Development and Performance Evalution of a Recirculatory System Fish Incubator

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ABSTRACT

Hatching of fish eggs during the raining season is more or less difficult and time consuming in terms of heat provision for the eggs which results in a high cost of production. Consequently there is need to design and construct an effective recirculatory system fish incubator which operates under a controlled environment. An incubator with an hatching unit of (306mm x 303mm x 207mm) dimension was designed and constructed using locally available materials to reduce cost. The recirculatory system incubator has three units: the Incubating unit, the Sedimentation unit and Bio-tower system unit, The incubating unit was constructed using angular bars of dimension 3mm x 50mm which were joined together to form a rectangular shape and lined up at the back with pipe to supply water from the bio-tower system. Inside are four metal trays made from metal plate to form the hatching units. Four bulbs (60watt) each generating heat for each tray were used as heat source. The sedimentation tank was constructed using angular bar of 840mm x 307mm x 900mm dimension and covered up with metal plates and then connected to an overhead tank (Bio-tower). The flow of water from the sedimentation tank to the bio- tower is powered by a 0.5hp electric motor. The bio-tower system is made up of a plastic bowl to contain a bio filter which breaks down the nitrogenous waste of the water and allow a mixed up with atmospheric oxygen before sending it to the incubator. Also, oyster shell and larve stones were included in the bio-tower to control the pH. Two hundred grams (200gm) weight of clarias gariepiaus egg was set in the incubator under a normal temperature range of between ±21^oC with PH range of 7and Do_2 of 9mg/L; about 63% of hatchability was obtained after about 24hours of set-up. The experiment was replicated thrice giving a mean value of 61.25%(T1), 63.75%(T2), 67.5%(T3) and 60%(T4) and when subjected to statistical analysis shows a significant difference ($p<0.05$) in the treatment means. The estimated cost of constructing the incubator is N87,150 which is an equivalent of $544.69. Therefore this device is cheap, affordable and very easy to maintain as compared to the imported counterpart that sell for between $2500 - $4500.

***KEY WORDS**: Re-circulatory, Bio-tower, Sedimentation tank, Incubator, Hatchability*

I. INTRODUCTION

Bulk of the domestic fish produce in Nigerian homes are from the in land capture fishes, dominated by the artisanal fishery sub-sector. Eyo and Ahmed (2005) reported that out of the 511,720 tons of fish produce in 2002. The art and fisheries sub sector accounted for 88.13% of the total production in that year. Hence the need has arisen to populate the wild fish to prevent extinction of the existing species. Incubator had been the most important source of hatching in the world. It has been in use in the southern California and China as far back 350BC till date. Push tray type, mats and a conical type are commonly used worldwide. Imported incubators are very expensive, difficult to repair and maintained. Owen (1991).The cost of buying an imported incubator has seriously restricted hatching operations by fish farmers during the raining season as the temperature is unfavorable for hatching at that period. In Africa, the traditional method of hatching the eggs is practice which involves the spawning of the eggs from the female fish through stripping and mixing the eggs thoroughly with sperm from the male fish. It is then spread on a small piece of net in a bath of water allowing sprinkle of water to flow into it under atmospheric temperature of 28-31 ^OC.

Tray type incubator consists of a container that is screened or perforated through which a flow of water permeate to supply the egg with oxygen and flush away waste productions. Tray type incubator is used for fish egg that can be injured by the flow of water during incubation. Conical shaped tank that are not adhesive are used for fish eggs and they require constant flow of water from constant tumble in the lower portion of the jar. This type of incubator, is made of net materials and requires structural support and must be suspended inside a layer tank or placed inside the rearing tank. The flowing water must be of good quality and also well oxygenated water. The larvae is poured out of the incubator into the rearing tank as they are hatch into a soft materials shaped into a cone and used as an incubator. It is advantageous to use a screen because greater surface area is provided for water to flow out, thus preventing the egg yolk and larvae from been crush. During incubation constant flow of water is essential to prevent accumulation of a waste product and also allowing gas exchange between the egg and the surrounding water. Developmental embryos and newly hatched larvae (fry) are very sensitive and delicate at this stage of their life, so great care must be taken to provide them with the proper incubating and hatching environment. Water temperatures, water quality, size of the egg are very important factors to be considered in the design of incubator. Artificial incubation of egg is hatching a practice that will increase the economic efficiency of a commercial fish culture operation, hatching rate and survival will increase using artificial incubator. The removal of the eggs from the parent may increase egg production by shortening the time for another spawning. *Ellis et. al* (1996).Therefore, the aim of this work is to reduce the problem of hatching during the raining season by maintaining the temperature which will enable hatchability, and also to evaluate the performance efficiency of the recirculatory system fish incubator in order to meet the need of the farmer.

