

Evaluation of Different Feeds for Optimal Growth & Survival of Parthenogenetic Brine Shrimp, *Artemia*

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Four types of food, each at 5 levels were evaluated for optimal growth and survival of *Artemia* larvae (1-4 d and 4-8 d), under laboratory conditions. The food types used were rice bran and 3 species of algae (*Porphyra vietnamensis*, *Enteromorpha intestinalis* and *Ulva fasciata*). Rice bran yielded best growth at an optimal level of 0.1 and 0.5 mg.ml⁻¹ d⁻¹ respectively for 1-4 and 4-8 d old larvae. Rice bran was also the best food for outdoor cultures. *Artemia* fed rice bran took shortest time to reach maturity and released maximum number of nauplii per adult than the other feeds.

Information on survival and food value of the brine shrimp *Artemia*, non selective, obligate filter feeder, is important as they are extensively used in aquaculture as a diet for fish and many invertebrates. Various types of live and inert food sources have been used in brine shrimp cultures¹. The present study evaluates the suitability of 4 feeds for *Artemia*. Since the quality of food for optimal growth and survival varies from one type to another, varying rations of each food have been tested on 1-4 d and 4-8 d old *Artemia* and then growth studies extended to small scale outdoor culture until the adults attained maximum body length.

Materials and Methods

Different types of feeds used were rice bran, red alga (*Porphyra vietnamensis* Tanaka et Ho) and green algae [*Enteromorpha intestinalis* (L) Link and *Ulva fasciata* Dellile]. The macroalgae were washed with distilled water, oven dried and powdered. *Artemia* cysts obtained from Balamba (lat. 23°42'N, long. 70°17'E) were hatched in natural seawater (sal. 35×10^{-3} , temp. $29^\circ \pm 1^\circ\text{C}$).

In the 1st set of experiments, brine shrimp nauplii were fed each type of food at 5 levels (0.025, 0.05, 0.1, 0.2 and 0.3 mg ml⁻¹ d⁻¹) for the first 4 d after hatching. Nauplii of 1st instar (100) were introduced into 250 ml culture flasks containing 100 ml millipore filtered (0.45 µm) natural seawater. To ensure oxygenation and to keep the food particles in suspension, mild aeration was provided. Treatments were run in triplicates and food was added every day. After 4 d, length and percentage survival were determined.

For the 2nd set of experiments, each type of food was tested on 4-8 d old *Artemia* larvae. Experimental setup was same as in 1st set except, that for the first 3 d, nauplii were acclimated with optimal rations of food determined from the 1st set of experiments. For 4-8 d food was given at the rate of 0.1, 0.3, 0.5, 0.7 and 0.9 mg.ml⁻¹.d⁻¹. After 8 d, length and percentage of survival were determined. An experimental period of 8 d was appropriate as the larvae reach pre-adult stage in 8 d.

The 3rd set of experiments were run to test the effect of these 4 feeds on a small scale outdoor. Fibre glass tanks (80 × 45 × 45 cm) with 100 l capacity containing 20 l natural seawater were used. Nauplii of 1st instar stage were introduced (400 l⁻¹). Optimal levels of different feeds determined from the 1st and 2nd sets of experiments were given for 1-4 d and 4-8 d old *Artemia*, thereafter, the amount of food was doubled and given twice a day for later stages of *Artemia* until the animals reached maximum body length. The number of nauplii released per adult was determined by maintaining 10 adults individually, fed respective food.

It was demonstrated that the maximal size of particles that can be ingested is 25-30 µm for nauplii and 40-50 µm for adult brine shrimp¹. Hence algae as well as rice bran were passed through 25 µm sieve for 1-4 d old *Artemia* and 50 µm for later stages prior to feeding.

