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GENETIC APPROACH OF RED TILAPIA

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ABSTRACT

The electrophoretic analysis of muscle myogen of the different phenotypes of red tilapia; *Oreochromis niloticus* and *O. aureus* revealed that myogen patterns were not exactly similar and specific for each species. On the other hand, esterase isozyme patterns show mobility differences between them at Est II and Est III and were used to detect similarity between the species examined.

Analysis of variance of fish body weight, growth and harvesting parameters revealed that black Tilapia possessed a significantly highest growth in weight, while red black tilapia was tha second one. But *O. niloticus* had the poorest one which was not significantly different with red tilapia value. The genetic similarity between BT and RB is closer, while the similarity between BT, *O. niloticus* and RT has the same value. This result agrees with the results of food conversion.

INTRODUCTION

Red tilapia is one of the recent important hybrids of tilapia. It displays a fast growth rate; adequate food conversion; ability to grow in fresh brakish and salt water and low susceptibility to disease. The habit of red tilapia is extermely similar to that of the common mouth breeding tilapia Jen-Lein et al., 1983.

The origin and history of red tilapia are not well documented. Briggs (1981) produced red or golden progeny by the hybridization between female O. mossambicus hornorum hybrid from singapore with Japanese strain of O. niloticus and produced red or golden progeny. In Taiwan (Kuo, personal communication) obtained a reddish orang F_1 progeny from the cross between a mutant reddish orange female O. mossambicus and a normal coloured gray male O. niloticus (Fitzgerald 1979).

Gilman and Avtalion (1983) studied the morphometric meristic of red tilapia from the philippines and compared it with those of Oreochromis spp., aureus, hornorum, mossambicus and niloticus Their results revealed high heterogeneity of the different traits of red tilapia. Dowidar and Essa (1988) added that, as a heterogenesis hybrid the F_1 generation of the original stock red tilapia was composed of about 55 % red Tilapia and 45 % white and dark coloured tilapia hybrids.

In the present study the electrophoretic patterns of proteins and esterase isozyme variants were used to test for genetic differences between O. aureus; O. niloticus and the different phenotypes of red tilapia. A second goal is to estimate the genetic similarity and biochemical genetic distances between Oreochromis spp and the phenotypes of red tilapia in order to achieve the taxonomical status of these species. A third goal is to discuss the relationship between these characters and growth performance, the food efficiency for O. niloticus and the three phenotypes and red tilapia.

MATERIALS AND METHODS

The red tilapia (RT) used in this experiment was imported from Aqua Service, France and originally belonges to the strain from Taiwan. The F_1 generation of the original stock was produced through the interbreeding of (RT) and was composed of (RT), red-black tilapia (RB) and black tilapia (BT). They were reared in eight rectangular 200 L aquaria with standing water for a 56 days, from 8-1-1988 to 4-3-1988. Fifty fish were reared in each aquarium. There were replications in this experiment. The aquaria were all continuously aerated and equiped with an internal gravel and charcool filter, the water being completely replaced once a week.

For genetic studies, electrophoretic analysis of O. niloticus (ON), O. aureus (OA) and the different phenotypes from the F_1 generation of (RT) were used. The 7.5 % polyacrylamide gel served for the electrophoresis migration of the muscle myogen samples from tilapias. The methods were modified from Davis (1964). The esterase isozymes were studied in the muscle. The staining method was modified from Stordeur (1976), Shaw and prasad (1970).

The genetic distance and coefficient of similarity were estimated for the different phenotypes of (RT), (ON) and (OA) according to Sokal and Sneath (1963).

For growth parameters studies, initial fish weights averaged 3.88, 3.63, 3.27 and 3.13 g for (RT), (RB), (BT) and (ON), respectively with no significant differences (0.05 level) among aquaria. Fish were fed with pelleted artificial feed twice a day at 9: 00 Am and 3: 00 PM with a daily feeding rate of 5-8 % of total body weight adjusted accordingly at weekly intervals after weighing fish. The ingredients and chemical compositions of feed were used according to Jauncey and Ross (1982).

Differences in growth, food conversion, conditions factor and survival were evaluated.

