Impact of Agrimin and Fishmin on the Aspects of Fecundity, Fertilization and rate of hatchling of the Fish Species *H.Molitrix, C.Carpio, C.Idella*

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ABSTRACT

The present study examined the effect of supplementary feeds on Fecundity and Fertilization of the selected fish species *Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella.* Two year old fish species were selected for the study and divided into two groups and were fed for 30 days, twice a day, at 10 a.m. and 6 p.m respectively and the parameters evolved were the rate of fecundity, fertilization and hatchling. The results on fertilization indicate that the selected fish species registered a higher rate of fertilization in Agrimin than Fishmin this might be due to nutritional status. It is also reported that in most Fecundity represents the number eggs lay by the female. The results of present investigation on the rate of fecundity in selected fish species shows maximum in Agrimin over Fishmin.

Keywords: Fecundity, Fertilization, Agrimin, Hatchling, Fishmin

Introduction

Studies on fecundity are receiving much attention now a days as they play key role in fish stock management. This is the most important aspect of fish biology. Fecundity is a measure of reproductive capacity of female fish and its adaptation to various conditions of environment. Range of fecundity has been determined for many fishes which provides information of population dynamics, racial, characteristic production and stock recruitment problems. The important studies on fish fecundity were made [1-4].

Fecundity is usually defined as the number of ripening eggs found in the female just prior to spawning. This contrasts with fertility which is the number of eggs laid. The fecundity of fishes as that of other animals ensures the survival of the species under varying conditions. [5] used fecundity for the number of eggs produced by a mouth breeding and fertility for the number of young produced. Large fecundity evolves under conditions of heavy mortality, particularly when this is due to predators. Changes in individual fecundity are regulated by changes in the food supply. Faster growing individuals usually have a high fecundity than slower growing ones of the same size [6]. The species responds to changes in the environment by changes in its fecundity. The absolute fecundity is dependent on the length and weight of the female [7].The number of eggs laid by various groups of fishes varies considerably i.e., from a few large eggs as in several sharks to three thousand millions of eggs in the ocean sunfish (*Mola mola*). On the whole, the fecundity of fishes is much higher than that of terrestrial vertebrates [8]. The most fecund fishes are those which have floating as well as pelagic eggs. With respect to specific gravity, two egg types exist among ostiecthys. They are the buoyant of planktonic eggs, which is very common in marine fish families, and the non buryant type, which is common in fresh water fishes. Fishes having protective devices for the eggs are usually provided with a low fecundity in marine

fishes usually somewhat higher than those of fresh water or migratory fishes. The number of eggs contained in an ovary of a fish is termed as the individual, absolute or total fecundity. The suitable conditions are not found the eggs may become artresic, degerate and ultimately reabsorbed in the body [9]. The fecundity differences can be observed in fishes of the same length if kept under different conditions. Substantial differences have been observed in the fecundity between closely related species and even in the subspecies. The increase in fecundity of fishes may arise from several factors.

1. It may be due to the reduction of the passive feeding period which may be due to the decrease in the reserve of yolk in the egg. Therefore availability of food is also an important factor affecting reproduction.
2. Increase in the density of yolk may cause increase in fecundity.
3. Increase in volume of gonads also increases fecundity.
4. Individual fecundity is also increased when the eggs present in the ovary ripen together at any time [10].
5. Several environmental factors also affect fecundity.They are believed to act through the food supply [11].

Suggested that the fecunditydifferences of Grand banks haddock were associated with water temperature. The temperature itself does not directly affect fecundity. All the lake morphology factors were negatively correlated with fecundity. Food sources and growth were positively correlated with fecundity. Food resources and growth were positively correlated and population density was negatively correlated with the index of individual fecundity. Indian major carps are known for their high degree of fecundity [12].The eggs of Indian major carps like *Catla, Rohu, mrigal*, are not floating type in nature Round shape, but they differs in diameter and yolk colour. In *Rohu* egg size is 5.0mm and has red colored yolk.

