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COMPARISON OF SOME FISH SORTING TOOLS FOR GRADING *Clarias gariepinus* FINGERLINGS

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Abstract:

Over 200,000 of *Clarias gariepinus* two-week old hatched fry were sorted at different ages i.e 2, 3, 4, 5 and 6 weeks using nine differet grading tools, namely Dipnet (DN), grading cage (GC), hang grading net (HGN), meshed box (MB), plastic basin (PB), plywood box (PWB), sorting table (ST), woven basket (WB), and wood grading panel (WGP). The result from the study indicated that sorting table (ST), grades faster in all the age of the fry, having the highest number of graded fry. In all the ages, plastic basin (PB) consistently had the lowest. The highest mortality values were observed in sorting table (ST) in all the ages of fish sorted while the lowest values were recorded in grading cage (GC). The success of the grading cage (GC) was that it grades more efficiently through the bottom unlike other sorting tools which gradel through its sides. *Clarias gariepinus* fry between the age of 2 and 4 weeks is best graded using the grading cage for high survival rate and sorting table is best used with fish from the age of 4 weeks and above.

Key words: Aquaculture, Grading tools, Size diversity, Fingerlings, *Clarias gariepinus*

Introduction

Aquaculture in Nigeria has a history of at least four decades, with spectacular growth recorded in the last few years (AIFP, 2010; Akinrotimi e*t al.,* 2011a). According to Gabriel *et al.* (2007a) the full potential of aquaculture began to be realized recently when it became obvious that the ever-increasing demand for fish cannot be met from capture fisheries alone. Therefore, reducing the widening gap between fish demand and supply and achieving the ultimate goal of self-sufficiency in fish production is the major target of aquaculture as an enterprise (Ugwumba and Ugwumba, 2003).

The steadily growing importance of fish farming has compelled improvements in the technologies necessary for securing the initial and basic requirements for productive aquaculture; namely the production of fish seed for stocking (Akinrotimi *et al*., 2011b). Fish culture today is hardly possible without the artificial propagation of fish seeds of preferred cultivable fish species (Akinrotimi et al. 2013a). The need for the production of quality fish seed for stocking the fish ponds and natural water bodies has indeed increased steadily (Dada, 2006). Artificial propagation methods constitute the major practicable means of providing enough quality seed for rearing in confined fish enclosure waters such a fish ponds, reservoirs and lakes (Conceicao *et al*., 2005; Akinrotimi *et al*., 2011c). The production of marketable fish fingerlings or juveniles into rearing environment that assures optimum and rapid growth to allow harvest in the shortest possible time. The fish farmer has to obtain adequate number of young fish to meet “his” production goals. The possibilities of obtaining fish seed in adequate numbers from natural source is rather limited. Even the spawners which, reproduces successfully in confined enclosures are propagated artificially (Madu *et al*., 2004; Gabriel *et al*., 2007b). Apart from being able to obtain quality seed, the artificial propagation technique can also be used to develop strains superior to their ancestors by the methods of selective breeding and hybridization. Depending on the perfection of the system, at least 65% of the eggs produced can be raised to viable fingerlings as against less than 1% survival rate in natural spawning. It is through this method that out of season supplies of fingerlings are achieved (Dada *et al*., 2002).

For a fish production through aquaculture to meet this projected or potential demand for fish in the country there is the need to establish a pool of fingerlings annually (Ezenwa *et al.,* 1990; Dada and Wonah, 2003). According to Ayinla (1991), there are generally two sources of fingerlings: wild collection and hatchery production. It is obvious that the supply from the wild is unreliable; hence supply of sufficient fingerlings depends on hatchery production. Fish hatchery is the bedrock upon which true and sustainable fish farming is built (Nwadukwe and Ayinla, 1993; Ugwumba *et al.,* 1998; Anyanwu *et al*., 2007).

