POLYCULTURE OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) AND NILE TILAPIA (*OREOCHROMIS NILOTICUS*) IN CONCRETE TANK

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A SPECIAL PROJECT IN THE DEPARTMENT OF FISHERIES

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IJEBU - IGBO, OGUN STATE, NIGERIA

JULY - 2009

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ABSTRACT

This study was conducted to assess the effect of polyculture on tilapia (Oreochromis niloticus) growth and to evaluate African Catfish (Clarias gariepinus) as a predator control for unwanted tilapia offspring in a poly culture system. Three treatments were tested using three 100m^2 concrete tanks. Ponds were stocked with male tilapia in treatment (T_1), mixed sex tilapia in treatment (T_2) and mixed sex tilapia with catfish in treatment (T_3). This treatment (T_3) is stocked at the ratio 5:1, while treatment (T_1) and (T_2) is a control treatment. Fish were feds with a commercial diet ration 1.5% of body weight per day. Feed inputs is adjusted biweekly, were based on tilapia biomass. Water quality parameters were estimated biweekly.

A T-test was used to compare the weight gain of tilapia and net fish yield. Weight gain and net fish yield were significantly higher in treatment (T_1), while treatment (T_3) also have a high Weight Gain (WG) and Net Fish Yield (NFY) than treatment (T_2) which have a very low weight gain (WG) and net fish yield (NFY).

Tilapia (Oreochromis niloticus) production in poly culture with catfish (Clarias gariepinus) has a significant lower population than culture system with either all male tilapia or mixed sex tilapia. Clarias gariepinus predation of tilapia fry was sufficiently effective to serve as a population control for tilapia, thereby there was increase in weight of Clarias gariepinus.

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My profound gratitude goes to the almighty God, the creator and giver of life in Christ for wisdom, good health and His grace that enabled me to successfully conclude this study.

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I gratefully acknowledge the help, love and care shown to me by my Department Lecturer, Mr. Adejobi. I pray that you will not know any lack in life (Amen).

I am also indebted to my supervisor, Mrs. Olugbesan for her support and encouragement I enjoyed during this study. May God bless you abundantly (Amen).

I also wholeheartedly appreciate the help and cooperation I received from my parent, Mr. and Mrs. Yusuf, they were there for me at all time. You will live to reap the reward of your labour in Jesus name (Amen).

Finally, I acknowledge the cooperation and love of my course mates.

CERTIFICATION

I, certify that this original project work was carried out by **YUSUF, ADESINA MORUF** in the Department of Fisheries, and the report was prepared under my supervision.

Olugbesan

Supervisor Sign

MRS. M.A.OLUGBESAN

11-08-09

Date

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19/08/09

DEDICATION

This work is dedicated to God Almighty, THE ALPHA AND OMEGA the beginning and the end, the creator of all beings, the Lord my God.

Glory, Honour and Majesty be unto your name forever and ever (Amen).

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CHAPTER ONE

1.0.0 INTRODUCTION

Polyculture is the production of two or more fish species within a particular aquaculture environment. Most poly culture occurs in ponds (concrete ponds or earthen ponds). Some of the fish species grown in polyculture ponds include catfish, paddle fish, tilapia and big head carp. When considering pond polyculture, certain issues such as feeding, harvest and marketing should be considered first.

A general problem associated with the culture of tilapia like Oreochromis, Sarotherodon, Tilapia [spp] is the intensive reproduction which often produce large population of small-sized stunted tilapia recruits, which are of low value to consumer (Fagbenro 1987) in other to produce big tilapia (150g market size) special culture technique may be required several method have been used to control such undesirable tilapia populations. These include mono-sex culture (mono sex hybrids, manual sexing or grading ,sex reversal), cageculture, tank culture, the use of predators, stock manipulation, the use of irradation, chemosterilants and other reproduction inhibitors, stock manipulation, selective harvesting, the use of slow maturing tilapia species. Of all these methods, the use of local predatory fish species to control such unwanted/undesirable tilapia recruitment in ponds is one of the most effective methods recommended for Africa (Guerrero, 1982).

