AQUACULTURE GENETICS RESEARCH IN EGYPT

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ABSTRACT

Fish production in Egypt has significantly increased over the last few years reaching 546 000 t in 1998 compared to 306 000 t in 1988. The contribution of aquaculture in the overall fish production has increased as well reaching its utmost share in 1998 (26%). Research on aquaculture topics was conducted in several institutes targeting the increase of productivity as well as working on problems facing this promising sector. However, research on fish genetics in Egypt only started in recent years. The genetic improvement of tilapias and African catfish represents the focus of most genetics research in Egypt. This paper presents the status of genetics research within the International Network on Genetics in Aquaculture and in other national institutes in Egypt.

Introduction

Aquaculture in Egypt has become an increasingly important activity, as an immediate source of animal protein required for the country's growing population. The total fish production in 1998 was estimated at 546 000 t, of which 26% is from aquaculture. Aquaculture is being undertaken at extensive and semi-intensive levels. Most fish farms practice polyculture where tilapia represents about 38% of the total production. Along with tilapia (*Oreochromis niloticus* and *O. aureus*), mullets and carps are also stocked. Fish farms in Egypt include seven government farms (total area of 4 000 ha) and private fish farms (total area of about 50 000 ha) that are located around the lakes. All fish farms rely to some extent on hatcheries for obtaining their seed requirements. Most fish hatcheries belong to the General Authority of Fish Resources Development. The main fish seed produced are common carp, Chinese carps and tilapia. However, new tilapia hatcheries are now emerging. The total production of tilapia fry from hatcheries or fish farms in 1998 was estimated at about 49.9 million fry. *O. niloticus* and *O. aureus* dominate the fry production.

Most consumers in Egypt prefer tilapia compared to other freshwater fish. There are four tilapia species in Egypt: Nile tilapia (*O. niloticus*), blue tilapia (*O. aureus*), white tilapia (*Sarotherodon galilaeus*) and green tilapia (*Tilapia zillii*).

Fish Genetics Research

Fish genetics research in Egypt has a relatively short history concentrating initially on the biochemical identification and strain evaluation. The institutes/

universities working on fish genetics in aquaculture in Egypt are the: Central Laboratory for Aquaculture Research (CLAR), Abbassa; International Center for Living Aquatic Resources Management Regional Research Center for Africa and West Asia, Abbassa; National Institute of Oceanography and Fisheries; Veterinary College-Idfena, Alexandria University; Genetics Department, Faculty of Agriculture, Ain Shams University; Genetics Department, Faculty of Agriculture, Assuit University; Zoology Department, Faculty of Science, Zagazig University; Zoology Department, Faculty of Girls, Ain Shams University; and Genetic Engineering Research Institute, Sadat City, Monofaya University.

Performance evaluation and genetic characterization

CLAR is leading collaborative research along with two schools in Ain Shams University, i.e., Zoology and Genetics. The objectives of the research are to:

- determine whether Nile tilapia originated from a single strain or several strains;
- compare the reproductive performance among different stocks of Nile tilapia collected from three geographical locations: Maryout (MR) - Alexandria at North of Egypt (which has lower temperature); Zawia (ZW) - Kafer El Sheikh at the Delta area (which has saline soil); and Abbassa (AB) middle of delta area as a reference strain;
- compare the growth performances of the three stocks; and
- carry out a biochemical genetic analysis to determine the genetic variations within and among stocks collected from different locations.

This research was undertaken since strain differences, inbreeding and crossings could affect reproductive performance in cultured fishes. Large strain differences influenced reproductive performance in channel catfish (Dunham and Smitherman 1984) and rainbow trout (Kincaid 1976). If similar genetic differences exist for reproductive performance in tilapia, selection of a species or strain of tilapia with lower fecundity might be desirable for minimizing reproduction in rearing ponds. In contrast, strains with higher fecundity may be desirable for enhancing reproduction in hatcheries.

Abbassa stocks with an average weight of 150 g were collected from the production ponds. Maryout stocks were collected as fry (1 g) and then nursed to larger size in earthen ponds. Zawia stocks (150 g) were brought to Abbassa and maintained in ponds until used for spawning. All fish groups were acclimatized to Abbassa conditions upon their arrival.