It is often thought that since fish weight is connected to the condition of fish, fecundity is more likely to be closely correlated to its weight than to its length. However, where the correlations have been analysed adequately, very little advantage has been found in considering weight rather than length [13]. Perhaps more uncritical papers have been written about egg size and quality than any other aspect of fish fecundity. To start with, if the size of eggs is to be compared, they must be measured at the same development stage and this is impossible while they are in the ovary since they are developing fast. They are, therefore best measured after fertilization, by which time it is impossible to determine the fecundity by the usual methods. This difficulty is less with salmonids, or fish such as the herring or carp which lay adhesive eggs; and it is with these that the best work has been done. The first point to make is that in general large fish tend to lay larger eggs than the smaller ones found this with salmon[13].. Therefore an attempt is made on this investigation to study the rate of fecundity of selected fish species fed with supplementary feeds that are Agrimin and Fishmin. It can be said that greater fecundity the more acute will be the intraspecific competition. It will lead to the examination of the old forms and new species will emerge. The notion that an increase in the fecundity may lead to its own extermination is not correct.

In fact an increase in the fecundity of an individual with in the population represented an adaptive response of the population to environmental changes. The egg density of 1000 eggs per square inch with the egg stock together in many layers [14]. It does not include pathological conditions. fecundity weight

and length of the fish *Hypophthalmichthys molitrix* and correlated with the body has studied[15].Thus it can be concluded that an increase in fecundity ensures the preservation and not the extermination of the species. It ensures its relative stability both in space and time in the event of fairly wide fluctuations in the environmental conditions.

Fertilization

Reproductive cycle may be viewed as an integrated response of the individuals of a population to the environment both in a functional and a temporal sense. Temporal patterns of reproductive cycle may result through a complex coordination of a number of endogenous factors with respect to interacting exogenous factors at a given time and over a time period by members of a population [16] and reproductive behaviour like court play plays a major role in the successful forming and culture of fish species.

Fertilization is the fusion of male and female gamates, which in animals are the spermatozoan and the ovum respectively. It results in the formation of a zygote, from which the body of the off spring is formed. In the majority of fishes fertilization is external, but in a number of species, both egg laying and those in which the eggs develop inside the maternal body. Internal fertilization takes place, in connection with which they have often evolved special copulatory organs. In their simplest form the copulatory organs are represented by anal papiliae, as in the lampray (cyclostomes) and also in number of fishes - cottids : gobies and certain others [17]. In the female shark and skate internal fertilization occurs in both egg laying and viviparous species. Rohu is poly gamous fish and eggs of Rohu are demersal and sink to the bottom. Eggs when fully fertilized measures 4.5-5.0 mm in dia meter and are round, transparent, non adhesive, and reddish in colour. Yolk is spherical and devoid of oil globules [18].

There are also many viviparous species among the bony fishes. In the order cyprinodontiformes, which is very rich in species, a significant proportion of the species produce living offspring. In Indian major carps like *catla, rohu* and *mrigal* external fertilization takes place. In most species the eggs are more stenothermal than juvenile or older fish and are the most vulnerable stage in the life cycle to the effects of thermals stress. These effects will influence not only the survival of individual fish but also the ultimate survival of the population [19]. Prior to fertilization a more or less distinct courtship behaviour synchronizes spawning readiness. During this courtship behaviour the matured male chases the matured female in the curves where generally undisturbed water prevails. The male very gently rub the lower part of the abdomen of the female and in so doing the eggs from the female are released in the waters followed by ejection of the milt (Spawn) from the male over the egg mass, thus the process of fertilization is effected in water. Fertilizability of eggs and sperms is time-limited. The fertilization period of salmon eggs, for example is very short. The proportion of fertilized eggs drops sharply with time and the maximum time period ranges between 15 and 30 minutes [20]. The short viability of sperms also restricts the fertilizable period. For example this period is only about 30 seconds in rainbow trout *Salmo gairdeniri* [21,22].The physiology of fertilization has been reviewed [23,24]. In spite of the restricted time of fertilizability of salmonoid eggs, excavations of redds revealed a high degree of natural fertilization. An average fertilization of 98.2% in New Zealand Chinook salmon (Oncorhynchus shawytscha) redds and of 98.9% in brown (Salmo trutte) and rainbow trout redds [25]. 94.0% on the average from redds of king salmon silver salmon (O. Kisutch) and steel head trout (Salmo gairdneri) in a California stream [26] and found 92.5 to 98.4% of fertilized eggs of brown trout in swiss streams [27]. The Indian major carps are also known for their higher rate of fertilization [28]. The importance of different egg and sperm quality at the intraspecific level was mentioned [29] For example, yolk reserve and fat content of crucian carp (*Carassius auratus*) and roach (*Rutilus ratilus*) eggs vary with the age of spawning females. Sufficient yolk reserve improves the chances of level survival. In spawning groups of several marine fishes, egg volume declined from early spring through summer, presumably due to older females with larger eggs spawning early in the season. A correlation in time between the production cycle of an area; which guarantees an

