EFFECT OF THE ENVIROMENTAL AND NUTRITIONAL CONDITIONS ON CATFISH PRODUCTIVITY AND MEAT QUALITY

By

Doaa Khalaf Khamis Abdel-Rahman

B.Sc .Agric. Zagazig University, 2000

A Thesis Submitted in Partial Fulfillment
of
The Requirement For the Master Degree
in
Environmental Science

Department of Agriculture Science
Institute of Environmental Studies and Research
Ain Shams University

2009

Approval sheet

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ACKNWLEDGMENT

All praise to Allah (Almighty); Al-Rahman; the most merciful, without whose mercy and guidance this work would have never been started nor completed. I praise Him (Almighty) as much as the heavens of sky and earth and what is between or behind.

I have the pleasure to express my deepest appreciation and sincere gratitude to Prof. Dr **Mohamed Fathy Osman** Prof. of Fish Nutrition, Department of Animal Production, Faculty of, Agriculture Ain Shams University, (Principle Supervisor).

Thanks are also extended to Dr. **Mohamed Hassan Ahmed** Assistant professor of Fish Nutrition Central Laboratory for Aquaculture Research (CLAR) Abassa, Abu-Hammad, Sharkia.

Kindest regards and thanks are also due to Dr. **Mohamed Abd El-Baky** Lecture of Fish physiology Department of Animal Production, Faculty of Agriculture Ain Shams University.

Sincere thanks are also extended to Dr. **Ashraf Mohammed Soliman**, Limnology Department Central Laboratory for Aquaculture Research (CLAR) Agriculture Research Center for his help, support, and continuous encouragement.
I'm grateful to my colleagues in aquazoo2 group for their sincere cooperation during this work.

Many thanks to my dear friends, **Reham, Maha, Enas, Amany, Walla, Doaa, Abeer, Samah, Abd-El Rahman, Hossam and Ahmed.**

ABSTRACT

The present study was conducted to investigate different environmental conditions affecting fish farms that use different sours of water (fresh water and agricultural drainage water). The water was subjected to physical, chemical and bacteriological examinations. Also heavy metal residues (iron, copper, zinc, cadmium and lead) were determined in both water and fish muscle. Organoleptic evaluations on catfish were done. In a laboratory experiment; the effect of feed types (flooting feed vs. sinking feed) on growth performance, feed utilization and body composition of African catfish *(Clarias graiepinus)* was tested.

The physico- chemical properties of water differed significantly among the different sources of the culture water. The average concentration of heavy metals in water and fish were higher in drainage water than in fresh water. While, the average concentration of heavy metals in fish muscle samples was within the accepted limits according to international guidelines. Bacterial load (in muscles of reared fish) in agriculture drainage ponds was higher than that in fish reared in fresh water ponds. The statistical analysis of organoleptic properties showed ($P<0.05$) between agricultural drainage and fresh water fish; the values were (69.5 % and 85.1 %), respectively. Generally the quality of the fish reared in the agricultural drainage water was within the acceptable limits for the consumer.

On the other hand the laboratory study showed that no clear differences in fish growth performance when different feed types were used, while fish body composition were slightly different.

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ABBREVATION

Average daily gain	ADG
Body Weight Gain	WG
Body weight	BW
Crud Fiber	CF
Crude protein	CP
Dissolved oxygen	DO
Ether Extract	EE
Feed conversion ratio	FCR
Food and Agriculture Organization	F.A.O.
Feed Intake	F. I.
Fat Intake	Fa.I
Hydrogen ions concentration	pH
Protein Productive Value	PPV
Protein efficiency ratio	PER
Protein Intake	P. I.
Nitrogen Free Extract	NFE
Nitrate- nitrogen	$N0_3$-N
Relative growth rate	RGR
Secchi disk visibility	SD
Specific growth rate	SGR
Total alkalinity	T. alk
Total Bacterial count	T.B.C
TP	TP

1-INTRODUCTION

The River Nile is the main source of water for irrigation, industrial, municipal and other purposes in all of Egypt. A large number of canals transfer this water to various places in Egypt. Similarly, agricultural run-off and at times domestic wastewaters are also transported via canals and drains **(Gupta and Abd El-hamid, 2003).** The agricultural run-off and wastewaters are high in suspended solids, nitrogen, phosphorus, pesticides, heavy metals, and organic compounds **(Laws, 2000).** The River Nile's water is already high in nutrients (both nitrogen and phosphorus) resulting in high productivity of phytoplankton in the river **(Abou-Waly *et al.*, 2000).**

Water quality includes all physical, chemical and biological factors that influence the beneficial use of water. In fact a pond with good water quality will produce more and healthier fish than a pond with poor quality.

