Dept. of Animal Husbandry.
Fac. of Vet. Med., Alex. University.
Head of Dept. Dr. Khairy M. El-Bayomi.

EFFECT OF POLYCULTURE ON THE INTENSIVE FISH PRODUCTION UNDER CERTAIN ENVIRONMENT

(With 5 Tables)

By

M.M. EL-TELBANY; A.A. DRAZ* and H. SAMAHA*

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تأثير الاستزراع المتعدد الأنواع على الانتاج المكثف للأسماك تحت ظروف بيئية معينة

مسعد التلباني ، عبد الماجد دراز ، حامد سماحه

فى هذه الدراسة تم استزراع خمسة أنواع من الأسماك كل نوع على حده فى أحواض خرسانيه مساحتها ٨٤٠ م وبعمق مياه متر واحد ليعطى ٨٤٠ م مكعب لكل حوض وبكثافة استزراع ٣٥ ألف وحدة زريعة لكل حوض. وكانت الأنواع المستزرعه هى البلطى النيلى ، المبروك العادى ، البورى ، القاروص والدنيس بمعدل متوسط وزن ابتدائى ٢٨ ± ٣ر ، ١٢ ± ٢ر ، ٥ر ٣٠ ± ٧ر ١٠١ ± ١ر ، ٣ر١ ± ١ر جرام على التوالى.

كما تم استزراع كل من هذه الأنواع بنسبة ٧٠٠٠ وحدة لكل مع بعض ليعطى استزراع متعدد الأنواع وبكثافة استزراع اجماليه ٣٥ ألف للحوض أيضاً ، تم تغذية الأسماك بمعدل ٥ ٪ من الوزن مع تعديل الكميات على فترات حسب متوسط الأوزان على أعلاف صناعية محتوية على ٢٦ر٥٧ ٪ بروتين خام . تم أخذ عينات حوالى ١٠٠٠ سمكة من كل حوض كعينة لتدوين النتائج الخاصة بالنمو وكذلك عينة أسبوعية من كل حوض لفحص خصائص المياه طبيعياً وكيميائياً.

أوضحت النتائج أن أعلى متوسط وزن نهائى ، وأعلى انتاجية كلية ، أعلى انتاج صافى وكذلك أعلى معدل تحويل غذائى كان فى الاستزراع المتعدد الأنواع وليس فى النوع الواحد تحت نفس الظروف ماعدا نسبة مداومة الحياه فى المبروك العادى كانت على العكس من ذلك.

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*: Dept. of Microbiology and Animal Hygiene Fac. of Vet. Med., Alex. University.

SUMMARY

Five species of fish were cultured separately in concrete ponds, 840 cubic meters of water per each with a water circulation system. Every species was stocked at a rate of 35000 fish seeds per pond. Species involved were Oreochromis niloticus (O.niloticus), Common carp, Mugel cephalus, Marone labrax and Chrysophrus auratus with, 28.0 ± 0.3, 12.0 ± .20, 30.5 ± 0.7, 1.1 ± 0.1 and 1.3 ± 0.1 initial body wights in grams for each species, respectively. Samples of the same species with the same initial body wights were stocked together at the rate of 7000 fish seeds per species giving a polyculture with stocking density of 35000 per pond. Feeding rate was 5% from the stocked biomass and corrected biweekly according to the recorded average weights using diet containing 26.57% crude protein. Biweekly samples (to about 1000 fish) were collected from each pond, weighed and the average body weights were recorded and water samples were examined weekly for physico-chemical proporties. The results showed higher final average body weight, total production, net production and feed conversion of polyculture than those of mono-culture under the same environment. The reverse was true for survival rate in case of Common carp.

INTRODUCTION

Development of fish farming is determined by several factors, particularly the local environments, production technology and economics. Environment includes physical, institutional and social factors. Physical environments determine whether a selected species can be grown succesfully in a certain area as prevailing temperature, water quality and quantity are clearly important factors. Polyculture, rearing of more than two fish species in the same cultural unit, enjoys wide popularity throughout much the world *(BARDACH* et al., *1972)* since the technique allows species with different feeding habits to take advantage of each of the feeding niches in a pond environment. However, polyculture becomes less practical as the intensity of culture reaching super intensive or ultra-super intensive level. On the other hand, in mono-culture the fish being reared usually fails to accupy all portions of the environment, for example, the culture of dermesals species leaves most of the water column unccupied.