adequate food abundance for only a restricted time, and onset of external feeding is most probable for herring and place larvae. The fine structure of the egg envelops and micropyle of unfertilized spawned eggs of *Cyprinus carpio* was observed [30]. The outer surface showed regularly arranged pores (dia 0.20-0.25 m) but was devoid of any filaments, fibrils or wrinkles. The micropyle was funnel shaped which exhibited an outer pit (1 mm dia) narrowing into a distinct canal (4.5 mm dia). The larger diameter of micropylar canal in comparison with the sperm head size of Rohu and other cyprinids make intergeneric and inter specific hybridization easy in Rohu. Most fresh water fishes have demersal eggs with a specific gravity greater than the freshwater. Many of them are temporarily adhesive but the period of adhesiveness is short and restricted to the time immediately after expulsion. Cyprinoi species which lay their eggs on aquatic plants are typical of this group. The eggs are prevented from floating away and are located above bottom mud, thereby ensuring a sufficient water circulation over the surface. This will provide a good platform for breeding processes and thus effective fertilization. Spawning beds of herring contain layers or clumps of eggs which stick together and which cover large areas. After fertilization zygotes are formed. They zygotes (fertilized eggs) float on the surface of water and get exposed to the sunlight. Incubated by sunlight, the zygotes undergo cleavage and pass through different stages of development like morula, Blastula and Gastrula. The embryos hatch out and are designated as hatchlings. The hatching time mainly depends upon the atmospheric temperature. With this background, the rate of fertilization in rohu is studied in three different nutrient based freshwaters.

Materials and methods

Methods:

Determination of Rate of Fecundity:

Fecundity which represents the number of eggs released from a breeder is calculated in the following way. Before carrying out the breeding experiment the weight of the female is recorded with the help of a single pan balance. After the eggs are released, the weight is recorded again. The difference in the Weight indicates the mass of eggs released. This is converted into rate and % fecundity.

Rate of fecundity = W1 - W2

Where W1 = Weight of the female before releasing eggs.

W2 = Weight of the female after releasing eggs.

From the mass of eggs released, the number of eggs is counted by transferring them into a 10 ml measuring cylinder without water. The rate of fecundity is calculated by dividing the number of eggs released with the weight of the fisH.

The % of fecundity is calculated by using the following formula.

$$\% \text{ of fecundity} = \frac{No.\ of\ good\ released}{weight\ of\ the\ fish} X100$$

Determination of Rate of Fertilization:

After breeding, all the eggs are collected from the breeding tub and shifted to the hatching tub. While taking the sample eggs from the hatchery, the eggs are churned well and the eggs are collected into

10 ml measuring jar without water.

Thus collected eggs are transferred into a 50ml beaker which contains water. The eggs are counted with the help of petridish one by one. Thus the total number of eggs can be calculated while counting bad eggs (unfertilized eggs) and good eggs (fertilized eggs) separately. The rate of fertilization is calculated with the help of the number of fertilized and unfertilized eggs by using the following formula.

No. of fertilized eggs = Total No. of Eggs - No. of unfertilized eggs.