In Egypt, the African catfish, *Clarias gariepinus* is in high demand and despite the considerable research efforts, that have been put into its culture, the aquaculture production is till now low. This is due to poor management practices and scarcity of the fingerlings for culture.

African catfish, *Clarias gariepinus*, due to its tolerance to a wide range of temperature, low oxygen and high salinity levels, its high fecundity and growth rate is considered as a candidate for freshwater fish aquaculture **(Oteme *et al*. 1996),** moreover this fish has high nutritive value, good taste, and fewer bones. Fish usually contain the normal bacterial flora from their environment in addition to the contaminates picked up during harvesting and handling of the fish. The predominant bacteria in catfish belong to the genera *Pseudomonas, Achromobacter, Moraxella, Acinetobacter, Flavobacterium, Vibriobacteria*, also *micrococcus, Bacillus*, and *Clostridium* which occur variably in small numbers. Generally, the growth performance of fish is affected by many factors such as feed types (floating feeds and sinking feeds), feed processing, temperature, light, age, species and etc.

Fish feeding is one of the most important factors in commercial fish farming because feeding regime may have consequences on both growth efficiency and feed conversion **(Tsevis *et al.*, 1992 ; Azzaydi *et al*., 2000).**

Extrusion techniques were introduced into fish feed production as an attempt to increase the digestible energy content of the feeds via increased lipid incorporation. Extrusion has all the advantages of the expansion technique, the advantages of improving the physical quality of the feeds by decreasing the levels of dust and fines, and improving the water stability of the pellet.

Extruded pellets are water-stable for 4h, it may be stable for 24h or more if additional binders are included in the feed mix **(Kearns, 1993).**

Jobling *et al.* (2001) stated that the steam pelleting, during which the feed ingredients are compressed together, produces a dense pellet that sinks quite rapidly. Another characteristitic of compressed pellets is the relatively high proportion of dust and fines in the finished feed, which affects feed wastage.

During the last decade, there has been a marked increase in the use of extruded diets for feeding fish. These diets have superior water stability, better floating properties and a higher energy than pelleted diets **(Hilton *et al.*, 1981; Johnsen** and **Wandsvik, 1991,** and **Ammar *et al*., 2008).**

The objective of this study (in the first experiment) was designed to investigate the effect of water quality from different sources on meat quality of African catfish, *Clarias gariepinus*.

The second experiment was carried to evaluate the effect of the feed types (floating and sinking feeds) on growth performance, feed utilizations and whole body composition of African cat fish (*Clarias gariepinus*).

2. REVIEW OF LITERATURE

2.1. Water quality parameters:-

The term water quality includes all physical, chemical and biological characteristics that influence the beneficial use of water. However, fish culturists are more concerned with those aspects of water quality, which regulates the water suitability for holding or rearing fish. Since failure to maintain adequate water quality in ponds may cause poor growth or fish death **(Boyd, 1990).**

2.1.1Water temperature (°C):

Channel catfish and tilapia are examples of warm-water species. Their temperature range for its growth is between 24-32 °C, the temperature of 29 °C for catfish and 30 °C for tilapia is considered optimum **(Neill** and **Bryan, 1991). Law (1979)** reported that fish, unlike warm blood animals are polythermic creatures, which means that their body temperature fluctuates with the temperature of the water in which they swim, for this reason, water temperature plays an integral role in nutrient utilization by catfish.

A temperature higher than 10°C often doubles the rate of decomposition and consumption of organic substances **(Boyd, 1990).** Temperature is considered to be one of the most important physical factors influencing organisms, and the biological effects of these factors are complex and wide-ranging **(Ponce-Palafox *et al.*, 1997).** Lethal temperature differs not only according to species but also to strains originating from different geographical sources **(Khater** and **Simitherman, 1988).**

Baradash *et al.* (1972) reported that channel catfish should not be fed over 1% of body weight daily when water temperature is above 32^{o}C. The same feeding rate was also recommended to be increase to 2% daily at 16 to 21^{o}C and to 32^{o}C. Channel catfish in general do not feed well when water temperature is below 7^{o}C.

Alabaster and **Lioyd (1982)** stated that the normal range of temperature to which fish are adapted were 0.0 to 30^{o}C.

Water temperature influences the susceptibility to potential toxic compounds and ammonia levels **(Klontz, 1993)** as well as the bioaccumulation and detoxification **(Zweig *et al*., 1999)** and solubility of fertilizers. Responses to temperature stress may be related to an increased oxygen consumption rate **(Dong *et al.*, 1994).**

Royce (1984) speculated that many warm water species tolerate temperature to 35 ºC and preferred the range of 20-30 ºC during their growing season.

