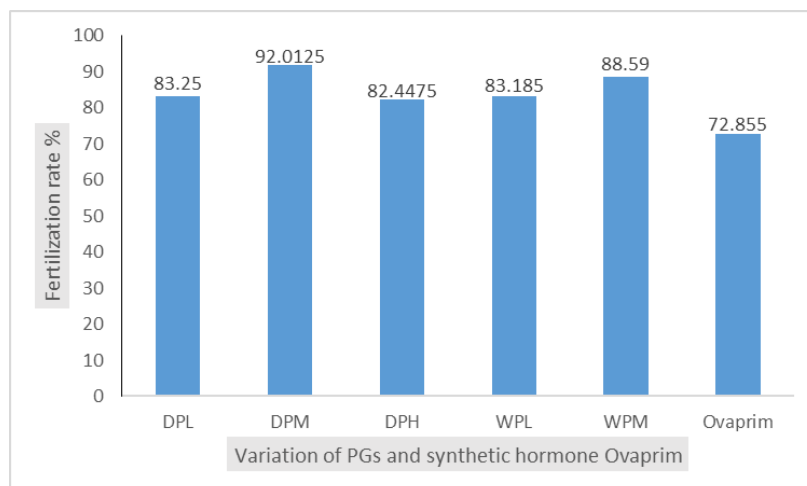


Fig. 1. Fertilization rate of catla by different doses of hormones

3.4.3 Survival rate

The survival rates were recorded in this study @ $77.24 \pm 0.49\%$, $87.12 \pm 0.46\%$, $73.09 \pm 0.42\%$, $75.8 \pm 0.30\%$, $80.76 \pm 0.64\%$, $69.2 \pm 0.77\%$ for the doses of DPL, DPM, DPH, WPL, WPM and ovaprim respectively (Fig. 3). According to the above calculated result of ANOVA 1% level of significance, the survival rate was the best at dry PG medium dose 87.12 ± 0.46 followed by low dose ($77.24 \pm 0.49\%$) and high dose ($73.09 \pm 0.42\%$). The survival rate by wet PG was the highest at medium dose $80.76 \pm 0.64\%$ followed by low dose ($75.8 \pm 0.30\%$) and ovaprim ($69.2 \pm 0.77\%$).

4. DISCUSSION

During the present study, PG 1 mg /Kg (DPL), 2 mg PG/Kg (DPM), 3 mg PG/Kg (DPH), 7 mg PG/Kg (WPL), 11 mg PG/Kg (WPM) and 15 mg PG/Kg (WPH) was given respectively for first dose for female and after six hours 2 mg PG/Kg (DPL), 4 mg PG/Kg (DPM), 6 mg PG/Kg (DPH), 10 mg PG/Kg (WPL), 15 mg PG/Kg (WPM) and 20 mg PG/Kg (WPH) body weight for second dose for female. For male catla, different dose of different hormones was administered such as Dry PG 1 mg/Kg, Dry PG 2 mg/Kg, Dry PG 3 mg/Kg, Wet PG 7 mg/Kg, Wet PG 11 mg/Kg, Wet PG 15 mg/Kg, ovaprim 0.25 ml/Kg body weight. Islam [9] reported that female fishes were injected with the second dose of PG at 4mg / Kg,

the fertilized eggs were hatched after 42-48 hours and after 6-7 hours of second dose of PG injection. Almamun [11] studied on induced breeding of *Labeo bata* and reported that the effective dose for induced breeding was 0.5, 1.0, 1.5, and 2.0 mg PG/Kg body weight for first dose for female while the second doses were 4.0, 4.6, 5.0 and 5.5 mg/Kg body weight for female and 2 mg/Kg for male. The present study stated that 0.5 ml ovaprim/Kg body weight for single dose for female. Almamun stated that the doses of ovaprim was 0.5 ml/Kg body weight oh both male and female for only first dose. which is relevant to the present findings.