Spawning activities

The spawning activities of the three strains and their crosses were carried out in circular earthen ponds of 100 m^2 each during 1996 and 1997 (Table 1).There were differences in the total number of fry produced from strains evaluated. During 1996 and 1997 studies, Abbassa strain was highly reproductive, while Maryout and Zawia strains had lower reproduction (Tables 2 and 3). There were differences in the total number of fry produced from each crossing. The cross between Abbassa x Zawia was highly reproductive, while Maryout x Abbassa came intermediate and Zawia x Maryout was the lowest (Table 4). Crossing with Abbassa strain indicated its superiority with regard to fry production.

Growth performance

To evaluate the growth performance of three stocks and their hybrids, the fish were stocked in 0.1 ha earthen ponds at a rate of one fish per square meter. Supplementary feed (25% protein) was given at a rate of 10% of body weight, six days a week for 45 days and later decreased to 5% of body weight. Biweekly samplings were carried out when random samples were individually measured for total length and weight. At the end of the growing season, harvesting was done and individual lengths and weights were estimated. The total yield for each pond was determined.

The growth rate is certainly a key element regardless of the production system. Studies undertaken during

Table 1. Details of spawning to evaluate performance of three strains of *O. niloticus*, 1996-1997.

Spawning	1996 season	1997 season
Period	6 Jun – 30 Sep	20 Jul – 15 Sep
Sex ratio	1.5 : 1	1.5 : 1
No. of females/ponds	66	66
No. of replication	2	2
Harvest intervals	3 weeks	3 weeks
Fish stocks	3 stocks	3 stocks
Crosses	3 crosses	3 crosses
No. of harvest	7	2
Temperature range (°C)	21-25	22-25

Table 2. Fry production of three strains of *O. niloticus* in circular earthen ponds of 100 m² each, 1996.

Strain	No. of female	Mean weight (g)	No. of harvest	No. of fry/ female	No. of fry/g body weight	No. of fry produced
Abbassa	25	144	7	286	1.99	50 000
Zawia	25	265	7	217	0.82	38 030
Maryout	25	282	7	196	0.69	34 230

Table 3. Fry production of three strains of *O. niloticus* in circular earthen ponds of 100 m² each, 1997.

Strain	No. of female	Mean weight (g)	No. of harvest	No. of fry/ female	No. of fry/g body weight	No. of fry produced
Abbassa	66	161.7	2	190	1.17	12 507
Zawia	66	187.0	2	158	0.84	12 507
Maryout	66	268.5	2	159	0.85	10 494

Table 4. Fry production of three crossings of *O. niloticus* in earthen circular ponds of 100 m² each, 1997.

Crossing	No. of female	Mean weight (g)	No. of harvest	No. of fry/ female	No. of fry/g body weight	No. of fry produced
Abbassa (F) x Zawia (M)	66	161.7	2	190	1.17	12 507
Maryout (F) x Abbassa (M)	66	187.0	2	158	0.84	10 424
Zawia (F) x Maryout (M)	66	268.5	2	159	0.85	10 494

1996 and 1997 showed that Maryout strain attained higher growth compared to Abbassa and Zawia strains (Tables 5 and 6).

At the end of the culture period, growth rate among crosses was significantly different (P = 0.01). In 1996, the highest growth was shown by the crossing of Zawia x Maryout, followed by Maryout x Abbassa; Abbassa x Zawia was the lowest (Table 5). The same trend was observed in 1997 (Table 6).

SDS-PAGE and isozymes by using starch gel electrophoresis were carried out for the three strains and their crosses starting from the parents, first generations, first crossings, second generations and second crossings. The analysis showed variations among and between strains from three different locations.

Salinity tolerance of Nile tilapia

Differences related to performance traits exist among fish species as well as among strains within a species. Compared to most tilapia species, *O. mossambicus* is more salt-tolerant while *O. aureus* is more cold-tolerant. Within species, differences were detected among Egypt, Ivory Coast and Ghana strains of *O. niloticus*. Examples of such differences gave this research group reason to study the salinity tolerance for strains of *O. niloticus*.

A study by CLAR and the Genetics Department, Faculty of Agriculture, Ain Shams University, aims: (1) to determine the lethal salinity levels of some strains of *O. niloticus* and compare these with other tilapia species and (2) to develop salinity-tolerant *O. niloticus* through subsequent use of survivors in breeding program. The study is in progress, and new data on genetic parameters and heritability values for salinity tolerance will be estimated.

