EFFECTS OF AIR STONE WITH PLASTIC STRAW AS INTAKE CONNECTOR ON AERATION OF AQUACULTURE TANKS

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ABSTRACT

Air stone used in this experiment was produced in the laboratory with river sand as the basic material. The air stone was comparatively tested with imported ones using a double-chambered air pump. Equal number (20 per m^3) of mud crab (Potamon ebonyicum), tilapia (Oreochromis niloticus) and African cat fish (Clarias gariepinus) were used for the experiment. Air bubbles as small as those from the imported stone were observed on the locally produced one. More bubbles were observed on the local air stone than the imported one. Temperature of the test water fell within the tolerable range for aquaculture. Dissolved oxygen content also fell within adequate measurement. More crablets than the fish fingerlings survived after aerating the tanks, probably because of their hardy nature. More fingerlings of tilapia and African catfish (100% and 90% respectively) survived in the tanks aerated with imported air stone. While in the tanks aerated with locally produced stone, survival rates were 80% and 85% respectively. The percentage survival in the tanks aerated with locally produced air stone was quite significant ($P < 0.05$), and seemed to suggest that the accessory was safe and effective for aquaculture.

Keywords: air stone, straw, tubing connect, aeration, aquaculture

INTRODUCTION

Rapid reproduction of bacteria in response to sudden increase in waste materials (for example due to overfeeding) are visible in fish tanks, sometimes forming what looks like cloud of swirling white smoke. This bacterial bloom can use oxygen in large amount, create harmful environment, and cause scarcity of dissolved oxygen in the tank. Fish in the aquarium needs air pump and air stone to supply fresh oxygen for efficient biological filtration (Foster and Smith, 1997). With the aeration device, building up of harmful gases such as carbon dioxide can be prevented, and proper gas exchange enhanced. Low oxygen in the aquarium is more harmful to the inhabitants than we often realized. Health levels of oxygen can be easily and efficiently achieved by using such aeration devices as air pumps and air stones (Foster and Smith, 1997, Live Aquarium, Undated, and Rockbottom Aquatics, Undated). Production of bubbles that are not uniform has been the common fault of all air stones of similar construction, regardless of shape and cost. Size of the gas bubble determines the surface area of given volume of air that may increase the efficiency of oxygen transfer (Aquarium Air Stone Comparisons, Undated). Air Stones do the most excellent thing - providing good water circulation to increase the oxygenation of the environment (First Tank Guide, 2012).

However, the need for proper distribution of oxygen in farm aquarium necessitated production of air stone with straw as air tube connector. Local production of air stone was necessitated in the first instance by devaluated local currency, which resulted in the low purchasing power at the international market. Owing to the currency devaluation, provision of fishery and aquaculture materials including aquarium accessories became difficult (Akpaniteaku, Unpublished). Reference was not made to any materials used for air stone production due to scarcity of information. It was considered however those chemicals and other kinds of material used for the production of fish-tank accessories must be non pollutant and fish friendly. Otherwise toxic material would dissolve in water and endanger the health of the inhabitants (pers. observation). The need to study the effects of the aquarium accessory on different cultivable aquatic organisms was suggested in the field. The research was therefore aimed at determining effectiveness of air stone made with straw tubing connector during aeration; and its effect on crablets and fish fingerlings.

MATERIALS AND METHODS

The air stone was produced with locally available materials. Sand was collected from the bank of Ezu River in Anambra State. The river sand was initially collected without considering the size of the grains. Wet sample was directly dried under the sun. Uniform grains were later obtained with plastic mesh 250 – 315 microns BP, measured at Project Development Agency Enugu, Nigeria. The grains were separated into sizes with plastic sieve. The initial sieve was vigorously done, and the sand was sieved twice. Plastic drinking straw which would serve as air intake connector was collected from local shop. Cement powder was collected from building material shop, and adhesive (Araldite©) purchased from local market. Material quantities for the production of air stone are shown in Table 1. The water-proof adhesive was mixed at ratio 1:1 before the sand was added. The materials were properly mixed before the cement which served as binder was added. Hexagonal and oval stones were loosely molded before the straw was incorporated. At the end of the molding, base of the tubing connector was carefully sealed with the adhesive.