To increase production, a pelagic fish may be cultured along with a dermesal one, as species combination that co-exist in a polyculture pond must be compatible. A good polyculture is the one utilizing four or more species of fish that feed on benthos, zooplanktons, phytoplanktons, aquatic macro-phytes and other aquatic organisms respectively. *(HALEVY 1979; DADZIE 1982; TORRANS and LOWELL; 1986; SARIG; 1988; MILSTEIN* et al., *1991 and HASSAN and EDWARDS; 1992).*

The aim of this work was to find out the effect of combining five fish species with different feeding habits in a polyculture on different production traits compared to monoculture of the same species under the same environment.

MATERIAL and METHODS

This research was carried out in the intensive fish farm belongs to (Mariott Fish Plant, Alexandria Governorate) to study the effects of polyculture system on the production charactarstics of intensive fish farming. Some physico-chemical properties of water used were also considered.

I- Experimental fish:

Five different species of fish were involved in this study Tilapia nilotica (Oreochromis niloticus), Common carp, Mugil cephalus, Marone labrax and Chrysophyrus aureatus. Oreochromis niloticus and Common carp fingerlings were obtained from Fuwwa Fresh Water Artifical Fish Hatchery, the other marine fish species were obtained from Rossetta Natural Collection Center (Rossetta - Behaira - Egypt). Fish fingerlings were obtained in enough numbers, transported in conditioned tanks and acclamatized for one month before stocking.

II- Experimental ponds:

Concrete, rectangular ponds were used for this experiment each of 840 m^2 with water column about 1 meter giving 840 cubic meters of water per each. There is a bottom central well controlled drainage opening. The ponds were supplied by high efficient areators and filtering machine.

III- Water supply:

Agricultural drainage water was available during the experiment.

Water temperature, pH, Dissolved oxygen, Salinity, Hardness, Alkalinity, Phosphate, Ammonia, Nitrate and Organic matter were examined weekly from each pond according to *A.P.H.A. (1975), ATTIA (1981), MARRIOTT (1974) and SWINGLE (1969).*

IV- Feeding system:

The fish were fed on 26.56% crude protein containing diet at a rate of 5% of live body weight daily, the composition and chemical analysis *(A.O.A.C., 1975) and HAROLD et al. (1981)* of this diet are presented in Table (2 a & b).

Table 1 a: Composition of the basal diet:

Ingredients	%
Fish meal	21.0
Rice bran	12.0
Ground yellow corn	39.0
Soya bean meal	27.5
Sod. chloriede	0.5

Table 1 b: Chemical composition of the experimental diet:

Components	%
Moisture	10.00
Crude protein	26.57
Ether extract	8.32
Total carbohydrates	47.17
Ash	7.94
Metabolizable energy (ME / M cal/Kg)	3549.69
Protein / energy ratio	74.85

V- Experimental design and stocking rate of fishs (Table 2):

Pond No.	Cultured species	Replicate (A,B)	Initial body weight (g)	Stocking
1 -	O. niloticus monoculture	A	28.0 ± 0.0	35000
		B	28.0 ± 0.0	35000
2 -	Common carp monoculture.	A	12.0 ± 0.0	35000
		B	12.0 ± 0.0	35000
3 -	Mugil cephalus monoculture	A	30.5 ± 0.7	35000
		B	30.5 ± 0.7	35000
4 -	Marone labrax monoculture	A	1.1 ± 0.1	35000
		B	1.1 ± 0.1	35000
5 -	Chrysophyrus auratus monoculture	A	1.3 ± 0.1	35000
		B	1.3 ± 0.1	35000
6 -	All above species polyculture (equal number per each sp.)	A	the same as above	7000 / each sp.
		B	the same as above	7000 / each sp.

VI- Measurments:

1- Growths: Biweekly samples of 100 fish per each pond were collected, drained, weighed to the nearest gram and subdivided by figure 1000 to get the average of body weight and calculated to the nearsest gram then recorded.

2- Survival rate: Estimated by the following formula:

$$\text{Survival rate} = \frac{\text{Total number of the fish at the end}}{\text{Total number of fish at the start}} \times 100$$

3- Feed intakes: The amount of biomass per pond was determined according to the sample average and multiplied by 5%.

4- Total production: (Total yield): Total amount of biomass harvested in the unite area (pond) through the rearing period (153 days).

5- Net production (Net yield): Differance between the initial and final total population weight of fish per pond in 153 day.

6- Feed conversion ratio (F.C.R.): Calculated by the following formula:

$$F.C.R. = \frac{\text{feed intake (Kg)}}{\text{Weight gain in (Kg)}}$$

7- Statistical analysis: The data were statistically analysed according to *Snedecor and COCHRAN (1971)* using the overall mean (X) and the standard error (SE).

