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DEVELOPMENT AND PERFORMANCE EVALUATION OF AN AUTOMATIC FISH FEEDER

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ملخص

Aquaculture, the process of raising aquatic animals in ponds, is gaining more attention in recent time feeding system is an important aspect of aquacultural practice. A simple, relatively inexpensive automatic fish feeder was designed, constructed and evaluated. The operation of the feeder does not require highly technical expertise. This paper reports the design considerations, materials used and the effectiveness of the device, based on analysis of manual feeding and automatic feeding. The main features of the device are: hopper (stainless steel), bi-directional motor, feed platform and electrical control box. The design was based on specific parameters which included capacity of culture tank, stocking density, fish biomass, diameter of the feed, angle of repose and bulk density (of the feed). The total cost of the device was 17,000 naira (approx. 106 U.S. dollars). The device was tested under two culture tanks (0.75 m3 each) with 10 kg-33 juvenile cat fish (*Clarias gariepinus*) placed in each tank with one feeding automatically and the other, manually. The feeder evaluation was based on feed conversion ratio (FCR) and feeding efficiency (FE). The total average gain in weight per fish was higher in the automatic feeding (89.50 g) than in manual (78.50 g). An FE of 20.9% was obtained in the automatic feeding and 18.6% in manual, in relation to their FCRs. A t-test,conducted at 5% significance level, indicated a significant difference in the two feeding methods.

الكلمات الرئيسية: Automatic feed dispensers;
Aquaculture; Fish ponds; Feeding;

مقدمة

Aquaculture (fish cultivation), a rapidly- growing entrepreneurial activity, contributes to food security and poverty alleviation in many developing nations. Feeding is one of the most important aspects of fish growth and production. A major challenge facing aquaculture development is the management of feeding systems. Feed adjustment to meet fish requirement is very important for income/benefit maximization. Feeding frequency is thus an essential consideration. Aderolu et al., [1] studied the effect of feeding frequency on growth performance, feed utilization and economic viability of African).*gariepinusClarias* catfish (

The efficiency and profitability of aquacultural practice could be enhanced with improved technology. This has necessitated the design, development and construction of automatic feeding devices to meet feeding needs and to reduce labor requirements, thereby reducing the cost of fish production.

Mohapatra et al., [2] developed and tested a demand fish feeder,

rials and MethodseatM

esign considerationsD

Some properties of the feed pellet considered were: angle of repose, specific gravity and bulk density. Also, parameters considered were:

Culture system .1
Capacity of the pond (culture tank) .2
Stocking density .3
Average feed requirement .4
Capacity and shape of the hopper .5
Discharge rate through the outlet of the hopper .6
Power requirement by the motor .7
Operation time and operation interval. .8

Fish biomass=capacity of the tank × stocking density (1)

fish biomass x % of the body weight feeding (2)=Daily Feed Need

Daily feed need number of = Amount of feed needed per operation (3)*operation per day*

(4) $D \ \rho k = 16Q$ Discharge rate through the outlet of the hopper [7],

Where:

Q=volumetric flow rate, m3/s

D=orifice diameter, m

g=acceleration due to gravity, m/s2

k=coefficient of drag

ρ=bulk density, kg/m3

Mass flow rate=volumetric flow rate x average density of the pellet (5)

Time of operation=amount of feed needed per operation/mass flow rate (6)

number of hours per day number of Operation interval(OP) = (7)*feedings per day*

esign of control box (Timer)D

The 555 timer IC can be configured in three different modes: astable, monostable and bistable. The astable and monostable were adopted for this project. These devices are precision timing circuits capable of producing accurate time delays or oscillation. In the time-delay or monostable mode of operation, the time interval is controlled by a single external resistor and capacitor network. In the astable mode, the 555 timer acts as a "one-shot" pulse generator. The time of operation was calculated to be 3 sec, and the range of the operation was assumed to be 1 to 10 sec. The variable resistor that can delay for this period was calculated from the equation.

Monostable (Timer)=1.1RC (8).

escription of the deviceD

Figures 1 and 2 shows the general features of the automatic fish feeder. The component parts of the machine (device) include: the hopper, top cover (LID), the base (comprising the motor and feed platform) and the electrical control box. The hopper is made of stainless steel (1mm thickness) and it is of composite shape (cylindrical and fulcrum). The top cover is made of the same material as the hopper and it protects the feed from rain and contaminants. The base consists of 6V, 3W bidirectional motor and feed platform attached to it. The feed platform opens and closes the discharge

Cut and folded to form a cylinder of 30 mm diameter. Then welded to the base of the frustum.	50 mm x 95 mm	Stainless steel	4. Base Cylinder (outlet)
PVC used to cover the motor, also as feed platform. The wire connects the base to the control box. The base was suspended to the feed hopper using copper wire.		PVC, motor and wire	5. Base
PVC used for casing. The components were laid on the veroboard.		PVC, veroboard, resistors, capacitors, transistors, relays, 555 timers, transformer, diodes and regulator.	6. Control Box

Table 1: Construction materials.

Total cost (N)	Unit cost (N)	Quantity	Materials
4,000	4,000 (1/4 sheet)	¼ sheet	Stainless steel
1,000	1,000 (1/2 sheet)	½ sheet	Acrylonitrile plastic steel
500	500	1 piece	Transformer (220-9V)
500	500	....	Resistors (R1,R2,…R9)
500	500	....	Capacitor (C1, C2, …C9)
2000	2000	1 piece	Bi-directional motor (6V-3W)
200	200	....	LED (D1, D2, D3)
1500	1500	....	Integrated Circuit (IC1, IC2 and IC3)
500	500	....	Regulator (RG1,RG2)
1000	1000		Relay (RL1, RL2 and RL3)
300	300	....	Variable Resistor
5,000			Hopper construction workmanship and other costs
17,000			Total

Table 2: Bill of Engineering Measurement and Evaluation (BEME).

