

CULTURE TECHNIQUES OF *Moina* SPECIES WITH ORGANIC AND INORGANIC FERTILIZERS

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Abstract: An experiment was conducted to determine the effect of organic (poultry dropping, cow dung, and mustard oil cake) and inorganic (urea) fertilizers on production of *Moina* in plastic container (2.5L) with or without aeration. Under this condition, the total production of *Moina* was significantly ($p < 0.05$) higher in both aerated (4950 individuals) and non-aerated (6505 individuals) containers when poultry dropping was used. Reproduction rate and maturation time were studied in the beakers (100 ml) with poultry dropping, cow dung, mustard oil cake, and urea while the aeration was absent. Maximum reproduction rate was 11 individual per mature species with the lowest maturation time of 78 hours for poultry dropping treatment. Among the organic and inorganic fertilizers used in this experiment, poultry dropping was found to be the most suitable for *Moina* culture in terms of total production, maximum rate of reproduction and the lowest time requirement for maturation.

Key words: *Moina*, poultry dropping, cow dung, mustard oil cake, and urea.

Introduction

Moina is a genus consisting of a vast number of tiny aquatic crustaceans often called water fleas for their hopping motion as they swim. It is mainly found in temporary shallow water bodies, which receive limited amount of sewage wastes, poultry, cattle or human wastes. This species can tolerate a temperature as low as 0°C to as high as 35°C but prefers a water temperature ranging from 20⁰–30⁰C with pH between 6.5 –9.5 (Rottmann *et al.*, 1992). *Moina* is mixotrophic, which means unselective filter feeders and basically feed on a wide variety of tiny organisms such as rotifers, Paramecium, bacteria, Euglena, protozoa, yeast as well as other nutrient or particle of appropriate size available in suspension long enough to be eaten. *Moina* has been used in the shrimp hatchery as larval feed in the neighboring countries.

Shrimp culturists in Bangladesh has expressed the need for nutritionally adequate and locally available live substitutes for *Artemia* in expanding *Macrobrachium* hatchery operations, particularly in developing countries (Hanson and Goodwin, 1977). Such a search for suitable live larval feed is stimulated by the high cost and unpredictable supply of *Artemia* cyst, as their demand is increasing (Bengtson *et al.*, 1991). A fresh water cladoceran, *Moina*, may be used successfully as a supplement to *Artemia*, rather than as a substitute, in overnight feeding of *Macrobrachium rogenbergii* larvae (Alam *et al.*, 1993a). The partial replacement of *Artemia* by *Moina* was also reported to have positive effect during the larval culture of freshwater prawn *M. rogenbergii* (Alam *et al.*, 1993b). Alam *et al.* (1991) further noticed that *Moina* could be used solely or in equal combination with *Artemia* without any adverse effect on the production of *M. rogenbergii* post larvae. Moreover, *Moina* could be utilized as an ideal food organism for carp, shrimp, and catfish larvae (Alam *et al.*, 1993a). In Bangladesh, *Moina* is locally known as “Makhon Poka” (Butter insect) or “Ghora Poka” (Horse insect). Some private carp hatcheries located in Jessore region use *Moina* for feeding carp fingerlings. On the other hand, most of the shrimp hatcheries in Bangladesh depend upon natural seawater and a particular food organism composing nauplii of imported brine shrimp, *Artemia salina* which is very expensive. In addition, the technology of *Artemia* nauplii production from cyst still remains very complicated compared to that of *Moina* production. Thus, a suitable alternative of live feed for the shrimp and other finfish hatchery has always been on search. Therefore, with a view to investigate the prospects of large-scale culture of *Moina* species in Bangladesh, the present research was aimed at finding out the most suitable medium for *Moina* in which a high and sustained production is possible. Furthermore, the reproduction rate and maturation time of *Moina* as well as the effect of aeration on *Moina* production were also observed.

