Design of a Feeding Device for Penaeus Vannamei Breeding Pond

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Abstract: At present, the mechanization of shrimp culture in China is still low, and most of them are artificially fed. Artificial feeding is not only labor-intensive, but also has the disadvantages of uneven feed throwing. In this paper, a feeding device for Penaeus Vannamei breeding pond is designed, which includes guide trolley, support body, feeding rod, storage plate and storage bucket, the feeding efficiency of Penaeus Vannamei is improved.

1. Subject research background and significance
Penaeus vannamei, belonging to the arthropoda, crustacea, decapoda and natantia and native to Pacific coastal waters of South America, is one of the three shrimps with the highest production in the world[1]. With delicious and nutritious meat and rich protein, minerals such as calcium, phosphorus and iron and iodine, it can nourish the vitality, invigorate the stomach, replenish essence, strengthen the body and extend life and is popular among the Chinese population. It has many advantages such as strong vitality, wide adaptability, strong disease resistance, rapid growth, low requirement for feed protein content, high dressing percentage and long survival out of water, and has high economic value. It has gradually become a main cultured shrimp species in south China.

With the rapid development of the Penaeus vannamei breeding industry and the expansion of its breeding scale in China, feeding becomes the main task in the process of Penaeus vannamei breeding. However, the breeding of white shrimps in China is mechanized to a small extent, and most of them are artificially fed. Artificial feeding is not only labor-intensive, but also has disadvantages such as uneven feed distribution. Most of the shrimp feeding devices available on the market are applicable to dry compound feed. There are few devices appropriate for fermented feed with high water content. In this paper, a feeding device for Penaeus vannamei breeding ponds is designed, which is applicable to different forms of feed and can improve feeding efficiency.

2. Demand analysis
Penaeus vannamei have many distinct habits from other types of shrimps. Many shrimps are generally active during the day when there is light, while Penaeus vannamei are active at night and tend to lie at the bottom of the pond restfully during the day. Chinese experts such as Yuan Kai, Ren Weimin and Lu Zhongnian summarized some experience in Penaeus vannamei breeding, including: 1. The change in water quality is one of the main reasons that affect Penaeus vannamei [2]. Therefore, it is required to conduct real-time monitoring and treatment based on the water quality, which allows to protect breeding...
ponds and the surrounding environment according to the change in water temperature and measures, master the pH value and temperature of water scientifically and ensure the feeding rate of the cultured fish. 2. Inadequate dissolved oxygen in water will cause a large number of Penaeus vannamei to surface, resulting in death by suffocation [3]. Therefore, attention shall be paid during breeding to the solubility in the breeding water and to increasing oxygen supply equipment in water, thereby increasing the dissolved oxygen in water. 3. Scientific bait feeding is required. Bait feeding is particularly important for Penaeus vannamei breeding as it directly affects the growth cycle and dressing percentage of Penaeus vannamei [4]. Scientific feeding can ensure the normal physiological need of Penaeus vannamei in the normal growth process, thereby avoiding the shortage of food in aquaculture which will result in small size and insufficient production of Penaeus vannamei. Therefore, it is required to control the feeding amount scientifically so as to avoid waste of feed and resources, maximize the application of feed and further improve the production of Penaeus vannamei.

The author has conducted a lot of research in order to solve the problem of feeding in the breeding process of Penaeus vannamei. The feeding device must meet the following basic requirements: 1. The feeding device for Penaeus vannamei breeding ponds should have a structure as simple as possible and easy operation for workers and be made at low costs, and can realize quantitative feeding. 2. The feeding device for penaeus vannamei breeding ponds can cover the pond with an area as large as possible and supply feed evenly in the breeding area. The feed storage device should be light and have sufficient capacity. 3. The feeding device for penaeus vannamei breeding should be easy to maintain so as to reduce maintenance costs. A residual feed treatment scheme should be designed to dispose of spoiled feed as soon as possible and prevent penaeus vannamei from getting sick after eating spoiled feed and infecting the entire pond.

