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Determination of Suitability of Egg Deposition Materials and Development of Larval Feeds for Higher Growth and Survival of Common Carp (*Cyprinus carpio* L.)

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ABSTRACT. *Due to the unavailability of indigenous lacustrine fresh water species, Sri Lankan inland fish production is heavily dependant on the exotic species, like common carp (Cyprinus carpio L). Common carp is a highly domesticated fish because of their cultivable qualities such as higher growth rate and fecundity, early maturity, hardness and better feed conversion rate. Recent developments in aquaculture have paved the need for live feeds as well as artificial feeds to meet their requirements.*

Experiments were carried out to find out whether the aquatic plant Hydrilla verticillata is more efficient as an egg collecting material for common carp than specially made Coconut (Cocos nucifera L.) fibre strands; and to determine the suitability of micro-worm, whole egg, egg yolk, and swine liver as feeds of common carp post larvae.

The total number of eggs deposited per unit area of material was found to be significantly higher ($p<0.05$) in coconut fiber than in hydrilla leaves. Therefore, compared to hydrilla bundles, coconut fibers were more suitable for egg collection during semi-artificial spawning of common carp. Compared to other three tested feeds, micro-worm treatment gave the least water pollution, (less NH^+_4 and H_2S production) and mortality rate, with highest weight gain ($P>0.05$). Therefore, out of the tested feeds micro-worms were found to be the best for common carp post larvae.

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INTRODUCTION

Sri Lanka consist of both the necessary climate and water resources required to develop successful production of many species of fresh water table fish. The raising of fish, to serve as food is still not popular in Sri Lanka. This is mainly due to herito dependent higher demand for marine fish and non-availability of technology. With the gradual realization that freshwater fish is not inferior to expensive marine fish and an availability of quality marine fish in the hinterland, the acceptance of freshwater fish as a food fish has been gradually increasing over the past few decades. Furthermore, the fresh water resources found in Sri Lanka have a high potential to increase the protein supply and the nutritional status of the population.

Due to the unavailability of suitable indigenous lacustrine fresh water species, the inland fish production is heavily dependant on the exotic species like tilapia, common carp, Chinese and Indian major carps. Among them common carp (*Cyprinus carpio* L.) is a domesticated fish, because of its cultivable qualities such as growth rate, early maturity, high fecundity, hardness and better feed convertion rate (De Silva, 1983).

Out of the different management practices in aquaculture, the most important is the feeding of fish. Larval rearing is a critical period of fish culture as there could be more deaths if feeding is not performed properly and adequately. Successes of aquaculture will depend upon the optimum growth and the maximum survival rate obtained through a provision of nutritionally balanced environmentally friendly and economically viable feed.

Suitability of *Teprosia purpuraria,* Pilla shrubs (Edirisinghe and Leelawathie, 1993), *Teprosia purpuraria*, Pilla creeper (Edirisinghe and Jayabalasinham, 1992), *Musa accuminata*, banana leaves (Edirisinghe *et al.*, 1989), polythene strips (Edirisinghe *et al.*, 1986) *Panicum maximum,* Guinea A grass leaves (Edirisinghe *et al.*, 1985) for egg deposition of common carp have been determined.

Recent developments in aquaculture have paved the need for live feed as well as artificial feed to meet their nutrient requirements. Therefore, this is an important area of research for the development of inland fish industry. Objectives of the study were to find out whether the aquatic plant hydrilla (*Hydrilla verticillata*) is more efficient as an egg collecting material for common carp than specially made coconut (*Cocos nucifera* L.) fiber strands; testing of four different feeds for post larval stages of common carp and study their survival rates and growth rates in each feed.

MATERIALS AND METHODS

Experiment 1: Rate of egg deposition, fertility and hatchability of common carp

Experiments were conducted at the Department of Animal Science, Faculty of Agriculture, University of Peradeniya. Mature hydrilla plants were collected, cleaned and bundled with the help of nylon thread. Each bundle was 35 cm in length and 10 cm in width. Average surface area was calculated. They were washed thoroughly with a $KmnO_4$ solution. Four '*Kakabans*' were prepared. Bamboo poles each of 0.5 m in length and 5 cm width were used. Two bamboo poles were tied with hydrilla plant bundles and the remaining two were used for coconut fiber brush pieces. Approximately equal surface areas of the two types of materials were used in these '*Kakabans*' to compare the egg deposition efficiency.