RESULTS AND DISCUSSION

1- Genetic studies and electrophoretic analysis:

The electrophoretic analysis of muscle myogen of the different phenotypes of (RT), (ON) and (OA) revealed that nine bands of proteins were detected (Fig. 1). It is clear that (OA) and (ON) are closely associated except in zones 5 and 6. Rt males and females differed in zones 1,3 and 8.

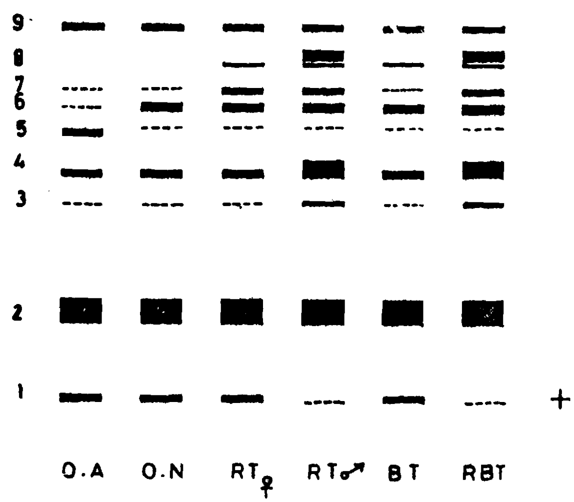

Fig. 1

Photograph of muscle myogen patterns in Red Tilapia and Oreochromis spp.

(BT) and (ON) are closely associated, differing in zone 8 only. RT males and RB are similar to each other. (BT) and (RT) females are closely associated differing in zone 7 only, since it presents in RT females and is absent in BT. Tt is quite apparent that myogen patterns were not exactly similar. Conversely, one can conclude that in these samples, myogen patterns are specific for each phenotype and constitute a single criterion by which these phenotypes may be identified.

The muscle myogen patterns show a high degree of species specificity in Tilapia (Hines & Yashouv, 1970; Avtalion, 1982 and El-Deeb 1983 and 1988). This observation has a particular value as a further descriptive criterion in the identification of Tilapia spp.

Researchers using isozymic variation as indices of genetic variability must address the basic hypothesis that the isozymic variation dose have a genetic basis and more specifically that the inheritance of these isozyme patterns follows a specified genetic model (Fairbairn and Roff, 1980).

By comparing the acid phosphatase, LDH and MDH of O aureus, O. niloticus and T. galileae, it was abvious that they were similar to each other. On the other hand, esterase isozyme patterns show mobility differences between them (El-Deeb, 1983).

The main point as demonstrated in Fig. 2 is the absolute species specificity of the muscle Est pattern. The photograph shows three regions of esterase, the most anodal group (Est I) consisted of minor band has low activity at (RT) and (RB). Est II exhibited a clear pattern of variation and heterozygous appeared at (BT). The more cathodal region

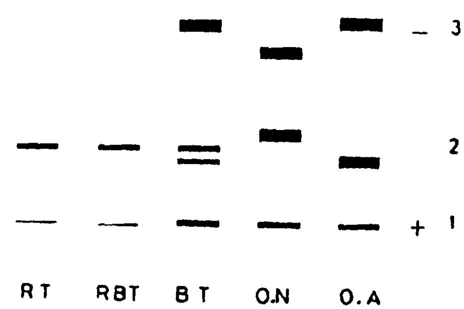

Fig. 2

Photograph of esterase patterns in Red Tilapia

and Oreochromis spp.

Est III exhibited clear pattern of variation at (BT), Oreochromis spp, while it disappeared or appeared with low activity at (RT) and (Rb).

The electrophoretic patterns of esterase were used to detect similarity between the species examined in the present study. The coefficient of similarity between the different phenotypes of (RT), (ON) and (OA) has been calculated according to the formula proposed by Sokal and Sneath (1963), from two loci of esterase isozymes (Est II & Est III). This coefficient and the genetic distance are tabulated in table 1. The values showed close similarity between (ON) and (BT), while (RT) and (RB) were less similar. The similarity between (OA) and the different phenotypes of (RT) was less than similarity between ON and the phenotypes of (RT). Jen-Leih et al, (1983) showed that the (RT) and (OA) are closely related, also O. mossambicus and OA are closely related. Kou and Neal (1982) suggested that (RT) are results of different hybridization from two or more tilapia species and OA have been involved in the hybridization of the stock. perhaps the ON used in cross-breeding with the mossambicus hornorum was a hybrid between aureus and niloticus.