According to Fagbenro (1987), tilapias are frequently cultured with other species to take advantage of many natural foods available in ponds and to produce secondary crop or to control tilapia recruitment. Polyculture uses combination of species that have different feeding niches to increase overall production without a corresponding increase in the quality of supplemental feed. Polyculture also improve water quality by creating a better balance among the microbial communities of the pond, resulting in enhanced production. The disadvantage of Polyculture is the special equipment (sorting devices, conveyors, etc.) and extra labor needed to sort the different species at harvest.

Use of predators has been effective on an experimental seale, but they have not bin used widely in commercial operations because of the difficulty in finding reliable sources of fingerlings. Few indigenous predators have been used or tested namely, Lates niloticus (Bedawi, 1985 and Ofori, 1988), Notopteris affer (Iscandari, 1986), Parachanna obscurus (De Graaf et al, 1996), Hemiehromis fasciatus (Fagbenro and Sydenham, 1997). These predators have some draw backs, for example, there is a difficulty in obtaining finderlings of Notopteris affer due to nonavailability in nature waters or inability to propagate in captivity. Lates niloticus requires large ponds and is sensitive to low oxygen regime. Hemichromis fasciatus is also prolific breeder and has a poor market values (due to small adult size). African clariid catfishes (Clarias gariepinus, Clarias anguillaris, Clarias isopterus) do not have these particularly in West African (Fagbenro and Sydenham, 1990, Hazard and Oswald, 1995).

According to De Graaf et al, 1996, advantage of rearing Clarias gariepinus in polyculture with Oreochromis niloticus is that the lower-valued tilapia fingerlings are replaced by a more or less equal quantity of the higher-valued catfish. Another advantage is those longer adult tilapias are obtained as the growth rate of the stocked adult increases.

CHAPTER TWO

2.0.0 LITERATURE REVIEWS

2.1.0 HOW DOES POLYCULTURE WORKS

Ponds that have been enriched through chemical fertilization, manuring or feeding practices contain abundant natural fish feed organisms living at different depths and locations in the water column. Most fish feed predominantly on selected groups of these organisms. Polyculture should combine fish having different feeding habits in proportions that effectively utilize the natural foods (Swingle, 1988). As a result, higher yields are obtained. Efficient polyculture systems in tropical climates may produce up to 8,000kg of fish per hectare per year (De Graaf et al, 1996).

2.2.0 FISH USED IN POLYCULTURE

Combinations of some tilapia are commonly use in polyculture. Other species may also be used. While fish may be grouped into broad categories based on their feeding habits, some overlap does occur. Descriptions of the feeding habit categories and examples of fish from each category follow

2.2.1 PLANKTON FEEDERS

Swingle (1988), prescribed that, plankton is normally the most plentiful food in a pond so it is very important to include a plankton feeding fish in a polyculture system. This group of fish feeds on the tiny, free-floating plants (phytoplankton) and animals (zooplankton) which multiply abundantly in fertilized ponds. Examples of fish use in this group are the blue tilapia, Oreochromis aureus and Nile Tilapia, Oreochromis niloticus.

2.2.2 HERBIVORES

This group of fish feeds aquatic vegetation. For example, Tilapia, Tilapia rendalli and Zillis tilapia, Tilapia zillii, are most noted for this behaviour and is stocked in ponds for the purpose of weed control.

2.2.3 BOTTOM FEEDERS

Fish in this group feed primarily at the pond bottom. They consume a variety of decaying organic matter, aquatic organisms such as clams, insects, warms, snails, and bacteria living in or on the sediments. The common carp, Cyprinus carpio is well noted for this behaviour.

2.2.4 PISCIVOROUS FISH

Swingle (1988) observed that these predatory fish feed on other fish, and must consume about 5g to 7g of prey in order to grow 1g. They are frequently stocked in ponds to control unwanted reproduction, particularly in tilapia, and other fish that enter the pond with the water supply and compete for food with the stocked fish. Commonly used predator fish that include the catfish, clarius spp and Silirus spp; Cichlids, Cichla spp; Hetero-branchus, Heterobranchus spp, etc. (Fagbenro, 1990).