Similar sized (30 cm total length) and matured common carps were selected. The male to female ratio was 2:1. They were introduced to the spawning tanks with '*Kakabans*' at about 1000 h.

Experiment 2: Survival rates and growth rate with different feeds

Water quality parameters such as DO (dissolved oxygen), pH, temperature, total hardness, total alkalinity and ammonia were measured using electronic instruments.

A whipped egg was added to 100 ml of warm water (60°C) and stirred well. This was used as the feed prepared from the whole egg.

Bread, Soy flour and water were used as the ingredients in making a feed for micro-worm. Added boiled water into 175 g of fresh bread which was broken into small pieces and stirred well to produce a thick jell. Five grams of soy flour were added into the jell and mixed well. The starter culture of micro worms was used as an inoculum which was added to the jell and the container was kept loosely covered. After three days, a white film of tiny micro worms formed on the sides of the container. They were scraped off with a knife and fed to the young post larvae. Separated egg yolk was whipped and used as a pure feed. This was considered as the control feed. Dried swine liver was ground well to the powder form and was directly fed to post larvae.

Four glass tanks of 60×30×30 cm^3 were used. Each tank was divided into 20×30×30 cm^3 compartments by using rigiform sheets. They were cleaned thoroughly and filled with clean water and kept for 48 h to remove chlorine. Each compartment was aerated. Post-larvae were introduced in the morning to reduce the stress. Ten post-larvae per tank were stocked. Three samples of the post larvae were weighed by using a top loading balance. Randomized Complete Block Design was used as the experimental design. Hence, fish were weighed at introduction to the tanks and at the end of the experimental period. Feeding was continued for 3 weeks and the stocking density was 12×10^5 pl/ha. SAS package was used for statistical analysis.

RESULTS AND DISCUSSION

Experiment 1

Results revealed that the fertility and hatchability were high in both materials. This is also due to the good physiological conditions of selected both male and female common carp spawners. In addition, favorable physico-chemical parameters of water and the better substrates for the attachment of sticky eggs of common carp also enhanced the fertilization and hatching of eggs (Chodar, 1980). Temperature range of water was 23.3-24.7°C (24.5 ± 0.2) and the *pH* was between 7.0 and 8.0 (7.1 ± 0.2) and these values were in the optimum range.

According to Chodar (1980), common carp lay eggs on substrate vegetation and would also have been stimulated by rubbing the body on the materials used for spawning. Coconut fibers are lignified and are rough in nature when compared with hydrilla leaves which are more smooth. Once these rough material rubs against the body of fish, they would have been stimulated to spawn on coconut fibers in contrast to the smooth hydrilla leaves (Table 1). This roughness also provides a suitable substrate for easy attachment of the sticky eggs of common carp.

Experiment 2

The weight gain and survival rates determined in this experiment are given in Table 2. A significantly high ($P<0.05$) body weight gain was obtained from the fry fed with egg yolk, when compared the other three treatments.

Table 1. Rates of egg deposition, fertility and hatchability in different materials.

Material	No. of eggs/day/ replicate X±SE	Fertility (%) X±SE	Hatchability (%) X±SE	Total number of eggs
Coconut fiber	623 ± 3^a	99.5 ± 1^a	88 ± 3^a	1895 (66%)
Hydrilla	326 ± 3^b	98.7 ± 2^a	87 ± 2^a	977 (34%)

X - Mean SE - Standard Error
^{a,b} - Means having different superscripts within a column differ significantly ($p>0.05$)

Table 2. Mortality, survival rate and weight gain of post larvae in different feeds after 14 days.