The major problem faced by the hatcheries operators’ center on the technicalities of handling fish fry on farms (Zaki *et* al., 2004). Grading of fish fingerlings is one of the most common management practices in fish farming that a serious hatcheries operator need to know in order to be able to maintain almost the same quantity of fish from fry to fingerlings stage. For example, some hatchery operators do have up to 500,000 fry at early stage, but before getting to fingerlings stage a lot of them would have been lost as a result of cannibalism which is more prevalent among the clariids (Ayinla and Nwadukwe, 2003). Hence the need for them to be sorted (graded). Sorting of fish according to FAO (2000), involves separating a mixed group of fish into different species, sexes, and sizes.

Significant size diversity within fish species requires that they be sorted. The main goal of this technique is to obtain maximum weight gain by all individuals and to increase their survival rate which result in obtaining the maximum biomass (Baarduik and Jobling 1990; Kamstra 1993, Sunde *et al.,* 1998). Sorting separates small and big fish fingerlings, thus minimizing the effect of inter individual interaction (Jobling, 1995). However, frequent sorting of the species sometimes can cause decreased growth rates as a result of stress (Baarduik and Jobling, 1990; Jamu and Ayinla, 2003).

Clarias gariepinus belong to the family clariidae and it is most popular fish for culture in Nigeria, next to the tilapia fishes (FAO, 1997; Adeogun *et al.,* 2007). They are characterized by highly variable individual growth rates. During early developmental stages this leads to intensified cannibalism (Barki *et al.,* 2000). In order to minimize losses at this early stage the stock must be sorted frequently. According to Kestemont and Melarde (2000) sorting of fish fingerlings into various size groups normally leads to equalization of the growth rates in the reared groups. This suggests that the growth rate of particular specimen is not only determined genetically, but that the phenomena of domination and hierarchies in fish stocks might also play some roles (Melard *et al*., 1995). According to Wedemeyer (1996), young fish are under significant stress due to increased inter-individual interactions such as high stocking density, competition for food and space, that they are costantly exposed to, this leads to differential rate of growth among individuals of the same age (Carmichael, 1994) necessitating the need for sorting.

However, report on the assessment of different sorting tools for grading of *Clarias gariepinus* fingerlings, a popular culturable fish in Nigeria is essential for the sustainability of aquaculture industry, thus necessitated the need to carry out this work.

Materials and Methods

The study was carried out in a privately owned farm, located at Kpite, in Tai Local Government Area of Rivers State, Nigeria under actual farming conditions. The *Clarias gariepinus* frys used for the experiment were obtained from the hatchery unit of the farm. The fish were observed to be active and apparently healthy.

Experimental Procedure

The experimental procedure was adapted following the method described by Ezenwa *et al*. 1990, who proposed a maximum number of 1000fries per sorting tool in grading of 2 weeks old catfish, *C. gariepinus* and which can subsequently be reduced as the fries grows older. The experiment started by grading a total number of 9,000 fries (two weeks old), consisting of 1000 fries per each of the nine grading tools, this was reduced, to 7,200 fries (3 weeks old) by the second week, consisting of 800 fries per each of the nine grading tools. This was further reduced to 5,400 fries (4 weeks old) during the third week at 600 per each of the sorting tool. At week 4 however, 3,600 fries (5 weeks old) were graded at 400 per each sorting tool. Lastly 1, 800 fries (6 weeks old) were graded at week 5 at 200 per each sorting tool. In all, the experiment lasted for a period of five weeks, grading over 200,000 fry by using 9 different grading tools for each stage of fry development.

Method of Counting of Experimental Fish

In counting the number of fry, an estimation method was used. This was done by using a strainer of 2.0g, which normally contain 1,800 fry. The weight of the fry was then determined using the formula

$W_2 - W_1 = W_3$

Where

W_1= Weight of strainer

W_2= Weight of strainer fish

W_3= Weight of fish

Grading Tools

Nine different grading tools were used for this experiment, namely:

a. Plastic Basin
b. Plywood Box
c. Meshed Box
d. Woven Basket
e. Sorting table
f. Grading cage
g. Dip net
h. Hang Grading net
i. Wooden panel

The fry was collected from the rearing trough, with the aid of scoop net and put inside a strainer for estimation. After this they were then placed inside each of the grading tools. The fry was only graded once using one type of grading tools to separate the smaller ones from the bigger one and placed inside a separate rearing trough to monitor the mortality.

