Journal of Agricultural, Food Science & Biotechnology
JAFSB, 2(3), 302-306, 2024
https://doi.org/10.58985/jafsb.2024.v02i03.60
ISSN (Print): 2959-3417

Short Communication

Innovative artemia delivery system for larval fish rearing

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Article Information
Received: 26 August, 2024
Revised: 23 September 2024
Accepted: 24 September 2024
Published: 04 October 2024

Academic Editor
Prof. Dr. Gian Carlo Tenore

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Keywords
Larviculture, initial feeding, live feed, fish.

Abstract

Brine shrimp (*Artemia spp.*) are small crustaceans routinely used during initial feed training of both freshwater and saltwater larval fish. This paper describes an artemia delivery system that conveniently and effectively dispenses consistent numbers of artemia to a fish tank at regular intervals throughout the day. This system consists of a cone-bottom, roto-mold tank where artemia are stored prior to delivery to a tank of larval fish, an aerator to keep them alive in the roto-mold tank, an electronic solenoid valve to open-and-close the tank opening, and a programmable timer to regulate the solenoid valve to determine the duration and interval of artemia delivery. The amount of artemia dispensed in a day is completely up to the operator's desires since the duration and interval of artemia can be set to the needs. This inexpensive (cost less than 500 USD) and simple system worked effectively to distribute artemia to the larval fish, eliminating the labor previously devoted to hand-feeding larval fish throughout the day.

1. Introduction

Brine shrimp (*Artemia spp.*) are crustaceans found in hypersaline environments around the world [1]. They are routinely used during initial feed training of both freshwater and saltwater larval fish, such as Atlantic cod (*Gadus morhua*), African lungfish (*Protopterus annectens*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), white bass (*Morone chrysops*), striped bass (*Morone saxatilis*), black sea bass (*Centropristis striata*), white sturgeon (*Acipenser transmontanus*), African catfish (*Clarias gariepinus*), trairão (*Hoplias lacerdae*), and other fish species that will not initially accept formulated feeds [2-10]. The introduction of live food such as artemia is especially important during the first-feeding of most marine larval fish [5].

Artemia cysts (eggs) can be easily transported and stored for long time periods [11]. Cysts are hatched and ready to be fed to larval fish within a day [12]. They can survive at high densities and cultured in a variety of systems [13, 14] For larval fish, artemia trigger feeding behavior, and are appropriately-sized and nutritious [12].

Most larval fish feeding applications require that artemia be continually available, making hand-feeding inefficient and impractical [15]. Increasing the number of feedings or artemia per day can increase fish growth [16, 17]. Freshwater fish applications in particular, require regular feedings because artemia typically live less than an hour in freshwater and feedings are sometimes needed 24 hours per day [8, 10].

Because of the limitations of hand-feeding artemia, a number of automated feeding systems have been designed. Relatively-expensive systems using video-tracking technology [18], infrared photocells [19], or a fully-automated system involving mechanics, electronics, fluidics, and computer software [20] have been described. Two lower-cost automated fish feeding systems for artemia have been described in the literature. Tangara et al. [21] described a battery-powered liquid artemia delivery system using an air pump, liquid pump, and a rheostat. This system is not automatic however, requiring the push of a button to dispense the liquid slurry. Candelier et al. [22] described a similar, not-completely-automatic system with several custom-made components and included microcontrollers and a printed circuit board.

There is a considerable need for a low-cost, low-complexity, automated system for artemia delivery to fish tanks. This paper describes an innovative, completely automatic, simple, and very low cost artemia feeder system.