2.2.0 PREDATOR FISHES USED IN POLYCULTURE

Adding predator fish to polyculture system increases the average weight of prey species. It is most efficient to use a predator fish that consumes small prey. This prevent the prey from growing large enough to compete for food with large fish of it species. Swingle (1988) stated that use of predator fish in polyculture systems is experimental in most areas of the world. In small ponds, it is almost impossible to stock the exact number of predator fish to achieve the same predator/prey balance occurring in nature.

Swingle (1950) confirmed that in small-scale aquaculture, predator fish are usually stocked at the rates of 5 to 20 fish per $100m^2$ of pond surface area to completely control reproduction of the prey species.

For instance, the survival and growth of tilapia and prawns are independent. Feed is given to meet the requirement of the fish. Prawns, which are unable to compete for the food, utilize wasted food and natural foods that result from the breakdown of fish waste. According to Lazard and Oswald (1995) stocking rates for 1 to 2grm prawns vary from 4,000 to 36,000/acre, but a rate of 8,000/acre is often used to obtain a high percentage of market size prawns (25grms) and a yield of about 445 pounds/acre. Tilapia can be stocked in the range of 2,000 to 4,000/acre.

Using of predatory fish like large mouth bass (Micropterus salmoides) to reduce tilapia recruitment also result in good outcome. Fagbenro and Salami (1996) stated that stocking predators with mixed sex tilapia populations controls recruitment and allows the original stock to attain a larger market size. Predators must be stocked at a small size to prevent them from eating the original stock. Predators may be stocked when tilapia begin breeding. Fagbenro and Syndenham (1997) confirmed that the number of predators required to control tilapia recruitment in culture ponds depends primarily on the maximum attainable size of the predator species, the ability of the predator to reproduce, and the number of mature female tilapia. In general, as predator grows, they eat larger sized tilapia recruits. Eventually this may result in an increasing biomass of small tilapia that are not consumed. However, this problem should not develop in ponds that are completely harvested one or more time a year. More predators are required to control recruitment when there are large numbers of mature female tilapia.

2.4.0 POTENTIAL OF PREDATOR FISH USE IN POLYCULTURE

De Graaf et al (1996) mentioned some predator fish that has been use successfully in polyculture with Nile tilapia in Africa.

- **Clarias gariepinus**

  Widely considered to be a "lazy" predator but works well as long as they are stocked at high densities (8000-9000 fingerlings/ha).

- **Hemichromis fasciatus**

  Good predator but has a low market value and is rather fragile with high mortalities often occurring at harvest.

- **Lates niloticus**

Good predator, but difficult to obtain fingerlings.

As mentioned earlier, African catfish must be stocked at high densities in order to obtain a complete reduction of the tilapia fingerlings excess population, as it prefer to feed on the supplied feed. (De Graaf et al, 1996).

2.5.0 FACTORS AFFECTING SPECIES SELECTION AND STOCKING RATE.

2.5.1 WATER TEMPERATURE

Many fish cannot survive or grow in cold water. Systems using cold-tolerant fish such as common carp and Chinese carps must be used if temperatures drop below 18ºc.

2.5.5 MARKET VALUE OF FISH

The market price and demand should be considered before a fish species is chosen for culture. When two or more fish can fill the same feeding niche in a pond, the choice should be based on which will maximize economic returns to the farmer.

For instance, the market value of tilapia fish is very low due to excess reproduction of tilapia fingerlings and they compete for food and space, which reduce their growth rate. Thus, predator like catfish are introduce into the tilapia culture to control the excess reproduction of tilapia fingerlings in the culture and this increase the growth rate of the originally stocked tilapia fish.

2.5.3 POND FERTILIZATION PRACTICES

Most polyculture systems are based on fertilizations. Manures and chemical fertilizers increase production of natural fish food organisms in ponds. Thus, more food is made available to fish. Fertilized ponds may be stocked at higher rates than unfertilized ponds.