Evaluation of Mortality Rates

The mortality rate was recorded by carefully removing and counting the dead fry, from each of grading tool throughthe rearing trough after each grading by usiing scoop net, they were later counted. The percentage mortality was then calculated according to FAO (2005) using the formula:

$$\frac{No\ of\ mortality}{Total\ \ no\ of\ \ fish\ graded} \times \frac{100}{1}$$

Evaluation of Water Quality Parameters

During the study, the following water quality parameters were monitored: temperature, hydrogen ion concentration (pH), dissolved oxygen (DO), ammonia nitrogen and nitrite nitrogen. Temperature measurements were taken during the experimental period using mercury in glass thermometer (^{0}C). Hydrogen ion concentration (pH) was determined by the use of a pH meter (Model HI 9812, Hannah products, Portugal). Dissolved oxygen levels in the experimental tank were determined, twice at the beginning and at the end of the experiment by the Winkler method (APHA, 1985). Ammonia nitrogen and nitrite nitrogen were measured using a test kit with calorimetric chart produced by SUNPU, Biochem, Beijing, China.

Data Analysis

The data obtained from this study were collated and subjected to ANOVA (Analysis of variance), difference among mean where existed were determined by Tuckeys multiple comparison test (Zar, 1996).

Results and Discussion

Physical Observation of Fish

The experimental fish used were very active and free from disease or any external bruise, which are capable of inducing stress or mortality.

Water Quality Parameters

The results of physico chemical parameters, pH temperature, dissolved- oxygen, nitrite nitrogen, ($N\text{-}N0_2$), ammonia- nitrogen ($N\text{-}NH_3$), recorded in the course of the trial were not significantly different ($p>0.05$) in all the experimental weeks (Table 1).

Number of Fries Graded

The results of fries graded were recorded for all the ten grading tools, in all the experimental weeks. In week 2, the lowest value of graded fish (3.14 ±5.00) was observed in plywood box (PWB), while the highest (720.67 ±26.63) was recorded in sorting table (ST). In week 3, PWB, had the lowest value (390.00 ±2.00) and sorting table (ST) had the highest. In week 4, 5, and 6 plywood box (PWB) consistently had the lowest value of graded fish, while sorting table (ST) had the highest value in these weeks (Table 2).

Mortality of Fish Fries Using Different Sorting Tools

The mean values of % mortality recorded by using different tools were presented in table 4.3. The result indicated that the highest values of mortality (91.67 ±12.58, 3.12.67 ±3.51, 173.67 ±7.77, 41.00 ±4.00 and 31.33 ±1.53) were observed in week 2, 3, 4, 5 and 6 respectively. While grading cage (GC), recorded the lowest values (4.67 ±1.53, 5, 33 ±1.53, 1.00 ±0.00. 0.00 ±0.00, 0.00 ±0.00) in week 2, 3, 4, 5, and 6 respectively (Table 3).

Comparative Percentage Mortality at Different Age of Fish Using Different Sorting Tools