Table 1.

Genetic distance (upper right) and genetic similarity (Lower left) between the different phenotypes of red tilapia and **Oreochromis** spp.

	OA	ON	BT	RB	RT
OA	-	0.04	0.12	0.2	0.25
ON	0.96	-	0.02	0.06	0.09
BT	0.88	0.97	-	0.01	0.02
RB	0.80	0.93	0.99	-	
RT	0.75	0.91	0.97	0.99	-

Genetic distance can be used to estimate the amount of taxonomic divergence between Tilapia spp.

The results of the present study revealed that, the estimate of biochemcal distance between ON, OA and RT is in accordance with the range of genetic distances between species. Also the genetic distance between the different phenotypes of RT is in accordance with the range of conspecific populations, according to Shaklee et al (1982).

2- Growth and harvesting parameters:

The preliminary study of the interbreeding of red tilapia reveals that, the F_1 genreation of the original stock was composed of about 55 % RT and 45 % of black and red black tilapia. This might be attributed to Red tilapia reveals a high heterogene of different Oreochromus species (Gilman and Avtalion, 1983).

Analysis of variance of fish body weight, growth and harvesting parameters of the three phenotypes (RT, BT and RB) and ON were summarized in Table 4. It was evident from the results that BT possessed a significantly highest growth in weight, while RB was the second one. But ON had a poorest value which was not significantly different with RT. This might be due to one or more of the following factors: i) the results of electrophoretic examination in the present study and the results of similarity indicated that the similarity between BT and ON as well as BT and RT have the same value (97.7 %). This result agrees with the results of food conversion; and ii) according to Jun-Leih et al. (1983), RT was presumably the hybrid of ON and the mutant O. mossambicus (Very fast growth), thus the superior results of the BT may be due to high genetic similarity of mutant O. mossambicus and BT.

Although BT, due to a highest growth rate did gave a highest level of total increments in weight than the other phenotypes cross-breds and ON, the RT had the highest survival rate (90 %), while RB had the best feed conversion ratio, whereas used less feed (1.21 to produce one unit of gain in body weight. Gilman and Avtalion (1983) mentioned that, RT reveals a high heterogenity of its different traits, combining the characteristics of different Oreochromus species. However some individuals are closer to O. mossambicus whereas others closely resemble O. niloticus or O. aureus.

In order to investigate genetically determined survival percentage further experiments are needed.

SUMMARY

In the present study the electrophoretic patterns of proteins and esterase isozyme variants were used to test genetic differences between O. aureus; O. niloticus and the different phenotypes of red Tilapia. The myogen patterns were not exactly similar and specific for each species. The esterase isozyme patterns show mobility differences between them and used to detect similarity between the species examined.

Analysis of variance of fish body weight, growth and harvesting parameters revealed that black Tilapia possessed a significantly highest growth in weight, while red black tilapia was the second one. But O. niloticus had a poorest value which, not significantly different with red tilapia, the genetic similarity between BT and RB is closer, while the similarity between BT, O. niloticus and RT have the same value. This result agrees with the results of food conversion.

Table 2.

Total and daily increment in body weight, survival and food conversion efficiency of the three tilapia cross-breds and *O. niloticus* reared in glass aquaria for 56 days.