2.5.4 FEEDING HABITS OF FISH

Supplemental feeds are commonly given to fish. Manure any serve as a food source for some fish by supplementing the nutrition available from natural food organisms in the pond. A wide variety of agricultural by products may serve as supplemental feed. When fish are fed, ponds can be stocked at higher rates. Stocking bottom feeding fish such as common carp prevents sinking foods being wasted.

2.5.5 TOLERANCE TO POND CONDITION

Polyculture ponds are usually heavily fertilized or manured. This practice may cause low oxygen levels and other conditions in the water that are stressful to fish.

2.5.6 POTENTIAL OF UNCONTROLLED SPAWNING IN GROW-OUT PONDS.

Certain fish, like tilapia, reproduce easily in ponds. Tilapia may become so over-populated that their growth steeps and they become stunted. Predator fish are often stocked in tilapia ponds to control reproduction. For instance, catfish as a piscivorous fish is normally considered as a lazy predating fish but works well as long as it is grown up to at least 50g before introducing it into the tilapia culture (De Graaf et al, 1996). And Swingle (1988) prescribe that the tilapia fish should start breeding before the introduction of catfish to prevent them from eating up the original stocked tilapia fish. And further more, Clarias gariepinus is widely use as a predating fish in tilapia culture because of its ability to control the tilapia fingerling recruitment and the lost of original stock fish is very low due to its lazy predating ability.

2.6.0 STOCKING RATES FOR POLYCULTURE SYSTEM

As mentioned earlier on, stocking rates of predators depends on the number of tilapia populations. For instance, Clarias gariepinus as a predator is stocked at a small size to prevent them from consuming the original stock. That is, the stocking ratio must be at least 1:5 respectively. In addition the predator size must also depend on the number of stock for the normal control of tilapia recruitment.

2.7.0 POTENTIAL PROBLEMS IN POLYCULTURE

Polyculture is an effective way to maximize benefit from available natural food in a pond. But, pond management becomes more difficult when stocking fish species having specialized feeding habits in the same pond because good fertilization and feeding practices must be followed. If inadequate fingerlings supply severely limits the choice of species available for polyculture, at least one species should have general rather than specialized feeding behaviour. This will allow more of the available natural food to be utilized. For example, the polyculture of catfish and tilapia is good cultures that have a general feeding habit. That is, the tilapia species feed on the natural resources available in pond and supplement feed, which catfish specie piscivorously feeds on the tilapia eggs, larvae, fry and fingerlings.

CHAPTER THREE

3.0.0 MATERIALS AND METHODS

3.1.0 THE EXPERIMENTAL SITE

The experiment was carried out in **ABRAHAM ADESANYA POLYTECHNIC, Ijebu-Igbo, Ogun State**. Three $100m^2$ concrete pond were selected for the experiment.

3.2.0 SOURCES OF EXPERIMENTAL FISH AND OTHER MATERIALS

Six hundred (600) juveniles of Oreochromis niloticus (400 male and 200 female) were purchase from a local commercial fish farm in Ijebu-Igbo. And also twenty (20) pieces of Clarias gariepinus fry were collected from the school hatchery.

Three ponds were selected to carryout the experiment. These ponds were well checked for leakage or seepage. After all this check, the ponds were washed and filled up with water to a normal level. The ponds are label with number ranging from treatment one to three (T_1, T_2 and T_3).

3.3.0 EXPERIMENTAL LAYOUT AND STOCKING

Each treatment received large and small fish at a ratio of 2:1 respectively. Tilapia was stocked at a density of 2 fish/m^2 (200 fish/pond) in all the three treatments. Which means the size of pond use is 100m^2/per pond. The sex ratio of tilapia in treatment T^2 and T^3 were maintained at approximately a 1:1 ratio.

In treatment T_1 200 males were stocked, treatment T_2 contains 100 males and 100 females; the last treatment (T_3) contains 100 males, 100 females and 20 catfish. But the catfish are 50g/fish in weight before their introduction into the culture and their introduction is after stocking tilapia for two weeks (their breeding period). This is done to ensure that Oreochromis niloticus fry were abundant in the culture system. The detail of stocking for each treatment are presented in the table below (Table 1).