Materials and Methods

The study was conducted in the laboratory of Fisheries and Marine Resource Technology Discipline, Khulna University. *Moina* culture was carried out in cylindrical plastic containers filled with 2.5-liter tap water in both aerated and non-aerated conditions. The cylindrical plastic containers were divided into four treatment groups each having three replicates. The water was then fertilized with poultry droppings, cow dung, mustard oil cake, and urea, respectively at the rate of 0.5 g/L. The containers were covered with closed mesh nets to avoid the interference of dragonfly. Adequate light was provided to enhance the phytoplankton production. When the water turned greenish (4 days later), approximately 80-85 *Moina* species were put in each container.

The population density of *Moina* was determined by fixing *Moina* from 4-ml sample with 70% alcohol.

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Moina were then placed in a petri dish and counted with a magnifying glass. For counting the total number of *Moina* in a container, four ml-samples of *Moina* were randomly counted 25 times and the average number was determined. Total production of each container was observed after 16 days of culture in both aerated and non-aerated containers. To compensate for the loss of water due to evaporation additional water was added when required.

Reproduction rate (total numbers of individual produced by 24 hrs. from one mature individual) and maturation time (times required for further propagation) of *Moina* were carried out in a 100-ml beaker with organic (poultry dropping, cow dung, mustard oil cake) and inorganic (urea) fertilizers. Three replicates were maintained for each treatment. For reproduction rate experiment, a mature *Moina* was kept in the beaker for 24 hrs. and the total number of individuals produced by one mature *Moina* was recorded. A newly hatched larva was collected from the previous (reproduction rate) experiment and placed in the beaker. Maturation time was recorded when the individual released first offspring. Adequate light was ensured throughout the whole experimental period.

Water quality parameters: Water quality parameters such as temperature, dissolved oxygen (DO), pH were recorded at an interval of 3 days throughout the experiment period. Temperature, DO, and pH of each container were recorded by a thermometer, DO meter (DO-5510, Lutron), and pH meter (RI-02895, HANNA), respectively.

Statistical analysis: One-way analysis of variance (ANOVA) was used to determine the effect of treatments on the production of *Moina* species. This was followed by Duncan's Multiple Range Test. Standard error (\pm SD) of treatment means were calculated from residual mean square in the analysis of variance.

Results and Discussion

Water quality parameters: Average mean values of water quality parameters in both aerated and non-aerated containers are summarized in Table 1. Water temperature of the containers varied from 26.28 to 27.45°C. Dissolved oxygen content of the containers ranged from 3.70 to 5.80 mg/L. Maximum and minimum values of pH were recorded in mustard oil cake treated (aerated) and poultry dropping treated (non-aerated) containers, respectively.

Table 1. Average mean values of physico-chemical parameters of the containers during the study period.

Treatments	Temperature (°C)		Dissolved Oxygen (mg/l)		pH	
	Aerated	Non-aerated	Aerated	Non-aerated	Aerated	Non-aerated
Poultry dropping	26.43 \pm 0.79	26.45 \pm 0.83	5.80 \pm 0.28	5.13 \pm 0.35	7.83 \pm 0.36	7.35 \pm 0.51
Cow dung	26.48 \pm 0.86	26.48 \pm 0.75	5.08 \pm 0.17	4.43 \pm 0.24	7.70 \pm 0.36	7.60 \pm 0.41
Mustard oil cake	26.50 \pm 1.02	27.45 \pm 0.62	4.23 \pm 0.21	3.70 \pm 0.14	8.55 \pm 0.38	8.18 \pm 0.47
Urea	27.40 \pm 0.79	26.28 \pm 0.79	4.98 \pm 0.13	4.10 \pm 0.26	8.52 \pm 0.36	8.30 \pm 0.26

Water quality parameters exert an immense influence in maintaining the aquatic environment and production of sufficient food organisms. Among the treatments, water quality parameters such as temperature, DO and pH were found to be more or less similar and within the acceptable range for *Moina* production as recommended by Rottmann *et al.* (1992).