Feed	Mortality % X±SE	Weight gain (g) X±SE
Micro-worm	13.3 ± 0.2^a	0.131 ± 0.00^a
Swine liver	53.3 ± 12.0^b	0.132 ± 0.00^b
Egg yolk	56.6 ± 13.3^{bc}	0.143 ± 0.00^c
Whole egg	86.6 ± 6.7^c	0.123 ± 0.00^{abc}

X - Mean SE - Standard Error
^{a,b,c} - Within columns, means with different superscripts differ significantly ($P<0.05$)

There was no significant difference in both survival rate and growth rate between egg yolk and whole egg fed post larvae.

Larval feeds generally should be of the appropriate particle size for easy adaptation (Jhingram and Pullin, 1985). The high nutritional values compared to micro-worms and swine liver may be the reason for the highest growth in the treatment with egg yolk. The lowest body weight gain in the treatment with whole egg may be due to low quality of the feed (Figure 1).

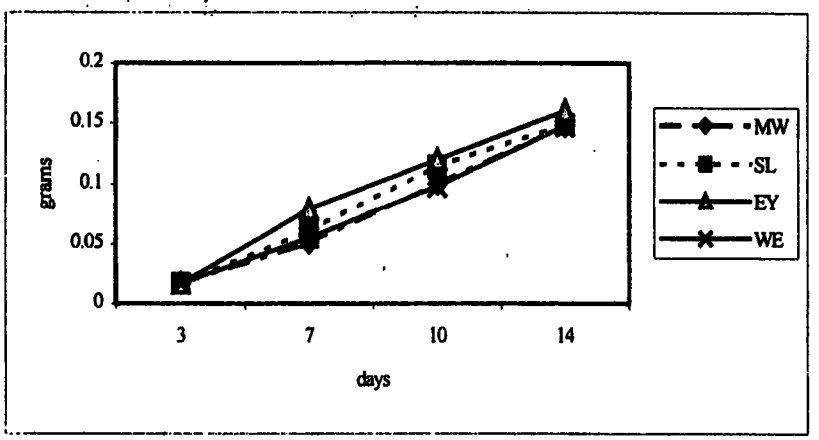

Figure 1. **Mean weight gain during experiment period.**
[Note: MW - Micro worm, SL - Swine liver, EY - Egg yolk, WE - Whole egg]

The ammonia production and the hydrogen sulphide production showed the same pattern in all the four treatments (Figure 2 and Figure 3).

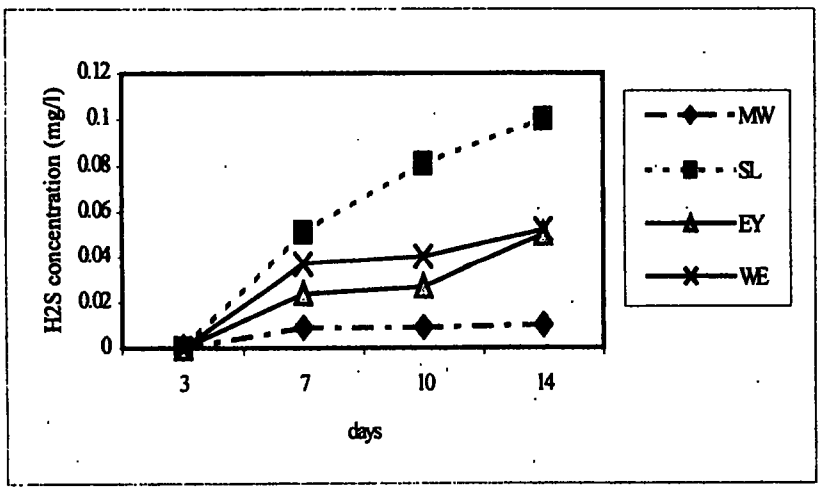

Figure 2. **Changes in H_2S.**
[Note: MW - Micro worm, SL - Swine liver, EY - Egg yolk, WE - Whole egg]