And the percentage of fertilization is calculated by using the following formula.

$$\% \text{ of fertilization} = \frac{\text{No of fertilized eggs}}{\text{Total No of eggs}} \times 100$$

Table: 1 Effect of Agrimin & Fishmin on rate of fertilization & fecundity in *H.molitrix, C.carpio, C.idella*

Name of the feed	Name of the parameter					
	Rate of Fertilization			Rate of Fecundity		
	Cyprinus carpio	*Hypopht halmichthys molitrix*	*Ctenopharyng odon idella*	*Cyprinus carpio*	*Hypopht halmichthys molitrix*	*Ctenopharyng odon idella*
Control Feed						
AV	1.35	0.88	1.50	1.86	1.34	2.72
SD	□0.055		□0.036	□0.024	□0.56	□0.37
PC						
t						
Control Feed + Agrimin						
AV	2.88	2.57	2.72	3.868	3.655	3.90
SD	□0.62		□0.066	□0.94	□0.34	□0.77
PC	113.33	192.04	81.33	107.95	172.76	43.38
t						
Control feed + fishmin						
AV	2.57	1.61	2.22	2.97	2.40	3.21
SD	□0.056		□0.35	□0.19	□0.24	□0.16
PC	90.37	82.95	48.00	59.67	79.10	18.01
t						

Each value is the mean SD of 7 samples
AV - Average
SD - Standard Deviation
PC - Percentage change over the control

* – P<0.001,

N.S – Not significant

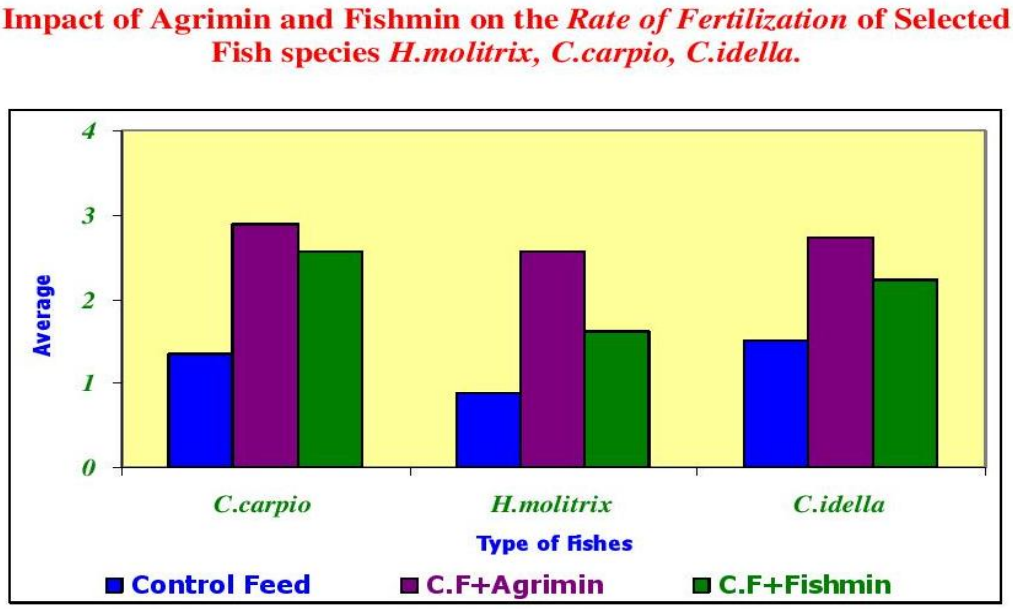

Fig 1: Impact of Agrimin and Fishmin on the Rate of Fertilization of selected fish species *H.molitrix, C.carpio, C.idella*