Production of *Moina*: The overall mean production with and without aeration for different treatments is presented in Table 2. In the non-aerated containers, total production was the highest in poultry dropping with a mean value of 6505.72 \pm 283.23 while the lowest average production (2242.22 \pm 857.90) was found in urea treated water. The mean production in the non-aerated containers was 6505, 2411, 4682, and 2242 in poultry dropping, cow dung, mustard oil cake, and urea, respectively. On the other hand, total production of *Moina* species was surprisingly dropped under aerated condition (Table 2) with the highest production in poultry dropping (4950.24 \pm 484.76) and the lowest production in the treatment of urea (1346.66 \pm 148.90). The mean productions of all treatments were found as 4950, 1815, 1695, and 1346 in poultry dropping, cow dung, mustard oil cake, and urea, respectively in aerated condition. As shown in Table 2, the mustard oil cake and urea treated containers having no aeration exhibited almost double production than aerated container. Total *Moina* production in containers treated with poultry dropping (aerated and non-aerated) differed significantly ($p < 0.05$) with each other.

Table 2. Mean production of *Moina* species under different treatments after twelve days.

Treatments	Total production/container (2.5 L)	
	With aeration	Without aeration
Poultry dropping	4950.24 \pm 484.76 ^a	6505.72 \pm 283.23 ^{a*}
Cow dung	1815.08 \pm 485.54 ^b	2411.12 \pm 578.37 ^c
Mustard oil cake	1695.14 \pm 117.56 ^b	4682.66 \pm 580.39 ^b
Urea	1346.66 \pm 148.90 ^c	2242.22 \pm 857.90 ^c

* Mean values in the same column having different superscripts are not significantly different ($p > 0.05$)

The use of organic fertilizers or manure in aquaculture is an ancient practice and continues to be used by aquaculturists as an efficient and economical means of increased production in aquaculture ponds. The most popular organic manure commonly practiced in Bangladesh are cow dung, poultry by product, and some plant originated materials including mustard oil cake, soybean meal and grain by product. They have no direct effect on fish production but act as an important catalyst in the food chain through improving the soil structure and fertility and thereby enhancing the primary production. Locally available organic manure as well as the combined treatments of organic and inorganic fertilizers for plankton production is of great value. The application of inorganic fertilizer with manure that contains a wide N:P ratio is beneficial because the nitrogen from the chemical fertilization stimulates microbial degradation of the manure. Thus, phosphorus and other nutrients are released more rapidly to the water and the rate of accumulation of organic residues in the pond is reduced (Chakrabarty *et al.*, 1976). The addition of nitrate and phosphorus stimulates water productivity through autotrophic and heterotrophic pathways (Green *et al.*, 1989). This experiment was carried out by using poultry dropping, cow dung, mustard oil cake and urea. Among the organic manure, poultry dropping performed the best media for the production of *Moina* species apparently because of more nitrogen that play a significant role in primary production (David *et al.*, 1969; Boyd, 1976 and Rappaport *et al.*, 1977). A recent report on fertilization compiled by Bangladesh Agricultural Research Council showed that mustard oil cake (Nitrogen 5% and Phosphorus 1.8%) and urea (only Nitrogen 46%) contain higher proportion of micro-nutrient than poultry dropping and cow dung (Table 3; BARC, 1997). It is known that only nitrogen (in case of urea treated container) cannot promote phytoplankton production unless it is added with other nutrients like phosphorus and potassium. During this experiment, a few droplets of oil were observed on the water surface of mustard oil cake treated containers that may pollute water or cause oxygen deficiency. Moreover, mustard oil cake contains toxic substances that have the ability to inhibit the proteolytic activity of certain nutrients (De Silva, 1985). All these factors could be responsible to limit the growth in mustard oil cake containers. It may be recommended that mustard oil cake should not be applied directly in the pond without complete extraction of oil or soak in water for 24 hrs.

Table 3. Chemical composition (% dry matter) of organic and inorganic fertilizers (Adopted from BARC, 1997).

<i>Chemical component</i>	<i>Poultry dropping</i>	<i>Cow dung</i>	<i>Mustard oil cake</i>	<i>Urea</i>
Total nitrogen	1.6	0.5 – 1.5	5.1 – 5.2	46
Total phosphorus	1.5	0.4 – 0.8	1.8 – 1.9	–
Total potassium	0.85	0.5 – 1.9	1.1 – 1.3	–

Poultry droppings were collected from a poultry farm where balanced diet was supplied to the chicken as the daily feed. This diet was prepared from various nutritionally rich ingredients like maize, rice bran, fishmeal, and vitamin (personal communication). On the other hand, cattle feeding source was unknown. Poultry droppings collected from the commercial farm may, therefore, have more essential micro-nutrients like, nitrogen and phosphorus which could accelerate the total production of *Moina* species through phytoplankton production.

