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 20°C–30°C 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 Microbrachium 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 (Bengston 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 phytoplant 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 (± 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.

| Treatments         | Temperature (°C) | Dissolved Oxygen (mg/l) | pH     |
|--------------------|------------------|-------------------------|--------|
|                    | Aerated          | Non-aerated             | Aerated| Non-aerated | Aerated | Non-aerated |
| Poultry dropping   | 26.43 ± 0.79     | 26.45 ± 0.83            | 5.80 ± 0.28 | 5.13 ± 0.35 | 7.83 ± 0.36 | 7.35 ± 0.51 |
| Cow dung           | 26.48 ± 0.86     | 26.48 ± 0.75            | 5.08 ± 0.17 | 4.43 ± 0.24 | 7.70 ± 0.36 | 7.60 ± 0.41 |
| Mustard oil cake   | 27.50 ± 1.02     | 27.45 ± 0.62            | 4.23 ± 0.21 | 3.70 ± 0.14 | 8.55 ± 0.38 | 8.18 ± 0.47 |
| Urea               | 27.40 ± 0.79     | 26.28 ± 0.79            | 4.98 ± 0.13 | 4.10 ± 0.26 | 8.52 ± 0.36 | 8.30 ± 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 ± 283.23 while the lowest average production (2242.22 ± 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 ± 484.76) and the lowest production in the treatment of urea (1346.66 ± 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.

| Treatments         | Total production/container (2.5 L) |
|--------------------|-----------------------------------|
|                    | With aeration                      | Without aeration               |
| Poultry dropping   | 4950.24 ± 484.76 ^a               | 6505.72 ± 283.23 ^a**           |
| Cow dung           | 1815.08 ± 485.54 ^b                | 2411.12 ± 578.37 ^c             |
| Mustard oil cake   | 1695.14 ± 117.56 ^b                | 4682.66 ± 580.39 ^b             |
| Urea               | 1346.66 ± 148.90 ^c                | 2242.22 ± 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 thorough 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 (Chakraborty 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).

| Chemical component | Poultry dropping | Cow dung | Mustard oil cake | Urea |
|--------------------|------------------|----------|------------------|------|
| 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 droppings, cow dung, mustard oil cake and urea treated container was 11, 8, 10, and 5, respectively. Reproduction rate in poultry droppings 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 droppings (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 drooping 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 droppings  | 11.33 ± 0.94**    | 78.67 ± 2.87**         |
| 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 droppinng 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 droppings not only as a supplement for Moina production in aquaria but also for enhancing pond productivity through aquaculture.

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