Table 1: Material quantity for the production of air stone with straw as intake connector

Material	Rate	Remark
Adhesive	1:1	7 drops
Graded sand	1:1	-
Cement	0:3	-
Straw	-	-

The product was kept on the bench over night - allowing 20 hours for solidification. Laboratory test with double chamber Faunty air pump CX – 3500 (made in China) was done three hours to ensure sufficient perforation, and free flow of gas through numerous tiny openings. The local and imported stones were connected to double chambered air pump with equal length (1.5 m) air tube for a comparative test. The air line tubing and stones were dipped in 3 litre plastic containers with 15 cm depth of tap water. The water was dechlorinated by exposing container to air for 24 hours. Aeration test was severally done at intervals of one hour. Dissolved oxygen (DO) was determined with electronic probe (portable and non-calibrated).

Subsequently, three different plastic containers of equal size (1 m^3), stocked with equal number of crablets (*Potamon ebonyicum*), *Oreochromis niloticus* and *Clarias gariepinus* fingerlings (20 each) and replicated three times were aerated for six hours. Water temperature was taken *in situ* with mercury-in glass thermometer (0 ^{o} – 100 ^{o}C). The temperature was taken by dipping the bulb of the thermometer into the water for five minutes. The stock was allowed to stand for 15 days after aeration. Data were generated, statistically analyzed and tabulated.

RESULTS

Binding reaction of the sand and cement with the adhesive was visible during the mix. The basic material (sand grain) seemed to attract and repel one another in the reaction. After hardening, the intake end of the air stone (straw) partially collapsed in the process of connecting the tube. It took a few more seconds to connect the local air stone than the imported one. Analysis of the cost of producing the air stone is shown in Table 2. The cost of procuring one air stone was almost the same as the cost of producing seven local ones.

Table 2: Cost analysis of the imported and locally produced air stones

Item	Imported Cost (₦)	Number of air stone	Local Cost (₦)	Number of air stones
Adhesive	-		150.00	
Base material	-		0.00	
Binder	-		100.00	
Total	200.00	1	250.00	7

Free flow of gas through the intake connector (straw) released bubbles in the water. Numerous gas bubbles were released through the air stone. The bubbles rose brightly through the depths to the water surface.

Dissolved oxygen content facilitated by the air stone are presented in Fig. 1. Mean dissolved oxygen facilitated by the imported air stone was 9.5 mgl^{-1}, while the mean dissolved oxygen facilitated by the local one was 8.0 mgl^{-1}.

Temperature differential of the aerated water (Fig. 2) was significant ($P < 0.05$). Mean temperature of the tank aerated with locally produced air stone was 27.5 ° C, while the temperature of the water aerated with imported air stone was 27 °C.

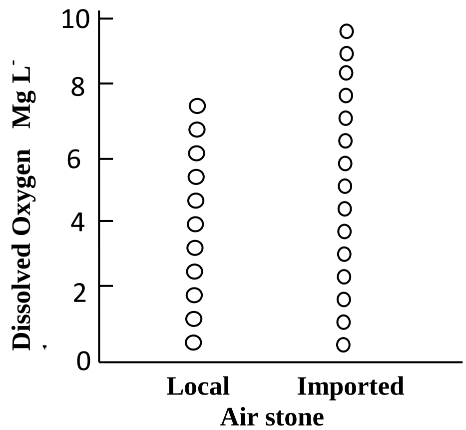

Fig 1: Dissolved oxygen content facilitated by the air stones

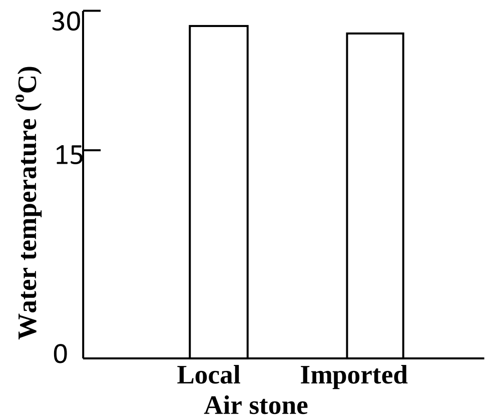

Fig 2: Temperature of the tank water after aeration

Sudden change in the activity of crabs and fish during aeration was recorded especially in the tanks facilitated by the local air stone. Survival rate of the fish species is shown in Fig. 3. High rate of survival was recorded with both local and imported air stones. The highest rate of survival (100%) was recorded in the tanks containing *P. ebonyicum* and *O. niloticus*. This was followed by *C. gariepinus* tank, which was aerated with the imported air stone, and recorded 90% survival. The lowest survival rate (85%) was facilitated by the local air stone in the tank containing *O. niloticus*.