According to Alam *et al.* (1993b) *Moina* cultured on poultry manure might have accumulated a high level of n-3 HUFA (Highly Unsaturated Fatty Acid) directly from the manure or indirectly from algae and other microorganisms induced by this fertilizer. Poultry manure may contain higher n-3 HUFA reflecting the diet (e.g. fishmeal) of the poultry. In Singapore, *Moina micrura* grown in ponds fertilized with mostly chicken manure or, less frequently, with pig manure were used as the sole feed for fry of many ornamental and tropical fish species with 95 to 99% survival (Rottmann *et al.*, 1992). Organic fertilizers are usually preferred to mineral fertilizers because they provide bacterial and fungal cells and detritus as well as phytoplankton as food for *Moina*. This variety of food items more completely meet their nutritional needs resulting in the maximum production (Rottmann *et al.*, 1992).

The present study revealed that the production rate is lower with aerated containers than that of non-aerated ones irrespective of the fertilizers used. Lower production of *Moina* species in aerated container might be due to presence of numerous small bubbles produced by the aerator. Rottmann *et al.* (1992) reported that extremely small bubbles should be avoided otherwise they could get trapped under the carapace that causes *Moina* to float at the surface and eventually die. Aeration requirements vary depending upon the stocking density and days of culture. Gentle aeration of the *Moina* pools oxygenates the water, keeps food particles in suspension; and increases phytoplankton production, this results in an increase in the number of eggs per female, the proportion of egg-bearing females in the population, and the population density (Rottmann *et al.*, 1992). However, further in depth investigations in these aspects are required. No multiplication or live species of *Moina* were observed in one of the urea treated containers (without aeration). This may be attributed to the toxic affect of ammonia or phosphorus and possibly other nutrient deficiency in water.

Reproduction rate and maturation time: Reproduction rate and maturation times of *Moina* species are

presented in Table 4. The mean reproduction rate in poultry dropping, cow dung, mustard oil cake and urea treated container was 11, 8, 10, and 5, respectively. Reproduction rate in poultry dropping and mustard oil cake treated beakers differed significantly ($p < 0.05$) with other treatments. The highest and the lowest reproduction rates were found in poultry dropping (11.33 ± 0.94) and urea (5.66 ± 0.47), respectively. The minimum maturation time of 78.67 ± 2.87 hrs. was required to obtain sexually mature *Moina* in poultry dropping treated beakers while 80.67, 79.33, and 90.33 hrs. were found to be required for the same in cow dung, mustard oil cake, and urea treated beakers, respectively. The reproduction rate and times taken for maturation varied among the treatments with the same trend as observed for *Moina* cultivation. Since all containers were kept under same environmental conditions the reproduction rate and maturation time varied due to the variation of different treatments of water. The fact that poultry treated water showed enhanced reproduction rate with the lowest maturation time of *Moina* is coincided with those reported by Rottmann *et al.* (1992) and Reddy (1991).

Table 4. Reproduction rate and maturation time of *Moina* species under different treatments.

Treatment	Reproduction rate	Maturation time (hrs.)
Poultry dropping	$11.33 \pm 0.94^{a*}$	$78.67 \pm 2.87^{a*}$
Cow dung	8.33 ± 0.47^b	80.67 ± 1.25^a
Mustard oil cake	10.00 ± 0.82^a	79.33 ± 1.70^a
Urea	5.66 ± 0.47^c	90.33 ± 2.1^b

* Mean values in the same column having different superscripts are not significantly different ($p > 0.05$)

The main advantage of cultivating *Moina* is that high production could be possible employing minimum cost and effort. Any farmer can easily adopt this technique and reduce the feeding cost during the larval stage of carp and shrimp species. The nutritional content of *Moina* varies considerably depending on their age and the type of food they are receiving. Although variable, on the average the protein content of *Moina* is usually 50% of the dry weight. Adults normally have higher (20-27%) fat content than juveniles (4-6%) as dry weight basis (Rottmann *et al.*, 1992). However, studies on *Moina* culture in aquaria with varying fertilization application are very limited and so far there is no published report in Bangladesh.