During the present study, the fertilization rate, hatching rate and survival rate of catla fish were investigated. The fertilization rate of catla were $83.25 \pm 0.85\%$, $92.01 \pm 0.45\%$, $82.45 \pm 1.04\%$, $83.18 \pm 0.68\%$, for the doses of DPL, DPM, DPH, WPL and WPM respectively. Jahan [7] observed the induced breeding of *Catla catla*. The mean fertilization rates were found $92 \pm 1\%$, $94.33 \pm 2.08\%$ and $91.33 \pm 1.53\%$ for catla in June, July and August, respectively. Aliniya [13] and Yeasmin [14] showed that observed fertilization rate was 91% and $84.00 \pm 6.89\%$ respectively which is relevant to the present findings. Mudnakudu [6] stated that the percentage of fertilization in most cases ranged from 70 to 99%. Hasan [8] reported that the fertilization rate was 88% by using HCG, which is more or less similar to the present study.

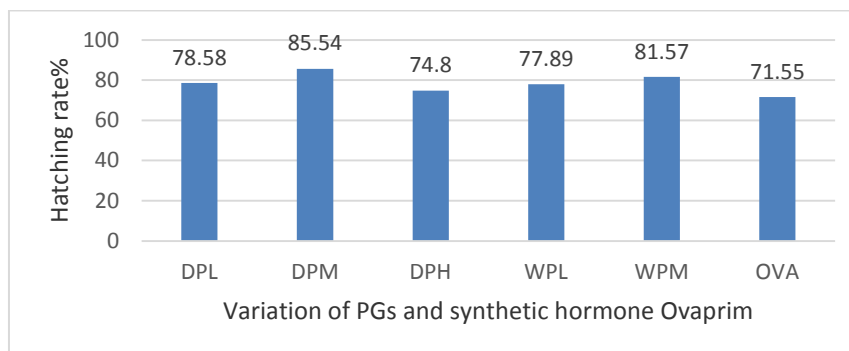


Fig. 2. Hatching rate of catla by different doses of hormones

Table 8. Fertilization, hatching and survival rate of catla, by different doses of hormones

Dose	Fertilization (%)	Hatching (%)	Survival (%)
Dry PG 1 mg/Kg	83.25 ± 0.85	78.58 ± 0.94	77.24 ± 0.49
Dry PG 2 mg/Kg	92.01 ± 0.45	85.54 ± 0.38	87.12 ± 0.46
Dry PG 3 mg/Kg	82.45 ± 1.04	74.8 ± 0.22	73.09 ± 0.42
Wet PG 7 mg/Kg	83.18 ± 0.68	77.89 ± 0.82	75.8 ± 0.30
Wet PG 11 mg/Kg	88.59 ± 0.48	81.56 ± 0.59	80.76 ± 0.64
Ovaprim 0.5ml/Kg	72.85 ± 0.43	71.54 ± 0.48	69.2 ± 0.77

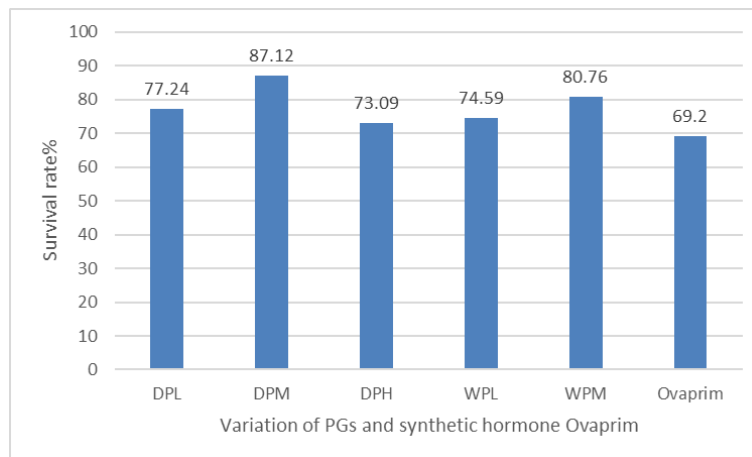


Fig. 3. Survival rate of catla by different doses of hormones

The present study observed the hatching rate of catla were $78.58 \pm 0.94\%$, $85.54 \pm 0.38\%$, $74.8 \pm 0.22\%$, $77.89 \pm 0.82\%$, $81.56 \pm 0.59\%$ for the doses of DPL, DPM, DPH, WPL, WPM respectively. Yeasmin [14] showed that hatching rate was $87.33 \pm 12.45\%$. Almamun [11] reported that by using PG, hatching rate was 85% and by injecting ovaprim, hatching rate was $71.54 \pm 0.48\%$. Bhuiyan [10] reported that the highest hatching rate was 71.80 ± 2.00 .

