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SUITABILITY OF COMMUNAL REARING FOR PERFORMANCE TESTING OF TILAPIAS

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SUMMARY

Triplicate plastic pools were stocked separately with either Tilapia aurea, T. hornorum, T. nilotica, or Taiwanese red tilapia fingerlings (60 fish/pool) averaging 7.3, 5.7, 8.2, or 7.6 g, respectively. Three other plastic pools were stocked communally (mixed groups) with equal numbers of similarly sized fish of the above four groups. Fish were fed 32% protein sinking pellets at an initial rate of 5% and decreasing to 3.5% total body weight daily divided into two equal feedings. All the fish were harvested after 88 days. Gains in weight and total length for separately stocked pools were 62.8 g (78.8 mm), 59.8 g (79.0 mm),69.8 g (80.7 mm), and 73.5 g (86.0 mm); and for communally stocked pools were 64.6 g (77.2 mm), 61.5 g (79.5 mm), 70.6 g (81.7 mm), and 91.0 g (89.4 mm) for T. aurea, T. hornorum, T. nilotica, and Taiwanese red tilapia, respectively. Males gained more than females for all groups in separate and communal cultures, however, a significant group by sex interaction existed. In separately stocked pools, males gained 23, 119, 76 and 43% more in weight, and 12, 59, 35 and 21% more in length than females for T. aurea, T. hornorum, T. nilotica, and Taiwanese red tilapia, respectively. Rankings of gains were the same for separately and communally stocked pools indicating that communal rearing is an efficient means of performance testing tilapias.

INTRODUCTION

Tilapia are important fish for culture in many regions of the world. The need for improving yields of tilapia through genetic selection programs has been identified as a

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high priority for research (Pullin and Lowe-McConnell 1982). However, the need for developing methodologies appropriate for performance testing genetic groups of tilapias is a prerequisite (Wohlfarth and Hulata 1981).

The use of mixed (communal) ponds rather than separate ponds was identified as an effective method of testing various genetic groups of common carp (Cyprinus carpio (Moav and Wohlfarth 1974). The objective of this study was to determine the effectiveness of the communal rearing method for tilapias.

MATERIALS AND METHODS

This study was conducted in 10.5 m^2 plastic pools located at the Lajas Station, Puerto Rico Agricultural Experiment Station, University of Puerto Rico. Triplicate pools were stocked separately with either Tilapia aurea, T. hornurum, T. nilotica, or Taiwanese red tilapia (red phenotype) fingerlings averaging 7.3, 5.7, 8.2, or 7.6 g, respectively. Three other plastic pools were stocked communally (mixed groups) with equal numbers of similarly sized fish of each of the above four groups. All pools were stocked with a total of 60 fish. The left pelvic fin of T. aurea and the right pelvic fin of T. nilotica were clipped to assist in the identification of these groups. Fish were fed twice daily, six days a week at an initial rate of 5% and a final rate of 3.5% total body weight per day. Feeding rates were adjusted according to samples of fish weighed every 3-4 weeks. Fish were harvested after 88 days and the weight and total length of each fish determined. Condition of each fish was calculated as weight (g) x 10^5/total length $(mm)^3$.

Since the primary objective of this study was to determine the effectiveness of communal rearing as a means of performance testing groups of tilapia; little effort was made to eliminate prior differences in rearing conditions between the four groups. The T. aurea, T. hornorum, and T. nilotica fingerlings used in this study were all spawned and reared in earthen ponds and were 2-3 months old. These groups were all mixed progeny of several matings. The Taiwanese red tilapia were 4-5 month old progeny of no more than 3 females and 3 males reared in a plastic pool.

Differences between groups by sex were determined by one-way and two-way analysis of variance for separately and communally stocked pools, respectively. Analysis of variance

for a split-plot design was used to determine if group by sex interactions existed. If error terms from the split-plot analysis were not different, analysis for a nested design was used. Least significant difference (LSD) was used to compare pairs of means when F-tests were significant ($P < 0.05$). A t-test was used to compare means between sexes. Methods described by Moav and Wolhfarth (1974) were used to analyze group performances in separate and comunal pools.