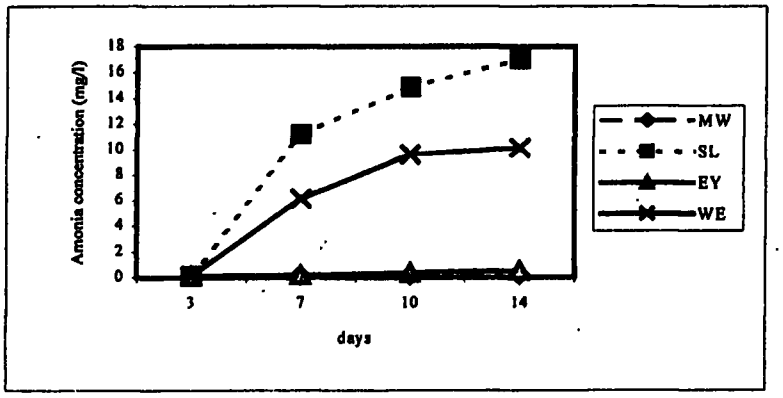

Figure 3. Changes in ammonia concentration.
[Note: MW - Micro worm, SL - Swine liver, EY - Egg yolk, WE - Whole egg]

Hydrogen sulphide decreases the pH value where as ammonia increases the pH value of water. Swine liver fed treatments showed the highest production of hydrogen sulphide and ammonia. However the lowest pH fluctuation was observed in the same treatment (Figure 4). This can be explained by considering the acid-base reaction of hydrogen sulphide and ammonia forming $(NH_4)_2S$ which would have kept the pH at a constant value.

The high content of proteins and blood cells in swine liver may be the reason for highest production of ammonia. Whole egg comprised of albumin in addition to egg yolk which resulted in the production of higher concentration of ammonia than pure egg yolk. Initially, 0.02 mg/l of NH_4^+ was found to be present in normal tap water while the concentration of H_2S in tap water was 0.002 mg/l.

In water, un-ionized ammonia exists in a pH and temperature dependent equilibrium with the ammonium ion.

$$NH_3 + H_2O = NH_4^+ + OH^-;\ K = 10^{-4.74}$$

Un-ionised ammonia is highly toxic to fish, but the ammonium ion is relatively nontoxic (Boyd, 1982). But ammonia becomes less toxic when dissolved oxygen concentration is high. According to the Colt and Armstrong (1979), as cited in Boyd (1982), as the ammonia level increases in water,

ammonia excretion by fish decreases and levels of ammonia in blood and tissue increases. In this experiment, the high ammonia concentrations of swine liver and whole egg may be the reason for higher mortality in these two treatments (Table 1). According to Boyd (1982), ammonia concentrations between 0.6 and 2 mg/l are the toxic to many fish species.

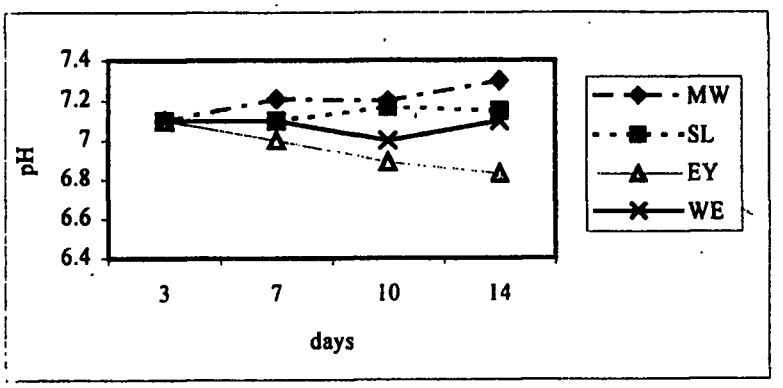

Figure 4. Changes in pH.
[Note: MW - Micro worm, SL - Swine liver, EY - Egg yolk, WE - Whole egg]

According to Adelman and Smith (1970), egg survival and fry development in many fish species were limited when the H_2S concentration increased beyond 0.006 mg/l. They also showed that the proportion of unionized hydrogen sulphide decreases with increasing pH, and may be responsible for poor growth of larvae. The sulphide excreted is an ionization product of hydrogen sulphide and participates in the following equilibria:

$$H_2S = HS^- + H^+;\ K_1 = 10^{-7.01}$$

$$HS^- = S^{-2} + H^+;\ K_1 = 10^{-23.89}$$

Highly polluted water was found in swine liver fed treatment, with an unpleasant odour of H_2S. However the highest discoloration was found in water with the whole egg.