Genetic and physiological studies on fish from polluted locations

Seas, rivers and lakes are the eventual sinks for many of harmful or waste substances disposed of by humans. Aquatic life, including food fishes, is capable of absorbing and accumulating various chemicals especially heavy metals which cause adverse effects on the aquatic biota. These effects include deleterious changes which disrupt the metabolic activity at a biochemical level (Hinton et al. 1973).

Egypt's coastal lakes act as temporary reservoirs for drainage water and often are highly contaminated with anthropogenic materials. This is true particularly for Lake Manzala and Lake Maryout and to a lesser extent for Lake Edku (El-Rayis and Saad 1984).

Collaborative research between CLAR and the Department of Zoology, Faculty of Science, Zagazig University, is in progress to study the genotype of fish collected from different polluted areas, chromosomal aberrations, biochemical electrophoresis analysis for protein, and some isozymes and micronucleus test on freshwater fish.

Table 5. Comparison of growth performance for three strains of *O. niloticus* and their crosses after 105 days of culture in earthen ponds, 1996.

Strain	Abbassa (AB)	Zawia (ZW)	Maryout (MR)	AB (F) x ZW (M)	MR (F) x AB (M)	ZW (F) x MR (M)
Date of stocking	14 Jul 1996	14 Jul 1996	14 Jul 1996	1 Aug 1996	1 Aug 1996	1 Aug 1996
Growing period	105.00	105.00	105.00	105.00	105.00	105.00
Mean initial weight (g)	2.80	2.80	2.80	0.50	0.50	0.50
Mean final weight (g)	86.80	167.50	177.70	97.32	119.86	161.44
Survival rate (%)	93.00	90.00	98.00	91.00	90.00	95.20
Average daily weight gain (g/day)	0.80	1.57	1.60	0.92	1.12	1.53
Feed conversion ratio	1.13	1.78	2.30	1.51	1.67	1.80
Condition factor	2.22	2.51	2.73	2.26	2.33	2.46
Yield per feddan (kg)	339.00	633.20	731.40	345.25	424.30	614.67
Weight gain/fish (g)	84.10	167.70	168.90	96.82	117.63	160.94
Specific growth rate (%)	3.27	3.89	3.95	5.02	5.20	5.50

Table 6. Comparison of growth performance for three strains of *O. niloticus* and their crosses after 75 days of culture in earthen ponds, 1997.

Strain	Abbassa (AB)	Zawia (ZW)	Maryout (MR)	AB (F) x ZW (M)	MR (F) x AB (M)	ZW (F) x MR (M)
Date of stocking	10 Sept 1997	10 Sept 1997	10 Sept 1997	10 Sept 1997	10 Sept 1997	10 Sept 1997
Growing period	75.00	75.00	75.00	75.00	75.00	75.00
Mean initial weight (g)	1.40	1.20	1.80	1.40	1.20	0.30
Mean final weight (g)	32.81	41.87	46.60	36.03	33.00	39.75
Survival rate (%)	94.00	88.10	90.00	86.50	89.50	87.50
Average daily weight gain (g/day)	0.39	0.51	0.53	0.43	0.43	0.49
Feed conversion ratio	0.35	0.36	0.41	0.36	0.30	0.55
Condition factor	2.20	2.24	2.25	2.23	2.10	2.28
Yield per feddan (kg)	129.50	154.90	176.14	131.20	124.10	146.10
Weight gain/fish (g)	31.41	40.67	44.80	34.63	31.80	45.00
Specific growth rate (%)	4.21	4.73	4.33	4.21	4.54	6.51

The study is also undertaking hematological examination to determine the total erythrocyte count, hematocrit value, hemoglobin concentration and hematological index (mean corpuscle volume, mean corpuscle hemoglobin and mean corpuscle hemoglobin concentration). It also conducts biochemical analysis to determine the total protein, total lipid, and liver and kidney functions.

DNA fingerprinting

The Genetics Department, Ain Shams University, is doing genetic fingerprinting in *O. niloticus* and detecting some of its lines by isozyme, organ distribution and RAPD-PCR DNA markers. Three lines of *O. niloticus* collected from different locations - Lake Manzala, Lake Nasser (Foki line) and Sohag hatchery - were analyzed. Six isozyme systems (Adh, Acph, Est, Ldh, Mdh and To) were detected in 10 organs using starch gel electrophoresis technique. The data revealed that Esterase and Lactate dehydrogenase isozymes systems are more powerful in line-detecting organs, while the other systems are sufficient to differentiate line-detecting localities. The DNA markers using RAPD-PCR technique were carried out.