2. Design

The artemia delivery system consists of a holding tank and paired stand, aerator, electric solenoid valve, and digital controller (Fig. 1). Hatched artemia are held in a 37.8-L cone-bottom tank and associated stand (Ace Roto-Mold Full Drain Inductor Tank and Poly Stand Set, Den Hartog Industries, Hospers, Iowa, USA) and is illustrated in Fig. 2. A small, 110-volt aerator (Aqua-Life Singe Output Aerator, Frabill, Plano, Illinois, USA) provides oxygen for the artemia in the holding tank (Fig. 3). The 120-volt, 34.5 kPa minimum-operating-pressure-differential, 2.54 cm pipe-size, electric solenoid valve (ASCO Solenoid Valve, Emerson, St. Louis, Missouri, USA) opens and closes the discharge opening at the bottom of the holding tank (Fig. 4). An adapter and metal pipe were used to transition from the 38.1 mm Roto-Mold tank outlet to the 12.7 mm electric solenoid valve.

A digital controller regulated the interval and duration of artemia delivery (Fig. 5). It was assembled using a digital timer (Digital Timer Outlet Short Period Repeat Cycle Intermittent Interval Timer

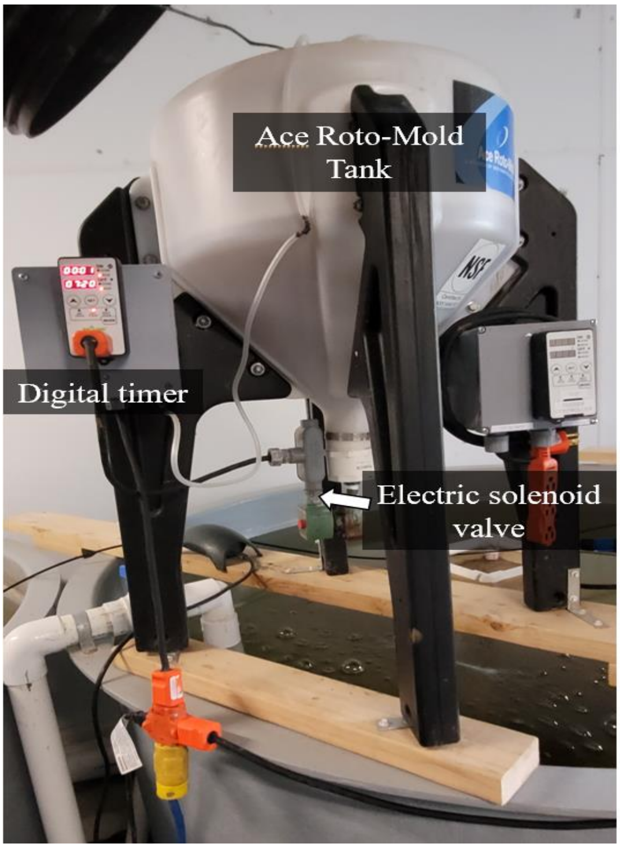

Figure 1. Automatic feeding system to deliver artemia on a regular basis to a fish rearing tank

Figure 2. Roto-Mold tank used to hold and dispense artemia as live feed to larval fish tanks

https://doi.org/10.58985/jafsb.2024.v02i03.60

Figure 3. 110-volt aerator used to keep artemia alive throughout the day in the roto-mold holding tank prior to release into a larval fish tank

Figure 4. Electric solenoid valve to regulate release of artemia into larval fish tanks

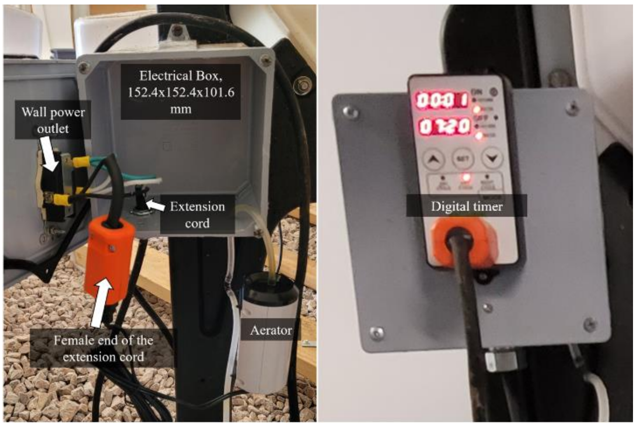

Figure 5. Digital controller system used to control the electric solenoid valve to distribute artemia throughout day