RESULTS AND DISCUSSION

Evaluation of Groups

Sex ratios varied between groups, however, for the densities tested, no trends were found relating gains in weight or length with the number of males, females or all the fish in a pool. Therefore no adjustments were made in gains of males or females. Males gained more in weight and length than females for all groups separately and communally stocked. In separate rearing, the difference in weight gain between sexes was significant ($P < 0.05$) for all groups except T. aurea, while for communal rearing, the only significant difference ($P < 0.05$) between sexes for gain in weight and length was with T. hornorum. The only difference ($P < 0.05$) in condition existed between male and female T. nilotica.

Comparisons of each group by sex are presented in Table 1. Even though no significant differences were found in gains between groups of males, T. aurea males tended to be more robust (higher condition). For females, T. hornorum gained significantly les ($P < 0.05$) than females of other groups in separate and communal environments.

There were significant ($P < 0.05$) group by sex interactions for gains indicating the relative gain between males and females by groups differed. In separately stocked pools, males gained 23, 119, 76 and 43% more in weight and 12, 59, 35, and 21% more in length than females for T. aurea, T. hornorum, T. nilotica, and Taiwanese red tilapia, respectively. In communally stocked pools, males gained 19, 93, and 43% more in weight, and 8, 52 and 20% more in length for T. aurea, T. hornorum, and T. nilotica, respectively. No significant group by sex interactions existed for condition.

Male tilapia of several species have been previously reported to grow faster than females (Chervinsky 1965; Fryer and Iles 1972). The relative growth of females to males is

Table 1. Performances of four groups of tilapia reared separately and communally in plastic pools for 88 days.

		Separate rearing[a]				Communal rearing[b]			
			Gain				Gain		
Group	Sex	No. of fish	Weight (g)	Length (mm)	Condition	No. of fish	Weight (g)	Length (mm)	Condition
T. aurea	M	24	69	83	1.905	6	70	80	2.011
	F	12	56	74	1.888	4	59	74	1.937
T. hornorum	M	25	82	97	1.765	4	81	96	1.790
	F	17	38	61	1.768	4	42	63	1.786
T. nilotica	M	23	89	93	1.860	5	83	89	1.829
	F	16	50	69	1.794	5	58	74	1.786
Taiwanese red tilapia	M	24	86	94	1.780	8	105	97	2.030
	F	7	61	78	1.706	0	-	-	-
		LSD[c]	M NS[d]	NS	0.0909		NS	NS	0.1321
			F 7.4	NS	NS		NS	11.1	NS

[a]means of 3 pools per group

[b]means of 3 pools

[c]least significant difference (P = 0.05)

[d]non-significant by F-test

probably dependent to some degree on culture conditions, ie., optimal conditions may give males a further advantage. It was not surprising that few differences existed between groups by sex because of inter-pool variation for separate rearing, low numbers of fish for communal rearing, and lack of similar pre-stocking rearing environments.

Some miscellaneous observations about the different groups include: 1) Taiwanese red tilapia were observed to feed more vigorously the first two weeks of the study, perhaps because of their previous rearing in pools, 2) spawning was observed within 25 days for T. hornorum, 46 days for T. aurea and T. nilotica, and 87 days for Taiwanese red tilapia (also the oldest group), 3) T. hornorum were more susceptible to stress induced by handling, 4) ease of manual sexing by visual inspection of the uro-genital region from easiest to most difficult was T. hornorum, T. nilotica, T. aurea, and then Taiwanese red tilapia, and 5) ease of capture by seining from easiest to most difficult was T. hornorum = Taiwanese red tilapia, T. nilotica, and then T. aurea. Except for ease of manual sexing, Taiwanese red tilapia appeared to have a better combination of traits important to culture than the pure species.