CLAR/INGA Genetics Project

This project is called "Genetic Enhancement of Egyptian Farmed Tilapia under Different

Environmental and Culture Conditions". Its research includes:

- evaluation of strains of *O. niloticus* to identify the ones that perform better under different environmental and climatic conditions (ponds, cages, ricefields);
- genetic characterization of different strains; and
- production of new breeds that are more suitable for Egyptian aquaculture conditions.

The data collected from evaluation work will be used to establish an effective selective breeding program.

For this research, four different stocks of *O. niloticus* were collected from Ismailia canal at the center of Delta area (around Abbassa area) with moderate temperature, Lake Manzala in the northern part of Delta, and Lake Nasser, south of Egypt, with high temperature climate and Maryout strain from Maryout hatchery, originally from north of Egypt with cold temperature climate. Reproductive performance of Ismailia, Manzala and Maryout stocks has been studied.

Winter growth evaluation of Nile tilapia strains

Temperature tolerance is a key factor in tilapia production in temperate zones and to some extent in subtropical zones where tilapia aquaculture is characterized by seasonal changes in water temperature (Lahav and Ra'anan 1997). During winter, water temperature may drop to levels that cause severe growth inhibitions and sometimes, mortality. A species or a hybrid with greater cold tolerance becomes more valuable and may significantly improve the profitability of the industry. Moreover, the relatively short growing season in temperate climates could be extended as species and/or strains of cold-tolerant tilapia are surviving and/or able to continue growing at temperatures few degrees less than their noncold tolerant counterparts. In a three-replicate experiment, three strains of *O. niloticus* were stocked in 0.1 ha earthen ponds starting 15 December 1998, as temperature was declining in order to compare the winter growth for the three strains. As the work progresses, new data on genetic parameters and heritability values for cold tolerance will be developed.

Genetic evaluation of African catfish

Taxonomists and systematists attempt to distinguish species and hypothesize lineage by conducting studies of genetically based differences and similarities among populations. Historically, genetic differentiation has usually been inferred from a comparison of morphological characters. There is, however, an increasing trend in taxonomy to supplement morphological, analogical, ethalogical, biochemical or karyotypic characters among populations as a means of detecting genetic divergence. The African catfish is widely distributed throughout Africa. It inhabits tropical swamps, lakes and rivers, some of which are subject to seasonal drying. In the northen and central part of Africa, it has been described as *Clarias lazera;* in the eastern part as *C. senegalensis;* in the western part as *C. mossambicus;* and in the southern part as *C. gariepinus*.

The research at CLAR aims to:

- evaluate different catfish strains collected from various environmental conditions;
- make a biochemical genetic analysis (SDS-PAGE and isozyme electrophoresis) and a RAPD-DNA marker analysis.

It plans to collect broodstocks of *Clarias* from three locations, Abbassa, Kafer El-Seikh and Nile River, and evaluate the origin of these strains.

Other Research Highlights

The following research activities are being undertaken at the National Institute of Oceanography and Fisheries, Alexandria:

- karyological analysis of two species of family Sparidae (*Sparus auratus* and *Lithognathus mormyrus)*;
- isolation of salinity-resistant gene from *Artemia salina*;
- genotype analysis of *Tilapia* spp. at Lake Manzala;
- determination of the effect of water pollution in Lake Manzala on RNA/DNA ratio in *Tilapia* spp. in Egypt;
- genetic differentiation of sarcoplasmic protein in family *Mugilidae* at different habitats;
- determination of genetic variability of *Mugil cephalus* in freshwater and marine habitats;
- determination of the effect of two herbicides, Saturn and Ronstar, on the cytological character of and on electrophoretic protein polymorphism of *C. lazera.*

At the General Authority for Fish Resources Development, genetic development within tilapia strains in Egypt was carried out through a selection

program in government hatcheries. *O. niloticus* (parent, first and second generations) was selected for body weight and total body length of each of the three lines (Saft–Khaled, Sohag and Foki lines).

At the Idfena Veterinary College, Alexandria University, research on tilapia includes commercial production of monosex tilapia and supermale production of *O. niloticus.*

Most research activities at the Genetic Engineering Research Institute, Monofaya University, Sadat City, deal with fingerprinting and gene transfer.

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