Results

In the 1st experiment, *Artemia* fed on *P. vietnamensis* had the best growth with optimal ration of

0.05 mg.ml⁻¹.d⁻¹ (Fig. 1A). In general, all the 4 feeds at higher levels did not induce any significant increment in length. At lower levels (0.025-0.1 mg.ml⁻¹.d⁻¹), survival rate on an average was 92.4% with all the 4 feeds. Survival at higher levels (0.2-0.3 mg.ml⁻¹.d⁻¹) decreased to 72% in *Artemia* fed algae, while it was 81% in *Artemia* fed rice bran. From these results, the ration (mg.ml⁻¹.d⁻¹) chosen as the optimal for *Artemia* was rice bran, 0.1; *E. intestinalis*, 0.025; and *P. vietnamensis* and *U. fasciata*, 0.05.

In the 2nd set of experiments, *Artemia* fed rice bran showed best growth. *Artemia* fed *P. vietnamensis* had a comparable growth at higher level (0.7 mg.ml⁻¹.d⁻¹) as against 0.5 mg.ml⁻¹.d⁻¹ (Fig. 1B). At lower levels (0.1-0.5 mg.ml⁻¹.d⁻¹) of food, very slight increase in length was recorded in *Artemia* fed *E. intestinalis* and *U. fasciata*, and 0.7 mg.ml⁻¹.d⁻¹ was found to be optimal

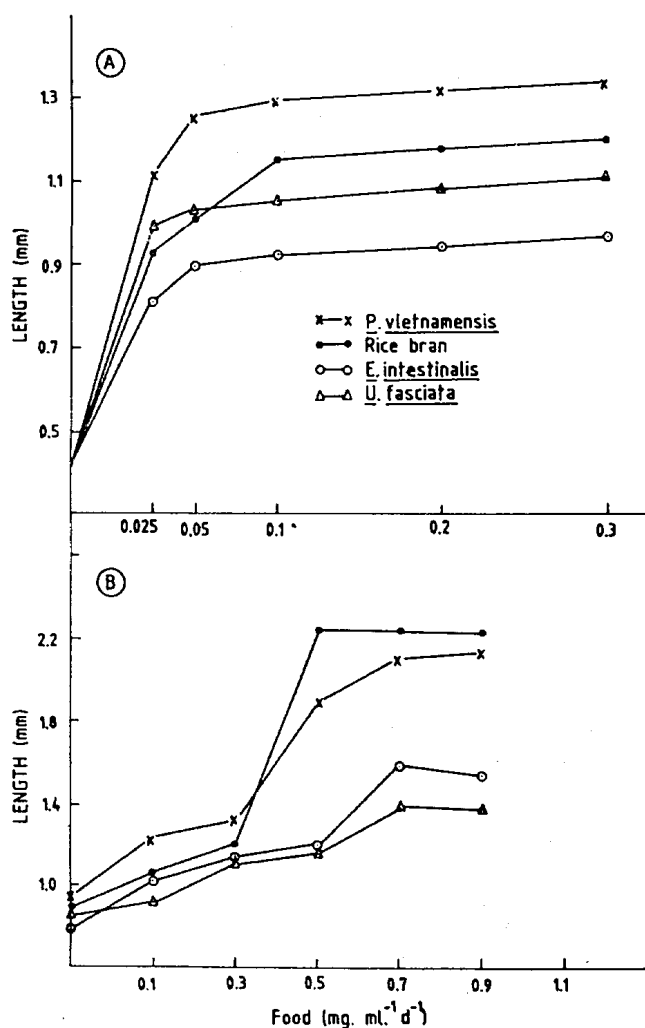


Fig. 1— Length of *Artemia* after feeding for 4 d (A) and 8 d (B) on different feeds at different levels.

and beyond this level, there was decrease in length. The optimal level for *Artemia* fed *P. vietnamensis*, *E. intestinalis* and *U. fasciata* was 0.7 mg.ml⁻¹.d⁻¹ with 80, 73, and 70% survival respectively. Survival of 90% was recorded in *Artemia* fed rice bran at the optimal level of 0.5 mg.ml⁻¹.d⁻¹.