The percentage mortality of fish recorded by using different sorting tools are shown in (Figure 1). The results indicated that in all the sorting tools the percentage mortality tends to decrease as age of the fish increases. In Dip Net (DN) the highest value (3.26 ±0.11) was recorded at age 2, while the lowest value (0.46 ±0.11) at 6 weeks of age, for grading cage (GC) the highest value (0.80 ±0.20) was recorded at age 2, while at age 5 and 6 no mortality was recorded. In hand grading net (HGN the highest value of 1.4 ±0.20 was observed at age 2, no mortality was recorded at 6 weeks. In using meshed box (MB), the highest mortality value of 1.96 ±0.47 was recorded at age 2, while age 6 has the lowest value of 0.87 ±0.11. The highest values of 2.53 ±0.40 and 7.03 ±0.49, and the lowest values 0.90 ±0.17 and 1.16 ±0.35 were recorded in PB and PWB respectively at week 2. The highest values of 50.20 ±0.20, 1. 36 ±0.25 and 1.80 ±0.20, with the corresponding lowest values of 2.13 ±0.11, 0.60 ±0.20 and 0.53 ±0.11 recorded respectively in sorting tools (ST) Woven basket (WB), and Wooden grading panel, (WGP), In rearing of fish. Malison (2000) reported that pH, temperature and dissolved oxygen are the three most important water quality variables in fish hatchery. The differences in survival and mortality among the nine grading tools were not attributable to water quality parameters because these variables were similar in all the grading groups and were within the acceptable limits for hatchery production (Ayinla and Nwadukwe, 1990; Haylor and Mollah, 1995).

It should be borne in mine that sorting fish according to size is a standard rearing procedure in commercial rearing system and on fish farms (Melntyre *et al.,* 1987; Popper *et al.,* 1992; Kamstra, 1993). Its aim is to simplify feeding (by applying the appropriate feed granulation size and ration) and to limit phenomena of domination and inter -individual interaction (Jobling 1995). The assumption is that separating smaller fish will protect them from domination by large fish, thus improving their growth rate and increase stock biomass (production). The results of this work indicated various degrees of effectiveness using different sorting tools as revealed in the diver's mortalities of fish recorded.

It was deduced from the results obtained in this study that the number of fish sorted, using different sorting tools varied significantly ($p<0.05$) from each other, with sorting table having the highest number, supporting the findings of Togugeni *et al.* (1997) who obtained similar results in using three different tools to sort tilapia (*Oreochromis niloticus).* This may be due to the fact that sorting table has a very flat and wide surface, which allows fry to be sorted easily. Also, the number of fry sorted using different tools in this work seemed to be increasing as the age of the fry increased. This disagreed with the findings of Melard *et al*. (1996) who observed a contrary trend in the number of larvae of perch (*Perca fluviatilis)* sorted after 44 days. This may be due to the fact that the two fishes were sorted at different ages after 44 days, the fish have grown to some extent, and cannibalism of the smaller ones by the bigger fish may have occurred thus reducing the number of the fish. According to Gabriel *et al. (*2007b), the variability of individual growth patterns especially at the early stages when growth is allometric and potentially maximal cannot be over emphasized. Therefore, huge discrepancies between individual growth patterns during this period would favour the precocious emergence of cannibal fish resulting in their lower number.

The mean mortality of baby fish observed in this work by using different sorting tools, vary significantly ($P<0.05$) from one sorting tool to another. Also, the mortality of the fish tends to decrease as the age of the fish increased. This result is in line with the findings of Koebele (1982) who observed similar results in red belly tilapia (*Tilapia Zilli)*. He postulated that sorting of fish with different tools modify the various degrees of mortality recorded. Wickins (2005) and Kamstra (1993) found that mortality of fish was mainly governed by physiological responses and not necessarily social interactions. While Purdom (2004) and Jobling (1982) found that mortality in larvae of sorted sole, *Solea solea* and plaice, *Pleuronectes platessa* depended on the efficiency of the sorting tools that were used. Conversely, Wickins (2005) observed an increase in larvae mortality as a result of defective grading tool.

Moreover, Dewandel (2002) found that the effects of four different sorting tools on the survival and mortality of Atlantic cod (*Gadus morhua)* vary from one tool to another, as observed in this study. This according to them may be as a result of social stress and increased motor activity, which ultimately leads to mortality. The various degree of mortality observed in the various sorting tools may be due to inter individual interactions as a result of the efficiency of the tools. Dill (1983) proposed the hypothesis that the highest level of inter individual interactions occurs between sorted fishes' relative to their sorting tool. In effect, this means that the survival of fish is directly proportional to the efficiency of the grading tools used.