TREATMENTS	Oreochromis niloticus MALE		Oreochromis niloticus FEMALE		Clarias gariepinus	
	TOTAL NO.	MEAN WT. (g)	TOTAL NO.	MEAN WT (g)	TOTAL NO.	MEAN WT (g)
T_1 (only Male Oreochromis niloticus)	200	31.5	N/A	N/A	N/A	N/A
T_2 (Mixed sex of Oreochromis niloticus)	100	34.5	100	30.5	N/A	N/A
T_3 (Mixed Sex of Oreochromis niloticus and Clarias gariepinus	100	32.0	100	30.0	20	50.1

TABLE 1: Stocking treatments of mixed-sex of Oreochromis niloticus, only male Oreochromis niloticus and mixed-sex Oreochromis niloticus with Clarias gariepinus.

3.4.0 FEEDING OF FISH AND GROWTH RESPONSE

During the first six weeks of the study, fish were feed a commercial diet ration of 1.5% of body weight per day. Equal rations were offered twice. And feeding input was adjusted biweekly based on Oreochromis niloticus biomass. The feeding details are in the table below (table 2).

TREATMENTS	FEED AMOUNTS APPLIED (g/pond/day)		
	16 June – 28th June 2008	30 June – 11 July 2008	13 July – 25 July 2008
Treatment (T_1)	92.3	154.1	227.4
Treatment (T_2)	94.0	136.2	174.4
Treatment (T_3)	92.3	136.9	179.7

TABLE 2: Commercial ration feed amount applied during the first six (6) weeks of the study.

To monitor growth of Oreochromis niloticus and Clarias gariepinus were sampled for individual length and weight measurement using (Electronic kitchen scale; type HR 2385/A). 20 male of tilapia from (T1), 10 male and 10 female of tilapia from (T2) and 10 male 10 female tilapia and 5 Clarias gariepinus from (T3) were pick at random for the measurement. Feeding was discontinued after six weeks because the catfish consumed feed instead of tilapia fry.

3.5.0 WATER QUALITY ANALYSIS

Standard methods (APHA, 1985) were used to estimate water quality parameters biweekly. One integrated water column sample was collected from each pond with a column water sampler and analysed for total ammonia, nitrite and nitrate, Total Suspended Solid (TSS), Total Volatile Solids (TVS), and some other water quality parameters were analysed.

3.5.1 DISSOLVE OXYGEN

Water sample was taken from the pond water to determine the dissolved oxygen content using oxygen meter (YSI model 57) the stable reading was then recorded.

3.5.2 HYDROGEN ION CONCENTRATION (PH)

The PH of the water was determined using a suntex digital meter (model sp-5A).The stable reading was recorded.

3.5.3 ALKALINITY

This alkalinity is also determined to know the alkalinity of the pond water, if sweetable before stocking the fish.

3.5.4 TEMPERATURE

The water temperature was measured with mercury-in-glass thermometer. This measurement is taken everyday of the study to determine the exact temperature of the pond water. The scale reading was then recorded in °C.

CHAPTER FOUR

4.0.0 RESULTS AND ANALYSIS

4.1.0 GROWTH PERFORMANCE AND SURVIVAL

At harvest (112 days after stocking <u>Clarias gariepinus</u> juveniles in treatment (T_3), ponds was drained. Original stock fishes and resulting tilapia juveniles were removed and sorted according to species, counted and weighed. <u>Oreochromis niloticus</u> mean population weight in all treatments ranged from 28.3-32.9g and <u>Clarias gariepinus</u> mean population weight in T_3 ranged from 49.5g - 50.1g.