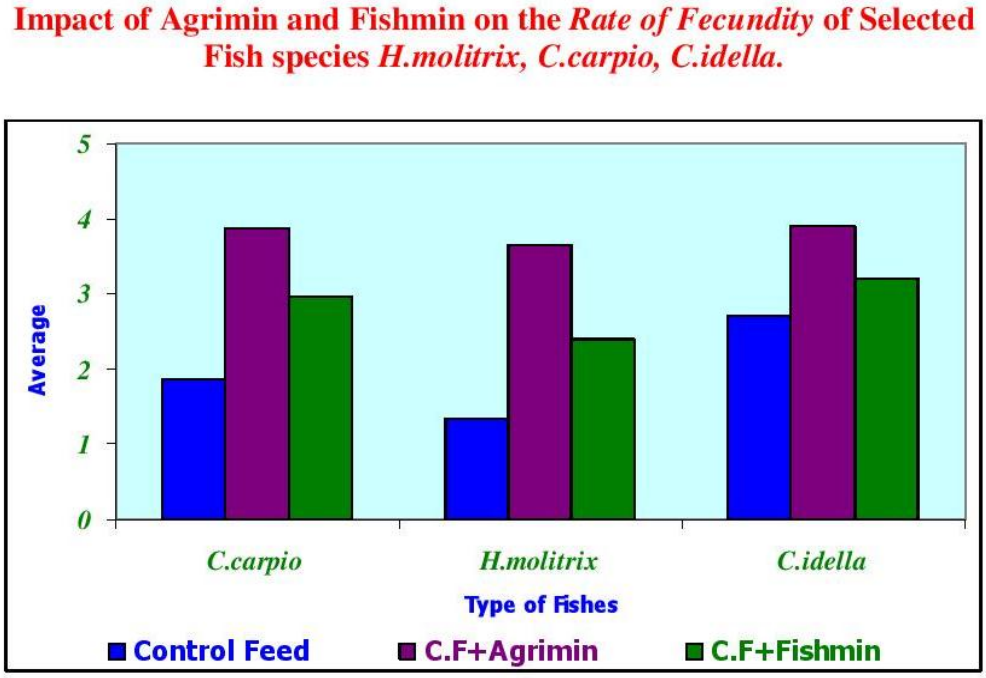

Fig 2: Impact of Agrimin and Fishmin on the Rate of Fecundity of selected fish species *H.molitrix, C.carpio, C.idella*

Determination of Rate of Hatchlings:

After the hatching of eggs, the hatchlings are collected from the hatch tub and shifted into a 50 ml beaker, containing fresh oxygenated water. The hatchlings are counted with help of Petridish one by one. Thus the total number of hatchlings can be calculated. While counting, bad hatchlings (dead ones) and good hatchlings (live ones) are separated. The rate of hatchlings is calculated with the help of number of good and bad hatchlings by using the following formula.

No. of hatchlings = Total Number of hatchlings - Number of bad hatchlings.

And the percentage of hatchlings is calculated by using the following formula.

$$\% \text{ of hatchings} = \frac{No.\ of\ good\ hatchlings}{No.\ of\ bad\ hatchings} X100$$

Table: 2 Effect of Agrimin & Fishmin on rate of hatchling in *H.molitrix, C.carpio, C.idella*

Name of the feed	*Cyprinus carpio*	*Hypopht halmichthys molitrix*	*Ctenopharyng odon idella*
Control Feed			
AV	1.108	0.489	1.00
SD	±0.026	±0.024	±0.005
PC			
t			
Control Feed + Agrimin			
AV	1.644	1.327	1.848
SD	±0.26	±0.024	±0.78
PC	48.37	171.37	84.8
t			
Control feed + fishmin			
AV	1.25	0.77	1.43
SD	±0.025	±0.008	±0.036
PC	12.81	57.46	43.00
t			

Each value is the mean SD of 7 samples
AV - Average
SD - Standard Deviation
PC - Percentage change over the control
* – P<0.001,
N.S – Not significant