Conclusion

Based on the results discussed above, it can be concluded that all organic fertilizers contained nitrogen and phosphorous content but poultry dropping seems to be superior to the commonly used cow dung or other fertilizers. Poultry droppings are neglected as a fertilizer in some areas of Bangladesh, and therefore, emphasis should be given for the application of poultry dropping not only as a supplement for *Moina* production in aquaria but also for enhancing pond productivity through aquaculture.

References

- Alam, M.J., S.H. Cheah and K.J. Ang, 1991. Possible use of *Moina* spp. as a live food substitute in larval rearing of the freshwater prawn, *Macrobrachium rogenbergii* (de Man). *Kurz*, *Aquaculture and Fisheries Management*, 22: 531 – 535.
- Alam, M.J., K.J. Ang and S.H. Cheah, 1993a. Weaning of *Macrobrachium rogenbergii* (de Man) larvae from *Artemia* to *Moina* (Kurz). *Aquaculture*, 112: 187 – 194.
- Alam, M.J., K.J. Ang, S.H. Cheah, M.A. Ambak and C.R. Saad, 1993b. Effects of *Moina micrura* (Kurz) from two different culture sources as replacement of *Artemia* spp. in production of *Macrobrachium rogenbergii* (de Man) post larvae. *Aquaculture and Fisheries Management*, 24: 47- 56.
- BARC, 1987. Fertilizer recommendation guide – 1997, Bangladesh Agricultural Research Council. 180 pp.
- Bengtson D.A., P. Leger and P. Sorgeloos, 1991. Use of *Artemia* as a food source for aquaculture. In: R.A. Brown, P. Sorgeloos and C.N.A. Trotman (eds.), *Artemia Biology*, CRC Press Inc., Boca Raton, FL. pp. 255-285.
- Boyd, C.E., 1976. Water quality in warm water fish ponds. Auburn University, Craftmaster Printers, Alabama. 359p.
- Chakrabarty, R.D., D.S. Murty, P.K. Sen, A.C. Nandy and D.P. Chakrabarty, 1976. Short – term rearing of Indian and exotic carps. *Journal of Inland Fisheries Society of India*, 8: 179 – 183.
- David, A.P., B. Ray, V. Govind and K.V. Banerjee, 1969. Limnology and fisheries of Tungabhadra Reservoir, Central Inland Fish Research Institute. *India Bulletin*, 13:70- 83.
- De Silva, S.S. and T.A. Anderson, 1985. Fish nutrition in aquaculture. Chapman and Hall, Aquaculture Series 1, 204 pp.
- Green, W.B., R. P. Phelps and H.R. Alvarenga, 1989. The effects of manures and chemical fertilizers on the production of *Oreochromis niloticus* in earthen ponds. *Aquaculture*, 76: 37 – 42.
- Hanson, J.A. and H.L. Goodwin, 1977. Shrimp and prawn farming in the Western Hemisphere. Dowden, Hutchinson and Ross. Stroudsburg, P.A. 439 pp.

- Rapport, U., S. Spring and Y. Bejerano, 1977. On the use of organic fertilizer in intensive fish farming at the Linosar station in 1976. *Bamidgeh*, 29(2): 57 – 70.
- Reddy, A.K. 1991. Mass Culture of *Moina* for *Macrobrachium rogenbergii* hatchery, Central Institute of Fisheries Education, Bombay. In: S. K. Majumdar and A.C. Nandy (eds.). Proceeding of National Seminar of freshwater aquaculture. 93 pp.
- Rottmann, R.W., J.S.Graves, C.Watson and P.E.Yanong, 1992. Culture techniques of *Moina*: The ideal Daphnia for feeding to freshwater fry in Florida Cooperative Extension Service, *Circular 1054*, Institute of Food and Agricultural Sciences, University of Florida.