The preferred market weight of adult tilapia and catfish were set at 150g and 500g respectively, as individual fish below these sizes generally not accepted by consumers in Nigeria. Effective recruitment control was set at a tilapia AT value (% weight of market-size tilapia in the population) of 90 or above. This level was considered high enough to prevent significant food competition between the original stock tilapia and their offspring. Partial recruitment control was indicated by tilapia AT values ranging from 71 to 89 (Swingle, 1950). Initial and final mean weight and Net Fish Yield (NFY) of <u>Oreochromis niloticus</u> are presented in the table below (Table 3). Fortnightly mean weight increases of <u>Oreochromis niloticus</u> and <u>Clarias gariepinus</u> are presented in the figure below (figure 1) and (figure 2) respectively. Mean NFY of Oreochromis niloticus for each treatment are presented in the below (figure 3).

PARAMETERS	EXPERIMENTAL TREATMENTS		
	Treatment (T_1)	Treatment (T_2)	Treatment (T_3)
Initial Mean Weight (g)	31.5 ±0.7	32.0 ±0.4	31.3 ±0.8
Final Mean Weight (g)	128.9 ±1.3	69.0 ±0.4	120.9 ±1.8
Net Fish Yield (kg/pond/112 days)	16.1 ±3.2	8.2 ±1.4	10.5 ±0.6

TABLE 3: Initial mean weight, final mean weight and net fish yield of Oreochromis niloticus for each treatment.

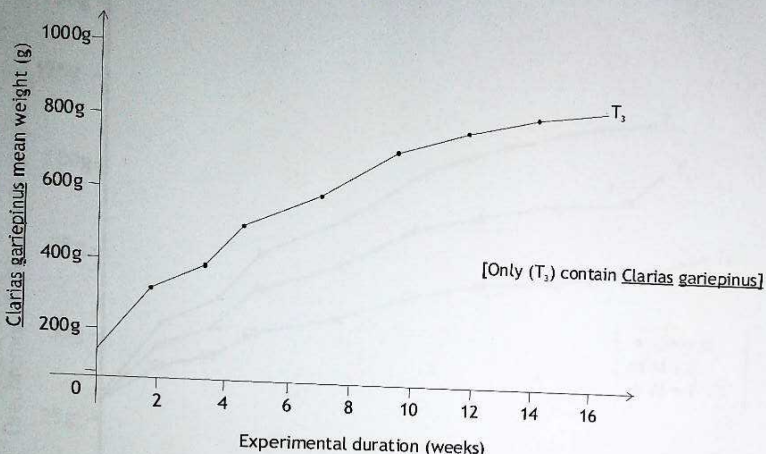

Figure 2: Fortnightly increase in Clarias gariepinus mean weight in treatment (T_3) only.

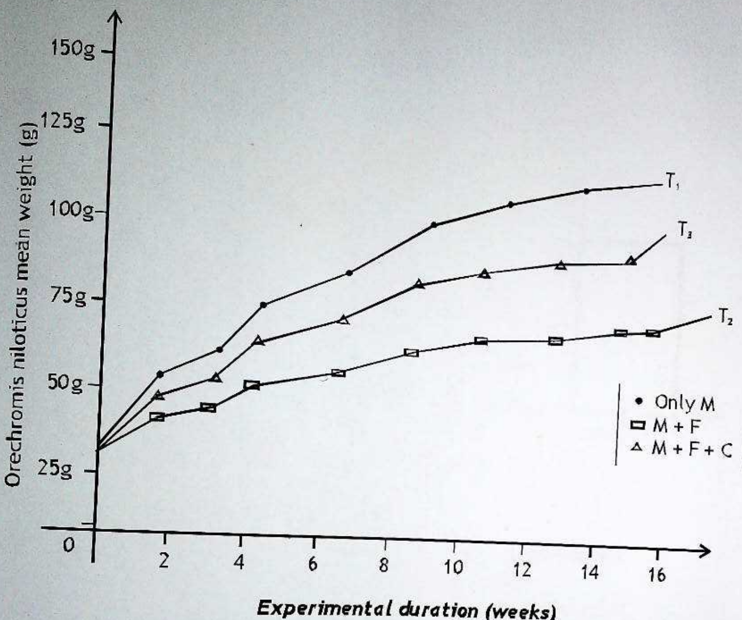

Figure 1: Fortnightly increase in Oreochromis niloticus mean weight for each treatment (T_1, T_2 & T_3).