However, the pooled data from the nine sorting tools indicated that the percentage mortality though varied according to the age of the fish, also varied in different sorting tools. Similar results were obtained with larvae of walleye (*Coho salmon)*. This support the relevance of size-sorting larvae fish, especially within a standard intensive rearing frame work, implying sorting at regular intervals as the age of the fish increases. This natural progressive sorting limits the cannibal emergence, although the variability of individual growth patterns may be substantial (Jensen 1988; Melard *et al.,* 1995).

Table 1. Physico-Chemical Parameters in Rearing Tanks During The Experiment (Mean ±SD)

	Experimental Weeks				
Parameters	**1**	**2**	**3**	**4**	**5**
pH	6.58±0.12	6.57±0.00	6.50±0.13	6.56±0.11	6.48±0.13
Temperature (^{0}C)	29.24±0.64	28.78±0.54	29.14±0.86	29.11±0.14	29.18±0.76
Dissolved oxygen (mg/l)	6.74±0.32	6.70±0.30	6.68±0.46	6.59±0.41	6.41±0.88
$N\text{-}N0_2$ (mg/l)	0.0030±0.02	0.0029±0.01	0.0028±0.01	0.0027±0.02	0.0026±0.06
NH_3 (mg/l)	0.30±0.03	0.32±0.04	0.36±0.06	0.38±0.08	0.39±0.08

Table 2. Number of Graded Fish Fries Using Different Sorting Tools.

	Tools								
AGE (WEEKS)	**DN**	**GC**	**HGN**	**MB**	**PB**	**PWB**	**ST**	**WB**	**WGP**
2	$508.67±58.31^a$	$577.67±22.01^d$	$573.33±6.35^d$	$445.00±5.00^d$	$383.00±2.65^d$	$314.00±5.00^c$	$720.67±26.63^d$	$448.00±2.65^b$	$556.33±20.50^d$
3	$477.00±1.00^a$	$604.00±6.93^d$	$588.33±11.50^d$	$448.33±2.08^d$	$420.69±4.04^c$	$390.00±2.00^d$	$796.33±11.84^d$	$450.33±1.53^b$	$600.67±24.01^c$
4	$490.00±1.00^a$	$652.33±14.50^c$	$638±0.000^c$	$459.33±3.06^b$	$444.33±4.04^b$	$447.67±2.52^c$	$1013.00±52.72^c$	$455.00±5.00^b$	$616.33±7.51^c$
5	$492.00±1.00^a$	$797.00±12.12^b$	$698.00±16.00^b$	$487.33±2.65^a$	$474.67±3.51^d$	$478.67±1.53^b$	$1256.00±105.13^a$	$476.33±5.51^a$	$693.00±23.89^b$
6	$527.00±8.54^a$	$857.33±24.50^a$	$744.00±10.39^a$	$487.33±2.08^a$	$477.00±4.35^a$	$485.00±1.00^a$	$1476.33±40.99^a$	$482.00±2.00^a$	$744.00±10.69^a$

Key: DN (Dip Net), GC (Grading Cage). HGN (Hang Grading Net), MB (Meshed Box), PB (Plastic Basin), PWB (Plywood Box), St (Sorting Table), WB (Woven Basket) and WGP (Wooden Grading Panel).