3. Overall scheme of feeding device
A feeding device for Penaeus vannamei breeding ponds designed in this paper is mainly composed of a feeding mechanism, a screw-driven mechanism of the storage plate, a feed storage bucket and a sewage discharge end. In terms of its operating principle, the servo motor 1 rotates to drive the rotation of two gears 2 and 3 of different sizes installed on the motor shaft; the thrust ball bearing 5 helps to withstand the axial force of the main rotating shaft 4; then, the feeding rod 6 rotates for feed throwing and distribution under gear drive; under screw drive, the storage plate and screw cylinder 7 rises synchronously, thereby completing the task of even feeding; finally, the motor rotates inversely to lower the storage plate and discharge waste through the sewage discharge end.

![Schematic diagram of a feeding device for Penaeus vannamei breeding ponds](image)
4. Design of feeding device

The structure of the feeding device for Penaeus vannamei ponds is shown in Figure 2. The breeding pond 1 is rectangular; the guide rail 2 is set above the breeding pond 1 on its longer side; and the trolley 3, set on the guide rail, is a small trolley capable of moving on the guide rail 2 at a constant speed. The bottom of the storage bucket 9 is located above the water surface of the breeding pond 1. As there is a large shed above the breeding pond 1, the feeding device in the present invention will not be affected by rainy weather during operation.

![Figure 2 Three-dimensional view of feeding device](image1)

The guide trolley of the feeding device for Penaeus vannamei breeding ponds is shown in Figure 3. To facilitate the operation of the breeding personnel, the trolley is designed above the feeding device, with room left for feed distribution and the sewage discharge end at the bottom to facilitate distribution and the cleaning of excess feed.

![Figure 3 Design of guide trolley of a feeding device for Penaeus vannamei breeding ponds](image2)

The storage bucket of the feeding device for Penaeus vannamei breeding ponds is composed of a storage bucket for storing feed, a storage plate and a sewage discharge end located below the storage bucket. As shown in Figure 4, the storage bucket 9 is cylindrical; the upper end of the support body 5 is fixed below the trolley 3; the first bracket 6 in a trapezoidal step shape is composed of four struts; upper ends of the four struts are respectively fixed at the four angles at the lower end of the support body 5, and their lower ends are respectively fixed at the four angles of the working table 7. The second bracket 8 is composed of four vertical rods; upper ends of the four vertical rods are respectively fixed to centers of the four side walls of the working table 7, and their lower ends are respectively fixed to the top side wall of the storage bucket 9. The storage bucket is designed as a semi-closed cylinder made of aluminum alloy. The sewage discharge end is designed as a circular ring with a through hole on the side to facilitate the discharge of dirt. It is also made of aluminum alloy. The sewage discharge end welded to the storage bucket.
bucket has the same inner and outer diameters as the storage bucket. The storage plate is driven by a screw and restricted by three limit rods in the storage bucket. The main rotating shaft rotates in situ. The storage plate can move up to the feeding rod and down to the through hole at the sewage discharge end within the storage bucket. There is a clearance fit between the feeding rod and the screwed pipe to prevent interference in the transmission process.

5. Summary
A feeding device for Penaeus vannamei breeding ponds is composed of a guide trolley, a support body, a motor, a feeding rod, a storage plate and a storage bucket, etc. The guide trolley drives the entire feeding machine to move above the breeding pond; the support body bears the weight of the entire feeding machine while fixing the main rotating shaft; and the servo motor makes it more convenient to control the feeding device and has advantages such as light weight, small size and low energy consumption. The feeding rod is used to tap out the feed. The storage plate is made of aluminum alloy to ensure light weight while supporting the weight of the feed. The screwed pipe above it is made of copper aluminum alloy to ensure the stability of the screw drive. The storage bucket is provided with a sewage discharge end at the bottom to remove the remaining feed from the feeding device in time and ensure that the feed thrown into the pond will not become moldy and decomposed. The feed is kept in the storage plate and the storage bucket. The storage plate moves linearly in the storage bucket under the action of the screw drive and limit rods. At the same time, the feeding rod rotates under gear drive to tap out the feed and complete feeding.

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