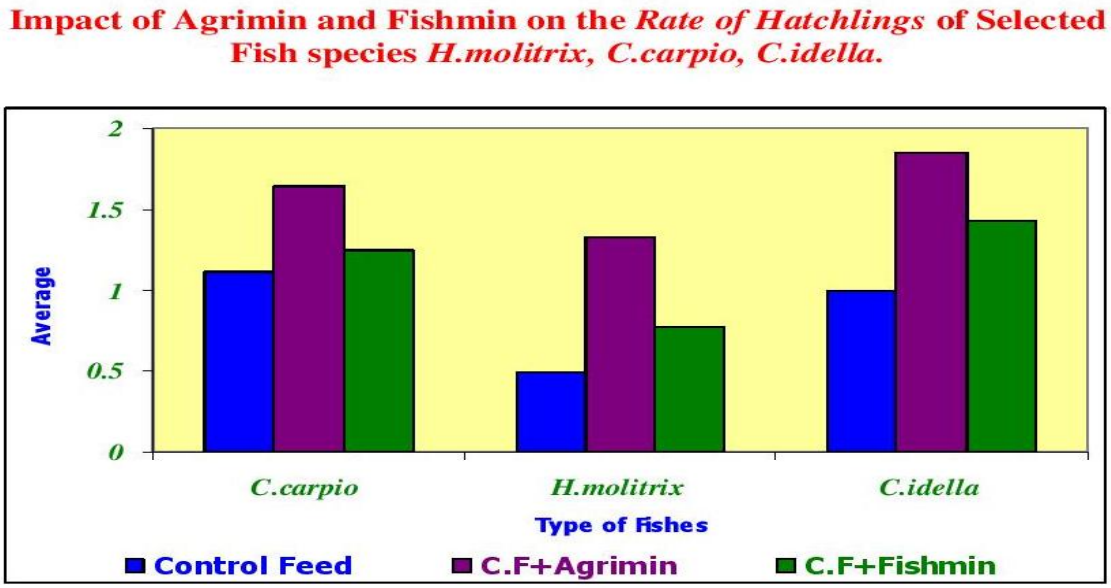

Fig 3: Impact of Agrimin and Fishmin on the Rate of Fecundity of selected fish species *H.molitrix, C.carpio, C.idella*

RESULTS & DISCUSSION:

Fecundity represents the number eggs laid by the female. This directly gives an indication of the rate of fertility in any organisms including fishes. The results of present investigation on the rate of fecundity in selected fish species shows maximum in Agrimin over Fishmin .(Table 1) (Fig.2)

These differences among the two types of supplemenrtary feeds , which are found to be highly significant ($P<0.001$) may be attributed to the nature of the growth and food habits of major carp as suggested[31]..

The higher rate of fecundity in Agrimin is due to the increased presence of micro nutrients and amino acids. These observations are supported by the fact that the water on acid soil is generally less productive than on alkaline soils as suggested [32]. Further the Agrimin and Fishmin particles might have absorbed considerable amount of nutrient elements like phosphates, potassium and nitrogen to enhance the nutritional status to produce more planktons ,the micro food for fishes. This is also supported as the plankton population on which the total aquatic life depends directly or indirectly [33]. It is found abundant growth of phytoplankton's and zoo planktons having high concentration of pH [34]. These plank tonic blooms are known to produce more oxygen in the water to increase the overall metabolic activities including the breeding and fecundity of fishes. In such conditions these extra nutrients present in Agrimin and Fishmin must have stimulated reproductive capacity including increased rate of egg production. (Table - 1) (Fig. 2).

The reproductive capacity of fish is also influenced by dissolved micro nutrients and pH of water as Sinha et al (1990) regarded pH as one of the influencing factors of the productivity of a water body. According to some limnologists, the largest fish crops are usually produced in water which is just on the alkaline side of between 7.0 and 8.0. The limit above or below which pH has a harmful effect like as 4.8 and 10.8[35]. In the present investigation pH of water is not changed by adding supplementary feeds which is between 7.5 to 8.0. The findings on fecundity in selected fish species finds application in population studies, production and mortality studies and also it can be used in estimating abundance of female population in fish species.

Thus basing on results at fecundity it may be concluded that the experimental fish *C.idella* is found to have a higher reproductive potential as compared to *H.molitrix or C.carpio.* Agrimin has resulted in higher fecundity in the experimental fish than fishmin.

Fertilization that is union of male and female gamates is external in Indian Major Carps as in the case of any other fish. Therefore it is found to be influenced by environmental factors of aquatic media and nutrients. The results on fertilization indicate that the selected fish species registered a higher rate of fertilization in Agrimin than Fishmin (Table-1 Fig.1). This might be due to nutritional status. It is also reported that in most species the eggs are more stenothermal than Juvenile or older fishes and are the most vulnerable stages in the life cycle to the effects of thermal stress. These effects will influence not only the survival of individual fish but also the ultimate survival of the population. Further courtship behaviour between male and female which forms a pre-requisite for fertilization will only be highly successful in undisturbed waters and provided micro nutrients as reported. *C.carpio* as a column feeder might have experienced least thermal changes and disturbances in the middle portion of the water because of generally calm and quite aquatic conditions. That's why the column feeder *C.carpio* has shown a significantly higher rate of fertilization in highly nutrient Agrimin over Fishmin. It is followed by *C.idella and H.molitrix.* (Table-1) (Fig.1).