Means within the row carrying different superscripts are significant ($p<0.05$)

Table 3. Mortality of Fish Fries Using Different Sorting Tools

AGE (WEEKS)	DN	GC	HGN	MB	PB	PWB	ST	WB	WGP
2	15.33±0.581[c]	4.67±1.53[e]	8.00±1.00[d]	8.67±2.08[d]	9.67±1.53[d]	26.67±2.08[a]	91.67±12.58[a]	6.00±1.00[e]	10.00±1.00[d]
3	10.00±1.00[b]	5.33±1.53[c]	6.33±0.58[c]	6.67±0.58[c]	9.33±1.53[b]	8.33±1.53[b]	82.67±3.51[a]	7.00±1.00[c]	8.00±1.00[b]
4	4.67±0.58[b]	5.33±1.53[c]	4.00±1.00[b]	5.67±0.58[c]	8.00±1.00[b]	8.00±1.00[b]	73.67±7.77[a]	5.33±1.15[b]	6.33±1.53[b]
5	2.33±0.58[c]	0.00±0.00[d]	0.67±0.58[d]	4.67±1.15[d]	5.00±1.00[b]	4.67±0.58[b]	41.00±4.00[a]	5.33±1.15[b]	4.67±1.15[b]
6	2.33±0.58[c]	0.00±0.00[d]	1.00±10.00[d]	4.33±0.50[b]	4.33±0.58[b]	5.67±1.53[b]	31.33±1.53[a]	3.00±1.00[c]	4.00±1.00[b]

Tools

Key: DN (Dip Net), GC (Grading Cage). HGN (Hang Grading Net), MB (Meshed Box), PB (Plastic Basin), PWB (Plywood Box), St (Sorting Table), WB (Woven Basket) and WGP (Wooden Grading Panel).

Means within the row carrying different superscripts are significant ($p<0.05$)

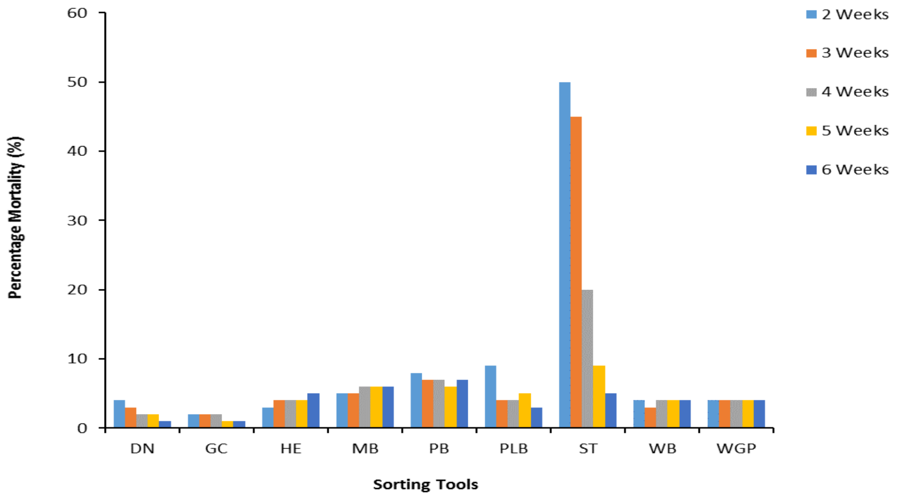

Figure 1. Comparative percentage mortality observed at different age of fish using different sorting tools

Conclusion

The results from this study indicated that the grading cage (GC) has the highest efficiency because of the very low mortality rates at all sizes and age. It is highly recommended to grade fry between 1-4 weeks old, the age regarded as the critical surviving stage of every baby fish. The sorting table (ST) has the highest capacity than other tools, as the tool has the highest mean value of graded baby fish. The highest mortality was also recorded in sorting table when compared to other tool The mortality of baby fish in various sorting tools reduced as the age of the fish increases, but the number graded increased with age. Results from the study strongly suggest that larvae of *C. gariepinus* should be sorted by using grading cage as this would proportionally increase the initial survival rate. Finally, the current experiment indicated that sorting of larvae of *C. gariepinus* using various grading tools enhance the survival, limit intra group variability and early cannibalism. This therefore helps most fish farmers especially the fish hatchery operators to achieve high survival rate of early fingerlings production.

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