2.1.2. Dissolved oxygen (DO):

Boyd (1989) considered that dissolved oxygen is the most critical water quality variable in aquaculture. Dissolved oxygen depletion rate depends on biological density of living organisms **(Boyd, 1990).** Dissolved oxygen (DO) is a very basic requirement for most of aquaculture species **(Zweig *et al.*, 1999).** However, the amount of oxygen available to aquatic animals is approximately only 0.0015% (w/v maximum) compared with 21% available in air. **Baradach *et al* (1972)** reported that the greatest potential of increasing production appears to be in methods of increasing the dissolved oxygen content in water used for catfish culture > 3ppm.

Andrews *et al*. (1973) cultured channel catfish at three levels of DO (100, 60 and 36 percent of air saturation) and found that the weight gain and feed consumption declined with decreasing dissolved oxygen. **Tucker** and **Boyd (1979)** observed that channel catfish showed reduction in their food intake after episodes of dissolved oxygen concentration below 1or 2 mg /L. **Royce (1984)** reported that the most carnivorous fish required oxygen at levels of 4.0 mg /L or higher, while omnivorous carp can tolerate levels of 1.0 mg /L. As suggested by **Zweig *et al*. (1999),** setting DO guidelines for source water is difficult as DO can be affected by many processes independent of the initial source water DO. For freshwater fish the recommended guidelines for DO is greater than 6 mg /L **(Lawson, 1995; Department of water Affaris and Forestry (DWAF, 1996),** where as **Anzecc&Armcanz (2000)** recommended guidelines for DO above 5 mg/L. for fresh water and salt water species. The toxicity of zinc, lead ,copper, hydrogen sulfide and ammonia increase at low DO concentrations **(Davis,1975)**. Low level of dissolved oxygen cause losses of aquatic animals and release of many materials normally bound to bottom sediments **(Correll,1999). Boyd** added in **(1990)** that the amount of oxygen required by aquatic animals is quite variable and depends on species, size, activity (levels increase with activity), water temperature (doubles with every increase of 10°C), condition (lean fish consume less than fat fish). Other species are air breathers and are able to be farmed under intensive conditions with very low levels of dissolved oxygen and poor water quality (e.g. catfish, eels, aquatic reptiles). **Ellawa (2008)** speculated that the annual average of dissolved oxygen ranged from 4.76 -7.92 mg/L in freshwater, while in drainage water it ranged from 8 - 8.68 mg / L. **Enas (2009)** speculated that the annual over all means of dissolved oxygen in water samples collected from freshwater and agricultural drainage water are 5.31 and 7.46 mg/l.

2.1.3. Secchi disk and phytoplankton (SD):

Seechi disk visibility is an appropriate index of plankton abundance only when plankton is the primary source of turbidity **(Almazan** and **Boyd, 1978). Boyd (1981)** studied Secchi disk visibility during different seasons at 5 channel catfish ponds showed that Secchi disk visibility decreased from more than 100 cm in spring to less than 20 cm in late summer. The effect of inorganic nutrient loading on chlorophyll "a" concentration is obvious, a 55 % increase in the amount of inorganic nutrients produced a 20 % increase in the average of chlorophyll "a" concentration **(Zhu *et al.,* 1990).**

Ellawa (2008) found that the annual average of Secchi disc readings ranged from 12.54 – 15.67 cm in freshwater, while in drainage water it ranged from 10.63 – 10.92 cm. **Enas (2009)** showed that the annual over all means of Secchi disc readings in water samples collected from freshwater and agricultural drainage water are 51.43 and 27.4 cm.

2.1.4. pH :

The pH is important factor affecting uptake of heavy metals in aquatic organisms. The hydrogen ion concentration may exert its effect either directly by affecting uptake sites, or indirectly by determining the chemical speciation of dissolved metal pool **(Peterson *et al.,* 1984).** Tolerance of pH ranged from 5 to 11, but optimal results can usually be obtained only between pH 6 and 9 **(Boyd, 1985).** In water containing high levels of ammonia, a pH of 9.0 will cause a high percentage of the ammonia to exist in the toxic unionized form **(Emerson *et al.,* 1975).** The pH level below 5.0 may killed several species of *Daphnia* **(Havas, 1985).** Low pH causes damage to the gills of fish **(Playle** and **Wood, 1991).** Chronic effects have been reported below pH 5, with harmful effects on eggs and fry **(Anzecc, 1992). Meade (1989)** recommended that pH should be