The present study stated that, the survival rate of catla were $77.24 \pm 0.49\%$, $87.12 \pm 0.46\%$, $73.09 \pm 0.42\%$, $75.8 \pm 0.30\%$, $80.76 \pm 0.64\%$ for the doses of DPL, DPM, DPH, WPL and WPM respectively. Ikechukwu [15] reported that, survival rates of fingerlings were 76.67% in pituitary. Almamun [11] found that survival rate was 84% by PG and by injecting ovaprim, was $69.2 \pm 0.77\%$. Yeasmin [14] showed that survival rate was found higher in dry PG (83.3%) followed by wet PG (79.5%), which is relevant to present findings.

5. CONCLUSION

The fertilization, hatching and survival rate were best in the medium dose of dry pituitary gland (2 mg/Kg body weight of fish). The use of 2 mg/Kg body weight of dry pituitary gland can be used as first dose of female and 4 mg/Kg body weight of fish as second dose of female and 2 mg/Kg body weight as first dose of catla male to obtained better fertilization, hatching, and survival rates.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. DoF. Fishery Statistical Yearbook of Bangladesh (2020-21). Fisheries Resource Service System, Department of Fisheries (DoF), Ministry of Fisheries and Livestock, Dhaka, Bangladesh; 2022.
2. Rath RK. Fresh water aquaculture. Scientific Publishing House, Jodhpur; 2008.
3. Islam MA. Fish Seed Production in Bangladesh Proceeding of the SAARC Work Shop on Fish Seed Production, Dhaka, Bangladesh. 1989:1-12.
4. Khatun N, Islam MT, Sultana N, Mrong S, Huq MA. Present status of carp hatchery and breeding operations in Bangladesh: A review. Res. Agric. Livest., Fish. 4(2):123-129.
5. Mudnakudu C, Nandeesh, Kondapalli GR, Rama NJ, Nick CP, Tharayil JV, Perar K, Shetty HPC. induced spawning of Indian major carps through single application of ovaprim-c. College of Fisheries, University of Agricultural Sciences, Bangalore, India; 2013.
6. Jahan I. Induced breeding of indigenous carps (*Labeo rohita*, *Catla catla*, *Cirrhinus cirrhosus*) using a synthetic flash hormone at a government fish hatchery, Maskanda, Mymensingh. MS thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh; 2015.
7. Hasan M, Rahman MM, Hossain A, Robbane GM. Journal of the Asiatic Society of Bangladesh Science. 2014; 40(2):231-241.

8. Islam MM, Al-Asif A, Amin MR. The induced breeding of common carps (*Cyprinus carpio*) in Bangladesh. Indian J. Sci. 2016; 23:619–632.
9. Bhuiyan AS, Islam MK, Zaman T. Induced spawning of *Puntius gonionotus* (Bleeker). Journal of Bio-Science. 2006;14: 121-125.
10. Almamun A. Dose optimization with PG hormone for induced breeding of *Labeo bata*. MS thesis. Department of Fisheries Management, BAU, Mymensingh; 2006.
11. Aliniya M, Khara H, Noveiri SB, Dadras H.. Influence of age of common carp (*Cyprinus carpio*) broodstock on reproductive traits and fertilization. Turkish J. Fish. Aquat. Sci. 2013; 13:19–25.
12. Ayyappan S. Handbook of fisheries and aquaculture, Indian Council of Agricultural Research, New Delhi. 2011: 590- 640.
13. Yeasmin SM, Rahman MH, Rahman MA, Al-Asif A, Farid MA, Billah MM. Influence of feeding administration of brood-stock on breeding performance of common carp (*Cyprinus carpio* Linnaeus, 1758). J. Aquac. Eng. Fish. Res. 2018; 4:127–137.
14. Ikechukwu CC, Nsofor CI, Ikeogu CF, Ogbonnaya HF. Comparative effects of ovaprim and pituitary hormone on the inducement, hatchability, survival and growth performance of *Clarias gariepinus*. J. Aquat. Sci. 2019; 34:125–131.
15. Chowdhury H, Singh SB, Sumumari KK. Experiments on large-scale production of fish seed of the chinese grass carp *Ctenopharyngodon idella* (C and V) and silver carp *Hypophthalmichthys molitrix* (9 C and V) by induced breeding in ponds in India. Pacific Indian Academy Science. 1996;63(2): 80-95.

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