The greater the nutrients higher will be the fertilization rate as noted in the present study. The presence of more nutrients in the water might have facilitated the union of sperm and ova when compared to their union in low nutrient water. It has also been reported most fresh water fishes have demersal eggs with a specific gravity greater than fresh water is also noticed in the present study. Many of the fresh water fish eggs including those of the major carps are temporarily adhesive but the period of adhesiveness is short and restricted to the time immediately after explosion. The eggs are prevented from floating away and are located above the bottom mud, thereby nsuring a sufficient water circulation over the surface. This will provide a good platform for breeding processes and thus effective fertilization. Such a good platform for breeding purposes might have been formed in waters with more turbidity and mud.

Statistical Analysis:

For each parameter, the mean of individual observations (for both control and experimental groups) were taken into consideration. Statistical significance of the data was analysed through two way ANOVA (Analysis of variance); SNK (Student Newman-Keuls) test and regression analysis (Zar, 1984).

Conclusion

The study revealed that supplementary feeds accelerates the overall the state of fish species yield parameters from the supplementary feeds fed fishes. Agrimin and fishmin increased the rate of fecundity of all the three fishes and more elevation was observed for Agrimin fed fish .These trends were more for *Ctenopharyngodon idella* compared to other two fish species. (Table - 1) (Fig. 2) Similarly Agrimin fed fish showed more rate of fertilization compared to fishmin fed ones over the control feed fed fish and the trend was more for Control Feed with Agrimin*. Cyprinus carpio* and was followed by *Ctenopharyngodon idella > Hypophthalmichthys molitrix*. (Table-1) (Fig. 1). Agrimin appeared to enhance the rate of hatchlings of all the fish species compared to fishmin fed ones. Increased rate of hatchlings was observed in the fish *Ctenopharyngodon idella* and was followed by *Cyprinus carpio > Hypophthalmichthys molitrix.* Thus Agrimin and fishmin enhance the biomass of the fishes and this result in improving the yield. Of all Agrimin appeared to be more beneficial in improving the metabolism and fish yield than fishmin. From the present experimental work, it concludes that both Agrimin and fishmin increase the productivity over the control hence they may be used in Aquaculture practices.

Reference:

1. Hora, S.L. and Pillay, T.V.R. 1962. Handbook on fish culture in the Indi-Pacific region, FAO. FisH.Biol. TecH.Pap. (14).:204.
2. Sukumaran, K.K. 1969. Growth, malnutrition and fecundity of cultivable fishes. FA0 / UNDP regional seminar on induced breeding of cultivated fishes, Calcutta. Rome.FAO/IBCF/5:52.
3. Rao, L.M., Rao, G.V. and Sivani, G. 1999. Hydrobiology and Icthyofauna of Mehadrigedda stream of Visakhapatnam,. Ap.J.Aqua. Biol. Vol. 13(1 & 2): 25-28.
4. sakhere, V.B. 2000. Fecundity of *Catla catla* (Ham.) from yeldari reservoir, Maharashtra. J. Aqua. Biol. Vol. 15(1 &2):50-51.
5. Welcomme, R.L. 1979. Fisheries ecology of flood plain rivers. Longman group Ltd. London and New York. 151.
6. Bagenal, T.B. 1971. The inter relation of the size of fish eggs the date of spawning and the production cycle, J.Fish Biology, 3:207-219.
7. Biswas, S.P., Nasar, S. and Chatterjee, K. 1984. Inter and Intraspecific comparisons on some aspects of the reproductive biology of the two carps *Labeo Pangusia* (Ham.) and *Labeo dero* (Ham.). *ArcH.Biol.* (Bruxelles). 95:11-27.
8. Sharma, U. and Grover, S.P. 1982. An introduction to Indian fisheries. Bishunsingh Mahendrapalsingh, Dehradun, India. 179-182.
9. Jobling, T. 1996. Environmental Biology of fishes. Chapman and Hall, London. 27.
10. Hodder, V.M. 1965. The possible effects of temperature on the fecundity of Grand Bank haddock. ICNAF Spec. Publ. 6:515-522.
11. Jhingran, V.G. 1983. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi, India. 258-366.
12. Bagenal, T.B. 1957a. The breeding and fecundity of the long rough dab *Hippoglossoides platessoides* (Fabr.) and the associated cycle in condition. J.mar.boil.Ass.UK. 36:339-373.
13. Baxter, I.G. and Hall, W.B. 1960. The fecundity of Manx herring and a comparison of the fecundities of autumn spawning groups. Unpublished *I.C.E.S.* Herring committee document No.55.
14. Pope, J.A., Mills, D.H.and Shearer, W.M. 1961. The fecundity of the Atlantic Salmon, *Salmo Salar* (Linn.). Freshwat.Salm.Fish.Res. 26:1-12.