The whitish colour of water and higher amounts of toxic gas production would be the reasons for highest mortality showed in whole egg treatment. The discolouration of water in egg yolk fed treatment was less than in those of whole egg but higher than the those of swine liver treatment. In swine liver fed replicates, the discolouration was not prominent but the gaseous odour (H_2S and NH_4^+) was highest. Therefore, the effect of those physico-chemical parameters would have caused the higher mortality rates in the swine liver, egg yolk and whole egg treatments.

The micro-worm fed treatment showed the least water pollution condition. In these replicates where micro-worm was the feed, the water was very clear and had comparatively low H_2S or NH^+_4 production. Therefore micro-worm fed replicates showed the least mortality rate during the experimental period ($P<0.05$) with higher weight gain compared with other feeds.

CONCLUSIONS

Total number of eggs deposited per area of material was found to be significantly higher ($p>0.05$) in coconut fiber than in hydrilla plants. Therefore compared to hydrilla bundles, coconut fiber bundles were more suitable for egg deposition during spawning of common carp.

The results of feeding trial indicated that the micro-worm was the best feed because of least water pollution, (minimum H_2S and NH^+_4 production) mortality rate, with higher weight gain compared with other feeds. Therefore, of the feeds tested micro-worm is the best for post larvae.

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REFERENCES

Adelman, I.R. and Smith, L.L. (1970). Effect of hydrogen sulphide on northern pike eggs and sac fry. Trans. Amer. Fish. Soc. 99: 501-509.

Bhowmick, R.M. (1982). Technique of hypophysation of Indian carps. J. Inland Fish. 1: 47-53.

Boyd, E.C. (1982). Water Quality Management for Pond Fish Culture. Developments in Aquaculture and Fisheries Sciences, Vol. 9, Elsevier, New York.

Chodar, S.L. (1980). Hand Book of Breeding of Indian Major Carp by Pituitary Hormone Injection. Satish Book Enterprise, India.

Daniel, D.J., Costa, M.H. and Wijeyaratne, M.J.S. (1988). The hydrobiology and fish production potential of major fresh water reservoirs in Hambantota District, Sri Lanka. J. Inland Fish. 4: 95-121.

De Silva, S.S. (1983). The reservoir fishery: present status and future strategies. J. Inland Fish. 2: 3-13.

Edirisinghe, U., Hemachandra and Rajaguru, A.S.B. (1985). Suitability of guinea and grass (*Panicum maximum*) as a collecting material of eggs of common carp (*Cyprinus carpio*) during spawning. Sri Lanka Assoc. Advmt. Sci. 41(1): 47-48.

Edirisinghe, U., Senewirathne and Tilak, C.R. (1986). Suitability of guinea grass (*Panicum maximum*) as a collecting material of eggs of common carp (*Cyprinus carpio*) during spawning. J. Inland Fish. 3: 91-95.

Edirisinghe, U. and Hathurusinghe, P. (1989). Suitability of Kithul (*Caryota urenus*) as a collecting material of eggs of common carp (*Cyprinus carpio*) during spawning. Sri Lanka Assoc. Advmt. Sci. 45(1): 33-34.

Edirisinghe, U., Mainndi, S.D. and Rajaguru, A.S.B. (1990). Suitability of Banana (*Musa acuminata*) as a collecting material of eggs of common carp (*Cyprinus carpio*) during spawning. Sri Lanka Assoc. Advmt. Sci. 47(1): 23.

Edirisinghe, U. and Jayabalasinham, A. (1992). Suitability of Banana Pilla (*Teprosia purpuraria*) as a collecting material of eggs of common carp (*Cyprinus carpio*) during spawning. Sri Lanka Assoc. Advmt. Sci. 48(1): 85.

Jhingram, V.G. and Pullin, R.S. (1985). Post larvae and fry rearing. A hatchery manual for common, Chinese and Indian major carps. ICLARM, Manila, Philippines.

Nathanial, S. and Edirisinghe, U. (1988). The natural spawning cycle of the common carp in the Victoria Reservoir. Sri Lanka J. Aquatic Sci. 3(1998): 85-95.