Species	stocking data			Growth and harvesting data					
	Pm_i* (g)	N /Aq	B_i (Kg /Aq)	Pm_f* (g)	B_f (Kg /Aq)	G (g /day)	survival (%)	FCE	condition factor
Red-Black tilapia	$2.88^{a} + 0.26$	50	0.194	$41.58^{b} \pm 1.61$	1.289	0.67	62.00	1.21	2.11^{b}
Red tilapia	$3.63^{a} \pm 0.22$	50	0.182	$36.22^{c} \pm 1.61$	1.630	0.58	90.00	1.25	2.23^{a}
Black tilapia	$3.27^{a} \pm 0.20$	50	0.164	$54.54^{a} \pm 0.96$	1.692	0.91	62.00	1.34	3.15^{ab}
O. niloticus	$3.13^{a} \pm 0.43$	50	0.157	$33.81^{c} \pm 1.71$	0.913	0.55	54.00	1.58	3.09^{b}

Pmi : mean weight at stocking
N /Aq : number of fish per aquarium (175 l)
Bi : mean biomass at stocking
Pmf : mean weight at harvest
Bf : mean biomass at harvest
G : average individual fish daily gain
FCR : food conversion efficiency
* In the same column insignificant differences between means with same letter (P > 0.05).

REFERENCES

Avtalion, R.R., 1982. Genetic markers in Sarotherodon and their use for sex and species identification. Page 269 277 In: Pullin, R. S V. and R. H. Lowe-McConnell, Editors. The biology and culture of tilapias. ICLARM Conference Proceedings 7, 432 p. International center for living Aquatic Resources Management, Manila, Philippines.

Briggs, P., 1981. Research in Philippines produce new breed of Tilapia. Aquaculture Magazine 7 (3): 6-8.

Davis, B.J., 1976. Disc electrophoresis II Method and application to human serum proteins. Ann. N. Y. Acad. Sci., 121: 404-427.

Dowidar, N. and M. A. Essa, 1988. Acclimation of red tilapia in Egypt. Page 63-73 In: Proc. of the first scientific conf. on the role of scientific research in the development of fish resources. Fac. of Agriculture, Alexandria University, Egypt.

El-Deeb, S.I., 1983. Genetical studies on Tilapia app. Ph. D. Thesis. Alex. Univ., Egypt.

El-Deeb, S.I., 1988. Zone electrophoretic studies on the proteins of O. aureus, O. niloticus and their F_1 hybrid in Egypt. Page 95-105 In: Proc. of the first Sci. Conf. on the role of Sci. Res. in the development of fish resources.

Fairbairn, D.J. and D. A. Roff, 1980. Testing genetic methods of isozyme variability without breeding data: Can we depend on the X^2? Can. J. Fish Aquat. Sci., 37: 1149-1159.

Fitzgerald, W.J., 1979. Red orange tilapia, a hybrid that could become a world favorite. Fish Farming Inter. 6 (1): 26-27.

Gilman, O. and R. R. Avtalion, 1983. A preliminary investigation of the characteristics of red tilapias from the Philippines and Taiwan. Page 291-301 In: Proc. of Inter. Symp. on Tilapia in Aquaculture, Tel Aviv Univ., Tel Aviv, Israel.

Hines, R. and A. Yashouv, 1970. Preliminary studies on muscle protein polymorphism occuring within the genus Tilapia. Bamidgeh, 22: 69-71.

Jauncey, K. and B. Ross, 1982. A guide to tilapia feeds and feeding. Inst. of Aquaculture, Univ. of Stirling, Scotland.

Jen-Leih, W.; H. Jun-Chin, and L. Sheng-Kuang, 1983. Esterase isozymes in Oreochromis niloticus, O. aureus, O. mossambicus and red tilapia. Page 281-290. In: Inter. Symp. on Tilapia in Aquaculture, Tel Aviv Univ. Tel Aviv, Israel.

Kuo, C.M. and R. A. Neal, 1982 ICLARM'S Tilapia research. ICLARM News Lettre, 11-13 p. Manila, Philippines

Shaw, C.R. and R. Prasad, 1970. Starch gel electrophoresis of enzymes: A complication of recipes: Biochem. Genet., 4: 297-320.

Shaklee, J.B.; C. S. Tamarus and R. S. Waples 1982. Speciation and evolution of marine fishes studied by the electrophoretic analysis of proteins. Poc. Sci. 36: 141-154.

Sokal, R.R. and P. H. Sneath, 1963. Principles of numerical taxonomy W. H. Freeman, San Francisco.

Stordeur, E., 1976. Esterase in the mosquito, Culex pipiens Formal genetics and polymorphism of adult esterase Biochem. Gener., 14: 481-493.