II. MATERIALS AND METHOD

CONSTRUCTION:

The recirculatory system incubator is made up of three units namely the hatching unit, sedimentation unit, and the bio-tower system.

[1] HATCHING UNIT

The hatching unit consists of a four hatching trays made from galvanized iron with a dimension of 306mm x 303mm x 207mm, which acts as a holding tank or tray for the eggs to be hatch. The trays are linked together with a pipe of 20mm diameter which transmits water from the hatching unit to the sedimentation unit.

Inside the hatching unit, there is a thermometer to measure the temperature reading of the incubator. Four bulbs were placed inside the incubator as the source of heat supply. The recirculatory system incubator temperature is controlled to the required temperature degree for hatching with the help of a regulator.

[2] SEDIMENTATION TANK

The sedimentation unit is made up of galvanized iron with a dimension of 840mm x 307mm x 900mm. The sedimentation unit consists of three chambers. The metal is welded together to form a rectangular box shape and each chamber consist of a net. The first chamber purifies the water coming from the incubator, while the second chamber consist of two nets in layers, which filters the sediments or dirt from the water before sending it to the pumping unit. The third chamber, the water that has been purified is being pumped back to the bio- tower tank with the aid of 0.5Hp pumping machine

[3] BIO-TOWER TANK UNIT

The bio-filter tank unit is made of a plastic tank of 100liters in volume. This tank serves as water reservoir and contains of a bio-filter, control valve, oyster shell and larvae stones.

The tank is connected to the 0.5Hp pumping machine which brings water into it, through a 2mm pipe from the sedimentation tank. The bio- tower is also connected to the incubator/ hatching chamber with the same size of pipe and regulated by a control valve. The valve connected to the pipe is used in the controlling water passage from the tank to the incubator and also used in regulating the pressure of flow to the tank and trays in the incubator.

The bio-filter is situated inside the bio-filter tank. This breaks down the nitrogenous waste in the incoming water. The oyster shell and the larva stone were also placed inside the tank to control the $_pH$ level of the water to 6.0 – 6.5 range which is suitable for the hatching and survivability of the eggs.

III. WORKING PRINCIPLE

The recirculatory system incubator that is made of three compartment unit namely the hatching unit, sedimentation unit, overhead tank or the bio-tower system unit with 0.5hp pumping engine.

Water from the bio-tower tank system which is free nitrogenous waste as a result of the mixing dissolved oxygen with the water flows to the hatching unit through a connecting pipe of 2mm and the pressure of flow is controlled by the tap. The dissolve oxygenated water is then released into the incubator in form of shower or spray which fills the hatching box and escapes through an opening into an outlet pipe. The four bulbs inside the hatching unit are regulated to produce the required heat which is monitored with the help of the thermometer. The water from the hatching unit flows down to the sedimentation tank where the dirt from the water settles down and later moves to the filtration tank through an opening at the base. It is then filtered before being sent to the pumping tank, where the filtered water is then pumped the bio-tower tank with the help of 0.5Hp electric motor.

IV. DETERMINATION CALCULATIONS

Design for flow of water in the recirculatory incubator

To calculate the rate of water flow in the incubator with an equation based pressure formula:

$V = A \times h$ … (1)

Where,

V = volume of water in the overhead tank (m^3)

A = area of overhead tank (m^2)

h = height or depth of the reservoir tanks (m)

$V = \pi D^2 \times h$ ... (2)

Where,

D = Diameter of the overhead (m)

The volume of water shield of discharge Q in m^3/sec was calculated

$Q = \frac{\text{volume discharged}}{\text{time taken}}$ ... (3)

Volume of discharge = Area × Velocity of Discharge Pipe … (4)

Area of Discharge Pipe = $\frac{\pi D^2}{4}$ … (5)

The energy possessed by the moving fluid (water) at an attitude above datum (ground surface) also given by Bernoulli's equation

Pressure heed +Velocity head + Potential head = Total Head … (6)