POE *Potamon ebonyicum* (crab)
ORN *Oreochromis niloticus* (tilapia)
CLG *Clarias gariepinus* (African catfish)

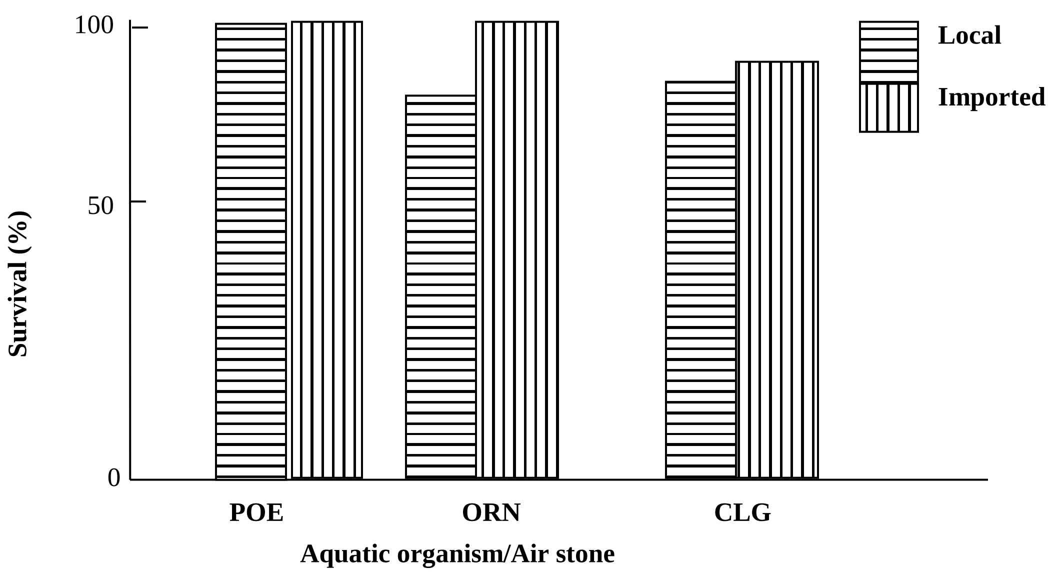

Fig 3: Percentage survival of aquatic organisms 15 days after aeration with local and imported air stone

DISCUSSION

Attract and repel reaction of the materials (sand, cement and adhesive) may indicate that resultant air stone is adequately perforated. Cost implication of procuring the air stone probably indicate that it is more economical to produce locally than to import from abroad. The release of numerous bubbles through the air stone seemed to indicate that there was little or no leakage on the tube connector. Foster and Smith (1997) reported that tiny bubbles detoxify aquarium, improve water quality and make it more hospitable to inhabitants. According to NACA (1989) dissolved oxygen content (DOC) does not only affect respiratory rate, but also feeding rate. Under normal conditions, the higher the DO the greater the food intake, the lower the food conversion factor and the faster the growth of fish (NACA, 1989). Nutrition was not considered in the present investigation. The DOC (figure 1) are within the tolerable range of both mesoxic and euryoxic fish species. According to Wootton (1992) stenoxic species require well-oxygenated water containing more than $10mgl^{-1}$. Although temperature differential was not significant (Fig. 2) Wootton reported that fish can detect a temperature gradient in water, which allows them to exert some behavioural control over their body temperature. According to Graham (1983), changes in temperature have direct effects on all aspects of metabolism of fish.