15. Galkina, Z. 1970. Dependence of egg size and age of the female salmon (*Salmo Salar* (L)) and rainbow
16. Outram, D.N. and Humphreys, R.D. 1974. The pacific herring in British Columbia waters. Fisheries and marine service pacific biological station, Nanaimo, B.C. Circular, 100:26 trout (*Salmo irideus* (Gibb)). J.Ichtyol. 10:625-633.
17. Rajender Rao, K., Sarojini, R. and Nagabhushanam, R. 2003. The influence of extrinsic factors on the spawning patterns of *Macrobrachium lamerii*. J. Aqua. Biol. Vol. 18(2) : 115-118.
18. Chakrabarthi, N.M. 1998. Colour of *Cyprinus carpio*. In: Biology, culture and production of Indian major carps. *Narendra publ. House*, New Delhi. Pp-89,131.
19. Elliot, J.M. 1981. Some aspects of thermal stress on freshwater teleosts. In stress and fish (A.D. Pickering. Ed.). Academic press, New York, 209-245.
20. Yamamoto, T. 1961. Physiology of fertilization in fish eggs. Intern.Rev.Cytol. 12:361-405.
21. Billard, R., Petit, J., Jalabert, B. and Szollosi, D. 1974. Artificial insemination in trout using a sperm dilutant, the early life history of fish (JH.S.Blaxter. Ed.). *Springer verlag*, Berlin, Heidelberg, Newyork. 716:723.
22. Ginsburg, A.S. 1963. Sperm egg associationj and it's relationship to the activation of the egg in salmonid fishes. J. Embryol. Exp. MorpH.11:13-33.
23. Blaxter, J.H.S. 1969b. Development eggs and larvae. Fish Physiology, (W.S. Hoar and D.J. Randall. Eds.). Reproduction and growtH.Academic press, New York, London. Vol. 111. 177-252.
24. Hobbs, D.F. 1937, Natural reproduction of quinnat salmon, brown and rainbow trout in certain New Zealand waters. NewZealand Marine Dept., FisH.Bull. 6:104.
25. Jhingran, V.G. 1983. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi, India. 258-366.
26. Nikol'Skii, G.V. 1962. On some adaptations to the regulation of population density of fish species with different types of stock structure. The exploitation of natural animal populations (E.D. Le Cren & M.W. Holdgate. Eds.). Blackwell Scientific publications, Oxford. 267-282.
27. Gopalakrishnan, A., Ponnaiah, A.G. and Lal, K. 2002. Ultrastructure of egg membrane of Rohu, *Cyprinus carpio*, Indian. J.FisH.49(1):93-95.
28. Alikunhi, K.H.1957. Fish culture in India. Farm Bulletin. Indian coun. Agri. Research, New Delhi. 5:24-28.
29. Alikunhi, K.H.1960. Experiments on Induced spawning of Indian carps with pituitary injections. Indian J.FisH.7(11):20-49.
30. Nisar and Yeragi, S.G. 2003. Seasonal temperature changes and their influence on free carbondioxide, dissolved oxygen (DO) and pH in Tansa river of Thane district, Maharashtra. J. Aqua. Biol. Vol (1) : 73-75.
31. Sinha, M. 1990. Polyculture of Indian and exotic carps a techno-economic appraisal. In: Suguna. V.V. Bhawmick, U.(Ed.). Technology for inland fisheries development. Published by Jhingran, A.G. ICAR, Barrackpore. 220.
32. Rath, R.K. 1993. Freshwater Aquaculture, Scientific publications. PP. 6-7, 16