Pressure head from the overhead tank = $P/_{\rho g h}$ ... (7)

Where,

ρ = density of water flowing in the incubator (kg/m^3)

P = potential head above datum (reference point) $N/_{m^2}$

g = acceleration due to gravity

Therefore

Velocity head = $\frac{v^2}{2g}$ □(8)

The fluid pressure due to depth & weight = $\rho g h$ …. (9)

Where,

ρ = water density

H = height of the overhead tank

Fluid pressure was given as 21582 $N/_{m^2}$

Atmospheric pressure was given as 1.01325 $N/_{m^2}$

Total pressure was reservoir before discharge in from as

P1 + Atmospheric Pressure …(10)

V. METHODOLGY

Matured male and female broodstocks were purchased and their weight was 1kg each when measured. The female bloodstocks was Injected with 0.5m/s of ovaprim (injection). The female broodstock was left to rest for 8-10hrs, so as to activate the release of eggs. After 10hrs of injection the female broodstock was stripped to release the eggs. The released eggs was weighted to determine the weight so as to be able to calculate the hatching percentage which was calculated as weight of egg x % hatchability, in which 50g of eggs is equivalent to 35,000 pcs of eggs. The male broodstock is cut open to remove the male semen sac and the semen sac is cut opened to released the content into the eggs mass. The content is then mixed properly by shaking the mixture thoroughly to allow for proper mix up of the content and for easy fertilization process.

The mixture of the fertilized eggs were then removed with the help of a tablespoon and spread on a net inserted into water in the incubating trays. Water was allowed to run at a speed of 0.02ppm/sec, and the heat inside the incubator was regulated to a temperature of between $\pm 21^0$C. The pH of the water was tested and regulated to a $_p$H of between 6.5-7, while dissolved (DO_2) oxygen level of the water coming into the incubator is between 7.0 – 9.0mg/L and ammonia level of the incubator was also controlled by removing the water from the sedimentation tank and replacing it with clean fresh water.The eggs were monitored and the hatching began at exactly 18hrs after the setting of the eggs. The net from the hatchery trays were remove and the shell waste from the water were siphoned using 5mm diameter hose. The velocity of the water dropping into the incubator is then increased to 0.05ppm/sec to allow for fast and proper evacuation of the water. Then the water level of the incubator was reduced through the bio tower system to a minimal and fresh water added to it to reduce the ammonia concentration level of the water. After the second day the larva were siphoned into the larva rearing tanks for further managerial activities.