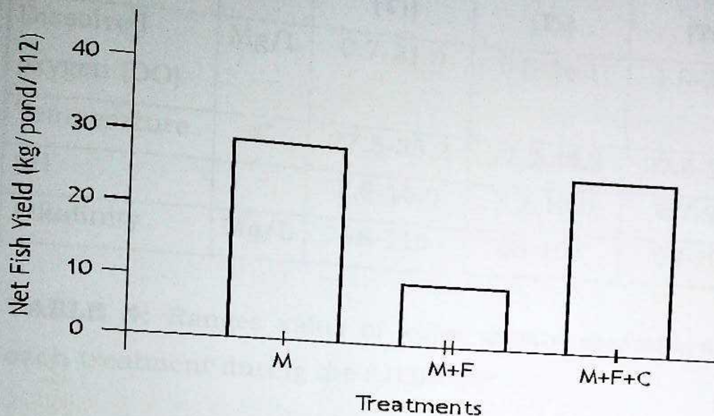

Figure 3: Mean net fish yield for each treatment.

4.2.0 WATER QUALITY ANALYSIS

The water quality was determine one each treatment by using their various measuring instrument. Biweekly variation in mean values for the water quality parameters like, Dissolve Oxygen, Temperature, PH and Alkalinity is presented for each treatment throughout the experimental period. Ranges of minimum and maximum values for different water quality parameters of different treatments are summarized in the table below (Table 4).

Parameters	Units	Treatment (T_1)	Treatment (T_2)	Treatment (T_3)
Dissolved oxygen (DO)	Mg/L	0.7-21.0	0.3-26.1	1.0-22.6
Temperature	^{o}C	27.5-35.2	27.2.35.3	27.4-34.9
pH		7.5-10.0	7.2-10.0	6.7-9.9
Alkalinity	Mg/L	48-116	54-108	54-102

TABLE 4: Ranges value of water quality parameters for each treatment during the culture period.

CHAPTER FIVE

5.0.0 DISCUSSION

At the end of the experiment, there was a different weight gain of the fish and total net fish yield under the three treatments. The weight gain and net fish yield of the Oreochromis niloticus populations were significantly higher in treatment T_1 (stocked with male Oreochromis niloticus) than treatments T_2 and T_3, which means male Oreochromis niloticus in a monosex population grow faster than individuals in a mixed-sex population.

But base on this study which deals with polyculture of Clarias gariepinus and Oreochromis niloticus, it was discovered that the weighty gain and net fish yield in Treatment T_3 is much more better than Treatment T_2. That is, Oreochromis niloticus in Treatment T_3 grow faster than Oreochromis niloticus in Treatment T_2.

In conform to (Fagbenro, 1993), Oreochromis niloticus weight gain and net fish yield in the Oreochromis niloticus and Clarias gariepinus treatment is higher ($p>0.05$) than in the control treatment (mixed sex tilapia culture) and was due to the consumption of pond-spawned tilapia fry by

Clarias gariepinus. These reduce the competition between adult tilapia and pond-spawned juvenile tilapia for food, thus enabling growth to adult tilapia.

The higher growth of Oreochromis niloticus in Treatment (T_1) than Treatment (T_2) might be due to the consumption of supplementary feed by Clarias gariepinus in Treatment (T_3) during the first six weeks of the study.

5.1.0 CONCLUSION AND RECOMMENDATION

Catfish used in African aquaculture do not have many of the limitations of other predators. Differences observed in predation efficiency of Clarias gariepinus is probably caused by its feeding habits and mode of predation (onset predation). (Fagbenro and Sydenham, 1990).

As the Clarias gariepinus is relatively more effective as predators, it is therefore recommended for the control of tilapia recruitment in ponds. Based on the results of this study, the recommendation tilapia and Clarias gariepinus combination for effective recruitment control and high yield of market-size of Oreochromis niloticus is at the ratio of 1:5 (Treatment T_3). The results obtained from this study affirm the suitability of Clarias gariepinus in solving the dual problems of the tilapia stunting and over population in pond culture.

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