Programmable, BN-Link, Santa Fe Springs, California, USA), wall outlet, extension cord, and electrical box (Cantex 5133164 Junction Box, Carrollton, Texas, USA). Two holes were drilled in the bottom of the electrical box, one for the extension cord input (19.05 mm), and one for the aerator output (6.35 mm). The hole for the extension cord included a through hole connector which reduced the diameter down to 15.9 mm. Three holes were also drilled on the front of the electrical box. One was for the opening for the power outlet and two were for mounting screws for the power outlet. The extension cord was spliced near the female connector, threaded through the power outlet, respliced back into the female outlet, and then connected to the aerator. The digital timer was then connected to the outlet and screwed through to the lower mounting hole of the power outlet. The entire unit cost less than $500 USD.

The entire artemia feeding system was mounted to wooden posts on top of the larval fish tank. Thus, the unit was directly above the larval culture tank so that the artemia were released via gravity into the culture tank.

3. Evaluation

This system was built and tested at Cleghorn Springs Fish Hatchery, Rapid City, South Dakota, USA. Three systems were built. Each system was placed on a tank containing approximately 33,000 largemouth bass larvae. During the initial evaluation, the timer was set to dispense artemia from the systems for a one second duration at an interval of every eight minutes for 24 hours per day. Each system effectively distributed

https://doi.org/10.58985/jafsb.2024.v02i03.60

approximately 18,000,000 artemia each day to each larval tank. During this evaluation, the systems conveniently distributed artemia to each of the larval tanks, saving a large amount of labor by eliminating the need for near-continuous manual feeding. The number of artemia fed at each feeding event, along with the timing of feeding throughout the day, was more consistent than had previously occurred when hand-feeding artemia.

Two one-time problems with this system were observed. In the first instance, the valve at the bottom of the holding tank became plugged with artemia eggshells which accumulated at the bottom of the tank. This issue was resolved by removing the artemia shells prior to placement in the holding tank. In the second instance, the aerator failed, which again led to plugging of the solenoid valve at the bottom of the tank. It is possible that a larger diameter solenoid would be less susceptible to plugging and that different components may be less likely to fail.

4. Conclusions

In conclusion, this artemia feeding system worked effectively and efficiently. It was inexpensive to make with easily-obtainable commercial products. It also has the potential to be scaled for use with larger aquaculture tanks or systems by using larger components, particularly with a larger artemia storage tank or electric solenoid valve, or by using multiple, relatively-small-size systems on a larger tank.

Authors' contributions

Conceptualization, C.T., B.F.; Methodology, M.E.B.; Formal analysis, C.T., B.F., J.M.V.; Investigation, C.T., B.F., E.K., M.S.; Resources, C.T., B.F., M.E.B.; Data curation, C.T., B.F., E.K., M.S.; Writing – original draft preparation, E.K., M.S., J.M.V., M.E.B.; Writing – review and editing, E.K., M.S., J.M.V., M.E.B.; Visualization, C.T., B.F.; Supervision, M.E.B.; Project administration, J.M.V., M.E.B.; Funding acquisition, M.E.B.

Acknowledgements

We would like to thank Jackson Bertus and Riley Henderson for their assistance.

Funding

This research received no outside funding.

Availability of data and materials

All data will be made available on request according to the journal policy.

Conflicts of interest

The authors declare no conflict of interest.

Institutional Review Board Statement

This experiment was performed within the guidelines set out by the Aquatics Section Research Ethics Committee of the South Dakota Game, Fish and Parks (approval code, SDGFPARC20231) and within the guidelines for the Use of Fishes in Research set by the American Fisheries Society.

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