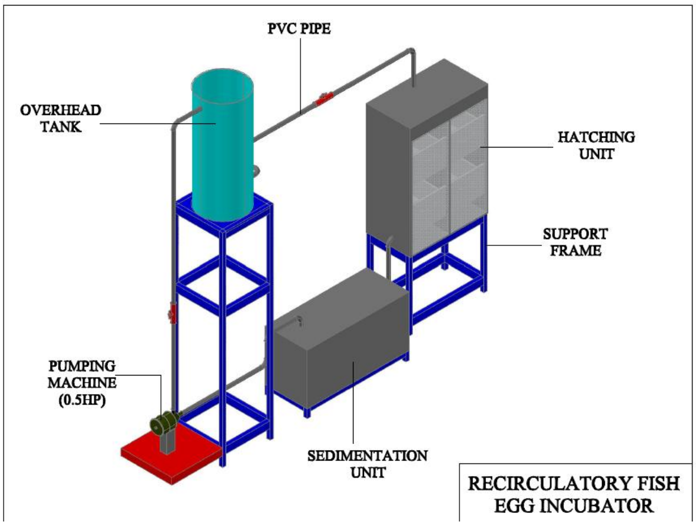

Figure 1. Recirculatory fish incubator

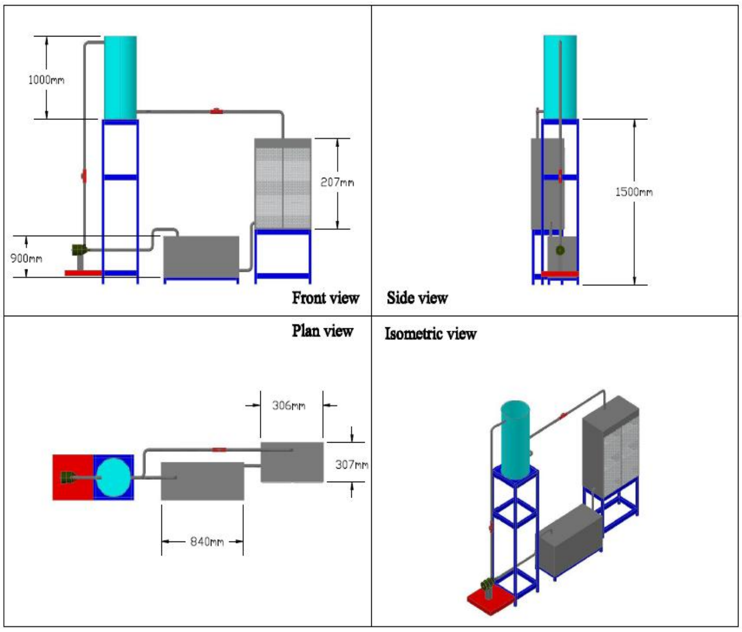

Figure 2. Recirculatory fish incubator

Figure 3 Showing the True picture of the constructed re-circulatory hatching incubator.

Table1: showing percentage hatchability when tested.

Test/wk	T1	T2	T3	T4	TEMP	PH LEVEL	(DO_2) mg/L
1	60%	70%	75%	65%	± 21 ^{0}C	6.8	7.00
2	65%	65%	70%	60%	± 21 ^{0}C	6.5	7.20
3	60%	60%	65%	60%	± 21 ^{0}C	6.9	8.50
4	60%	60%	60%	55%	± 21 ^{0}C	7.0	9.00
MEAN	61.25%	63.75%	67.5%	60%	± 21 ^{0}C	6.8	7.9

Table 2: showing the cost analysis of constructing the recirculatory hatchery incubator.

S/NO ITEM	QTY	UNIT COST	TOTAL COST
1 Angle Iron 50x50x60mm	5	2,900	14,500
2. Bio-filter	1 bundle	1,500	1,500
3.Control valve	6	300	1,800
4.Heat regulator	1	500	500
5.Overhead tank(100 litres)	1	3000	3,000
6.Thermometer	2	800	1,600
7.Lagging materials(fiber)		10,000	10,000
8.Galvanised sheet	4	3,500	14,000
9.Pumping machine(0.5hp)	1	4,000	4,000
10.lamp holder	4	50	200
11.Bulbs	4	50	200
12.1.5mm coil wire	15yds	70	1,050
13.Pvc pipe(20mm)	6	300	1,800
14.Pipe connector	30	50	1,500
15.Plastic glass	3	1,500	4,500
16.Larvae stone	2	100	200
17.Net (screen)	1yd	100	100
18.Paint(silver/green)	4cups	400	1,600
19.Topgit gum	2	250	500
Workmanship			25,000
TOTAL			N 87,150
$ 544.69			

VI. RESULT AND DISCUSSION

Figure 1.shows the details of the component that constitute the re-circulatory hatchery incubator. The result of the test for percentage hatchability is presented in Table 1. The mean hatchability percentage obtained for the 4 treatments were put at 61.3% (T_1), 63.75(T2), 67.5% (T_3), 60% (T_4). The result obtained was subjected to statistical analysis and it reveals that there were significant differences ($P<0.05$) in the treatment means and that T3 had the highest hatchability percentage(%) of 67.5%.And as such proves that the hatching incubator is very effective for hatching at any period of the year. The hatching Temperature, PH and the Do_2 level were favourable for the hatching FAO(2004).Table 2. reveals the cost analysis of the construction which proves that it is affordable by the hatchery farmer at #87,150 which is an equivalent of $544.69 as compared to that of imported counterpart whose cost ranges between $2500 -$4500.The size and operation of the incubator is very simple as compared to the imported incubator which looks so cumbersome in structure and maintenance.

VII. CONCLUSION AND RECOMMENDATION

Devices of simple technology with low cost of production as compared to the imported devices, easy maintenance conveniently Less space occupying like this will go a long way to reduce theproblem of hatching during the cold weather and thereby increasing the production of high quality fries from hatchery production.The device can easily be operated by a 0.5 HP machine which is fixed at the base of the bio-tower system on a frame. It is therefore necessary that more equipment trials be carried out so as to achieve perfection of the device. It is also recommended that the extension agent should try to enlighten the hatchery operators on this latest technology of re-circulatory hatchery incubator

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