Delicate fish species may survive in captivity with the aid of such aquarium accessories as air stone, air pump and filter (Akpaniteaku, 1994). The aeration facility might play vital role in the maintenance of biological filtration. Akpaniteaku and Ezie (2011) reported that indiscriminate use of stocking density, imported feeds and other materials had given way to uncoordinated practices. Proper use of the local air stone may have significant impact in the efficiency of the biological filtration. The change in activity of crabs and fish during aeration may probably indicate a sudden and significant increment in dissolved oxygen, especially in tanks facilitated by the local air stone. Akpaniteaku (1994) reported excess carbon dioxide in aquarium as major cause of mortality. According to Ufodike (pers. comm.) mortality in tropical fish culture could be the consequence of hypoxia (lack of oxygen) resulting from high biological oxygen demand (BOD). The DOC of static fish ponds mainly depend on the photosynthesis of phytoplankton, and diffusion of air against the water surface (NACA, 1989). In indoor situation, Akpaniteaku (1994) reported that use of pump and air stone could counter the effect of carbon dioxide in water, otherwise fish would indicate by swimming to the surface. The condition may sometimes be indicated by numerous gas bubbles on the water surface (Akpaniteaku, 1994). High rate of survival was recorded in the tanks containing *P. ebonyicum* and *C. gariepinus* probably due to their hardy nature. The cultivable crab, *P. ebonyicum* (Akpaniteaku, 2013) and fish species seem to be harder than the *O. niloticus*. The survival value of *C. gariepinus* is significantly high (Akpaniteaku, 2012), which may indicate that crowding does not adversely affect survival, feed utilization and growth of the fish. More so SPC (2011) reported that mud crabs are hardy organisms and little is known of disease problems in the juvenile and grow-out phases of their culture.

CONCLUSION

The use of air stone with straw as intake connector is an innovative approach to solving physic-chemical problems of intensive aquaculture. Modest contribution of innovation is in the area of waste management – making drinking straw an important component in the production of air stone. The thin plastic tubes found in dustbin around local shops were insignificant in the management of wastes until the present investigation. Cost analysis also revealed that it was cheaper to produce the accessory locally than importing from abroad. Making use of locally available materials to produce sensitive equipment would enhance development of indigenous technologies in fishery and aquaculture. However, aquaculture engineers are highly expected to fine tune the innovation for a better performance in the field.

REFERENCES

Akpaniteaku, R.C. (Unpublished). Fabrication of Air Stone using straw as Air line tubing connector. Ministry of Agriculture and Natural Resources, Fisheries Division Enugu 5pp.

Akpaniteaku, R. C. (1994). Guide to Aquarium and Fish keeping in Nigeria. Chife and Chife Publishers Nawfia, Nigeria 31pp.

Akpaniteaku, R. C. and Ezie, J. E. (2011). A study on catfish culture at various locations in Anambra State Nigeria. Nigerian Journal of Research and Production 19(1): 110-116.

Akpaniteaku, R. C. (2012). Effects of Stocking Density on Catfish Production in Anambra State, Nigeria. African Journal of Bioscience 5(1): 45-48.

Akpaniteaku, R.C. (2013). A study on cultivability and feeding of mud crab (Potamon ebonyicum) in Ebonyi State, Nigeria. International Journal of

Research and Advancement in Bioscience 3(2): 133 – 135.

Aquarium Air Stone Comparisons (Undated). Air stone comparisons. http://www.waynesthis and that.com/air%20 stone % 20 comparison.html.

First Tank guide (2012). Air Stone. Http://www.fisttankguide.net/airstone.php.

Foster and Smith (1997). Air pumps and air stones: Increase aeration for healthy aquarium. http://www.drsfostersmith.com/pic/article.C7m?c=3578.

Graham, J. B. (1983). Heat transfer in fish biomechanics, P.W. Webb and D. Weihs (eds.), Praeger, New York: 248 -279.

Live Aquarium (Undated). Air pumps and air stone: Increase aeration for healthy aquarium. http://www.live aquaria.com/pic/article – pdf.cfm?aid=139.

NACA (1989). Integrated fish farming in China. NACA Technical Manual 7. A World Food Day Publication of the Network of Aquaculture Centres in Asia and the Pacific, Bangkok, Thailand. 278pp.

Rockbottom Aquatics (Undated). Aquarium air pumps – Aquarium supplies Buy online from – http://www.rockbottomaquatics.co.uk/aquarium-supplies-aquarium-air-pumps—1.html.

SPC (2011). Mud crab. http//www.spc.int/aquaculture/indexphp?opinion=COM-Commodities.

Wootton, R. J. (1992). Fish Ecology. Chapman and Hall, London, 212pp.