Evaluation of Stocking Methods

The differences in gains between each group for separate and communal pools are found in table 2. Differences were corrected for varying sex ratios between groups by simply averaging the gain of males and females to give values equivalent for 1:1 sex ratios (instead of dividing the total weight of fish per pool by the total number of fish per pool). Differences were in the same direction (positive or negative) for most group comparisons between separate and communal pools indicating that rankings by group were the same. The three differences with opposite signs between separate and communal pools may be more of a reflection of the small number of fish per group in communal pools than an effect of that environment.

Using methods described by Moav and Wohlfarth (1974), the phenotypic correlation between gain in separate and communal pools was 0.82 for weight and 0.99 for length. Thus for weight and length, respectively, over 80% and 97% of the between group variation in communal pools could be explained by variation in separate pools. Small residual variations in communal pools could be due to experimental errors or group by environment (rearing method) interactions.

Table 2. Differences in gains in weight (g) and total length (mm) between Tilapia aurea (A), T. hornorum (H), T. nilotica (N), and Taiwanese red tilapia (R) reared separately and communally in plastic pools for 88 days. Differences were computed from adjusted mean gains per group (average of males and females).

Differences in weight gains

Rearing	A - H	A - N	A - R	H - N	H - R	N - R
Separate (Average)	3.0	-7.0	-10.7	-10.0	-13.7	-3.7
Communal (Replication 1)	8.1	-4.8	-17.8	-12.9	-25.9	-13.0
Communal (Replication 2)	8.4	-3.5	-25.0	-11.9	-33.4	-21.5
Communal (Replication 3)	-7.1	-9.7	-36.5	-2.6	-29.4	-26.8
Communal (Average)	3.1	-6.0	-26.4	-9.1	-29.5	-20.4
Differences in gains in length						
Separate (Average)	-0.2	-1.9	-7.2	-1.7	-7.0	-5.3
Communal (Replication 1)	-4.5	-7.5	-7.7	-3.0	-3.2	-0.2
Communal (Replication 2)	4.0	-4.0	-12.5	-8.0	-16.5	-8.5
Communal (Replication 3)	-6.5	-2.0	-16.4	4.5	-9.9	-14.4
Communal (Average)	-2.3	-4.5	-12.2	-2.2	-9.9	-7.7

The coefficients of regression of the differences between groups in communal pools on the differences between groups in separate pools was 1.9 for weight gain and 1.5 for length gain. Therefore, magnification through inter-group competition existed. Moav and Wohlfarth (1974) reported a similar response for carp reared separately and communally.

The estimates of the genetic correlation coefficient were 0.65 and 0.80, and the regression coefficient of growth rate in communal on separate pools was 1.88 and 2.12 for gains in weight and length, respectively. The inter-group genetic variance in communal pools was higher than in separate pools. Moav and Wohlfarth (1974) found the genetic correlation coefficient to be 1.0 in carp and concluded that a component dependent on growth rate in separate rearing accounted for all the amplification of the variance in communal rearing. In other words, there were no specific genetic factors affecting growth rate in the communal environment. Since the genetic correlation coefficient was less than one for tilapia in this study, it appears other genetic factors may exist in communal rearing that are independent of growth rate in separate rearing.

In the European carp strains tested by Moav and Wohlfarth (1974) under separate and communal rearing, the differences in growth rate between males and females was probably small. Wohlfarth et al. (1975) reported females were 9 to 16% larger than males for European strains of carp. In this study, the differences in growth were considerably greater and also varied greatly from group to group. Such differences between sexes may have confounded the responses of the groups resulting in a genetic correlation between separate and communal pools of less than one. In addition, the presence or absence of one sex of a group may have altered the growth rate of the other sex of that group. Kubaryk (1980) found that male T. nilotica grew faster alone than in the presence of females, while females grew at the same rate in the presence or absence of males. Such a response could act to decrease the magnification of inter-group differences that existed in communal pools.

In conclusion, communal rearing of tilapia can effectively be used to evaluate their performance. Inter-group magnification, reduction in the number of experimental units required, and standard environmental conditions are direct advantages of communal rearing. A possible disadvantage is genetic mechanisms independent of those manifest in separate rearing may exist in communal rearing. Further studies not compounded with group by sex interactions need to be conducted to determine if these independent mechanisms do exist for tilapia.

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