The maximum length attained and survival with 4 types of feeds in outdoor culture experiments are shown in Fig. 2. With rice bran, maximum survival was 65 ± 4.94% and the adults reached a length of 10.3 ± 0.31 mm after 24 d. *Artemia* fed rice bran showed good growth as well as shortest time needed for the formation of egg pouch (14 d) and maximum number of nauplii (96 ± 4) per adult compared to the other three feeds. Irrespective of the type of food, it took 4 d for the formation of

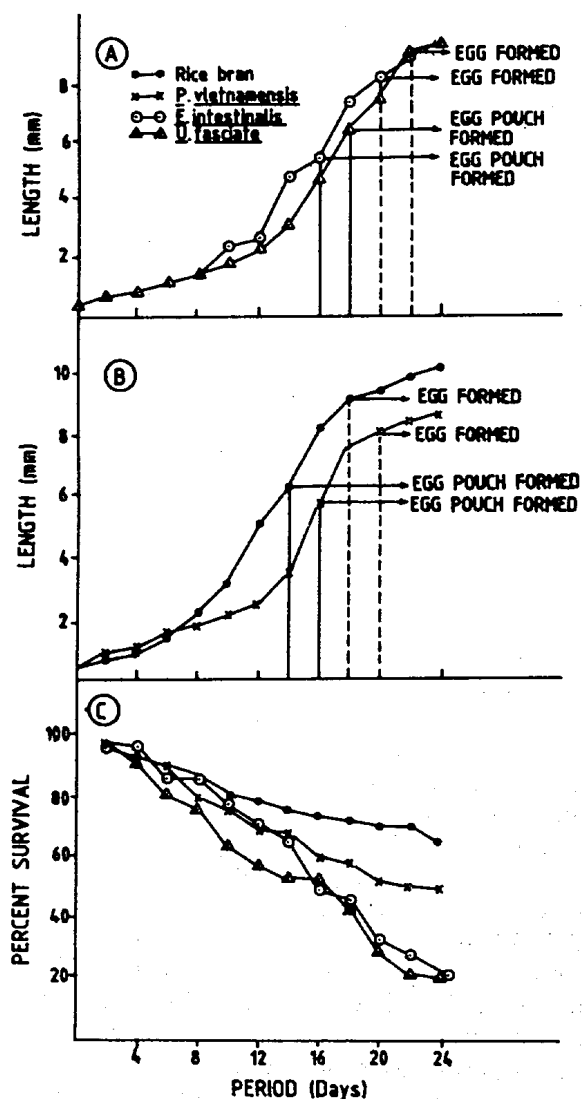


Fig. 2— Growth of *Artemia* fed *E. intestinalis* and *U. fasciata* (A) and rice bran and *P. vietnamensis* (B) and its percent survival (C).

egg in the egg pouch and 5 d interval between two successive batches of nauplii.

Discussion

Of the 4 types of feeds tested in the present study, rice bran supports good growth and survival. Even at high density culturing of *Artemia*, rice bran has been the most beneficial diet¹⁻³. Of the 3 types of algae used *P. vietnamensis* is suitable next to rice bran.

It has been shown that when the dietary protein level exceeds 28%, growth decreases in *Artemia* due to the increase of ammonia in the culture media⁴. Although protein level did not exceed 28% (Table 1) in all the test feeds, low growth and survival were recorded in *Artemia* fed *E. intestinalis* and *U. fasciata*. This may probably be due to high ash content⁶. It is reported that for developing embryos of *Artemia*, primary source of energy is carbohydrates, while for later development stages, protein and lipid are the major energy sources⁷. Carbohydrate was the major component in all the test feeds in the present study. However, from the present study it is evident that for early stages food levels appear to be more important.

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Table 1 – Proximate Composition of Different Feeds
(Values in percentage dry wt)

Food	Protein	Lipid	Carbohydrate	Ash
Rice bran	15.0	18.0	56.0	12.4
<i>E. intestinalis</i>	22.6	2.9	54.0	20.5
<i>U. fasciata</i>	11.0	8.67	54.0	24.3
<i>P. vietnamensis</i> *	17.49	0.85	50.5	11.8

*Jagtap⁵

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