Average gain in weight per fish (g)	Total feed consumed per fish (g)	Average weight of fish (g)	Number of Fish	Date	S/N
0.00	0.00	300.00	10	16/04/2013	1
5.00	42.00	305.00	10	23/04/2013	2
8.50	43.00	313.50	10	30/04/2013	3
9.50	44.50	323.00	10	7/05/2013	4
10.5	46.00	335.50	10	14/05/2013	5
10.30	47.00	345.50	10	21/05/2013	6
9.80	49.00	355.53	10	28/05/2013	7
10.5	51.10	365.80	10	04/06/2013	8
11.40	52.00	377.20	10	11/06/2013	9
12.00	53.40	389.20	10	18/06/2013	10

The total average of feed consumed per fish during the period of the experiment = 428.00 g

The total average gain in weight per fish during the period of the experiment = 89.50 g

outlet as the motor rotates. The electrical control box controls and regulates the feeding operation and the frequency.

n of the machineoitarepO

The hopper contains the feed which comes out through the discharge outlet. When the machine is switched on and reset, the feed platform moves in bi-directional (to and fro) motion, during which there is opening and closing of the discharge outlet for predetermined period. The desired amount of the feed would be dispensed into the pond and this completes an operation. After the operation is completed,the machine will automatically stop for preset hours (1, 2, 3………… hrs) based on the number of operations needed per day. When the hours are completed, the machine will start again and dispense the same amount of feed as in the previous operation, and the operation continues.

The machine is powered by electricity and it has a back-up (6V battery) which can last for at least 3 days (72 hrs) when fully charged. The device can be used for both local and imported dry pellet of size 0.5 mm-9 mm. The cost estimate for the production of the machine was N17,000 (approx. US $106). The construction materials and the Bill of Engineering Measurement and Evaluation (BEME) are shown in Tables 1 and 2, respectively.

rformance evaluationeP

The performance evaluation of the device was conducted using a recirculatory aquaculture system (RAS) located behind the Department of Agricultural and Biosystems Engineering, University of Ilorin; Ilorin, Nigeria.

Ilorin (longitude 4°35'E, latitude 8° 30'N), the capital of Kwara State of Nigeria, has two main seasons: wet (March-October) and dry (November-February). The experiments were conducted from April to June, 2013, involving two culture tanks, each of 0.75 m3 volume,) placed in each *Clarias gariepinus*with 10 kg-33 juvenile catfish (tank with one feeding automatically and the other, manually.

"Durante" fish feed, weighing balance and meter rule were also used in the investigation. The feeder was placed over a stand fixed at the corner of the culture tank. Growth rate of fish was estimated by sampling 10 fishes from the rearing tank every week (7 days interval). The feed conversion ratio (FCR) and the feeding efficiency (FE) were used for the performance evaluation:

(gram)*otal amount of the feed given t* =FCR

(gram) (9)*otal gain in weight by the fish t*

esults and DiscussionR

Tables 3 and 4 show the catfish growth rate for automatic and manual feeding, respectively.

For the automatic feeding (Table 3);

Remarks	Dimensions	Materials Used	Components
Cut out and folded to make a cover	260 mm (diameter)	Stainless steel (1 mm thickness)	1. Lid
Cut out and folded to form a cylinder of 250 mm diameter	300 mm x 790 mm	Stainless steel (1 mm thickness)	2. Upper Cylinder
Cut and folded to form a frustum of upper diameter of 250 mm and base diameter of 30 mm, height of 150 mm. The frustum joined to the upper cylinder at an angle of 50o.	195 mm x 790 mm	Stainless steel (1 mm thickness)	3. Frustum

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Table 3: Growth rate of catfish for the automatic feeder.

Average gain in weight per fish (g)	Total feed consumed per fish (g)	Average weight of fish (g)	Number of Fish	Date	S/N
0.00	0.00	300.00	10	16/04/2013	1
4.00	42.00	304.00	10	23/04/2013	2
8.50	44.00	312.50	10	30/04/2013	3
7.70	45.00	320.20	10	7/05/2013	4
8.80	46.00	329.00	10	14/05/2013	5
8.00	46.50	335.00	10	21/05/2013	6
9.50	47.00	344.50	10	28/05/2013	7
10.20	49.00	354.70	10	04/06/2013	8
10.80	50.00	365.50	10	11/06/2013	9
11.00	52.00	376.50	10	18/06/2013	10

The total average of feed consumed per fish during the period of the experiment=421.50 g

The total average gain in weight per fish during the period of the experiment=78.50 g

Table 4: Growth rate of catfish for manual feeding.

t-test value	Standard deviation (g)	Mean gain in weight per fish(g)	Feeding Method
1.077	3.57	8.95	Automatic feeding
0.973	3.23	7.85	Manual feeding

The mean gain in weight per fish in automatic feeding was higher than in manual.

Table 5: Result of statistical analysis.

استنتاج

n automatic fish feeder was designed, constructed and A evaluated. Its main components are: hopper, bi-directional and electrical control box. The device *motor, feed platform* was incorporated into a recirculatory aquaculture system (RAS) and the evaluation was based on feed conversion ratio (FCR) and feeding efficiency (FE) using juvenile catfish). The feeding efficiency was higher in the *Clarias gariepinus*(automatic feeding (20.9%) than in manual (18.6%). Use of the automatic feeder will improve aquacultural practice.

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