RESULTS

Are presented in tables 3, 4 & 5.

DISCUSSION

Final average body weight, total and net production per pond except for Marone labrax, the final average body weights of polycultured fish species were higher (164.6 $\pm$ 6.4, 290.1 $\pm$ 14.1, 148.1 $\pm$ 3.8 and 146.6 $\pm$ 1.9 compared to (132.5 $\pm$ 3.5, 260 $\pm$ 14.1, 121.3 $\pm$ 2.0 and 123.3 $\pm$ 2.9) in case of Oreochromis niloticus, Common carp, Mugil cephalus and Chrysophyrus auratus mono-culture respectively (Table 3). The same meaning for total and net pond yield except for Common carp total and net production were higher in polyculture (4474.6 Kg and 4009.4 Kg) compared with (3802.7, 2822.7), (3608.7, 2541.2), (1000.0, 961.5) and (2805.6) for total and net production resulted from Oreochromis niloticus, Mugil cephalus, Marone labrax and Chrysophyrus auratus mono-culture respectively (Table 4). These results agreed with the findings of *HALEVY (1979), DADZIE (1982), TORRANS and LOWELL (1986).*

Survival rate and feed conversion ratio (F.C.R.):

Except in case of Common carp mono-culture, survival rates of the polyculture were higher than these of mono-culture, they were 85, 90, 55 and 69% compared to 82, 50 and 65% for Oreochromis niloticus, Mugil cephlus, Marone labrax, and Chrysophyrus auratus respectively (Table 4). Moreover, feed conversion ratios were 5.69, 6.33, 3.82 and 3.23 compared to 6.93, 7.55, 5.55 and 3.74 in case of Oreochromis niloticus, Mugil cephalus, Marone labrax and Chrysophyrus auratus monoculture respectively. (Table 4), the only exception limited to Common carp mono-culture. These results are supported by those obtained by *MILSTEIN et al. (1991), HASSAN and EDWARDS (1992) amd YADEM (1992).*

Water quality criteria:

Good water quality is the key of successful fish production. An abundant hygienic water supply will solve many problems associated with intensive fish cultures by diluting out accumulated wastes and toxic products as well as maintaining optimal water condation.

Data recorded in Table (5) show that the water temperature and pH values ranged from 26 - 32°C and 7-9, respectively. These figures were considerd to be within desirable range for fish production *(BOYD AND LICHTOKOPPLER, 1979).* In addition, the average content of dissolved oxygen was 5.5 mg/L. wich would be satisfactory for most stages of growth, activities and reproduction of fish *(SWINGLE, 1969; ALABASTER and LIOYD, 1982).*

Table (5) revealed that salinity ranged from 200 - 400 with an average of 300 mg/L. These figures were found to be less than the highest concentration which permits normal survival and growth of fish *(CLAY, 1977).* Generally the growth and reproduction of fish are inhibited by increasing salinity *(ERIKSEN, 1978 and LIA and CHANE, 1983).*

Average content of hardness and alkalinity in examined water samples were found to be 590 and 256 mg/L. respectively which exceeded the desirable levels (20 - 300 mg/L.) as reported by *BOYD and LICHTKOPPLER (1979).*

The results also revealed that fish ponds contained phosphates varying from 0.15 - 0.45 mg/L. with an average of 0.3 mg/L. However, the addition of phosphate fertilizers will increase fish production in most ponds *(HICKLING, 1962).*

Moreover, the average concentration of ammonia and nitrate in the examined water samples of fish ponds were 0.09 and 0.001 mg/1 respectively which is below the toxic concentration (0.6 - 2 mg/1) as recorded by the *European Inland Fisheries Advisory Commission (1973) and BARICA (1975)*

Organic matter was found to be ranged from 250 - 420 with an average of 335 mg/1 (Table 5) which ecxeed the permissible limit (34 - 282.2 mg/1) for fish farms as recorded by *Zhang, et al (1987).* High concentrations of organic matter in ponds may be attributed to a high density of fish resulting in more fish excrement and higer plankton in such ponds *(Rappoport and Sarig, 1977 and Zur 1980).*

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Table (3): Average body weights and mortality percentages during the different rearing periods.

Periods	Oreochromis niloticus		Common carp		Mugil cephalus		Marone labrax		Chrysophyrus auratus	
	$\bar{X}$ ± SE Body weight	Mortality	$\bar{X}$ ± SE Body weight	Mortality	$\bar{X}$ ± SE Body weight	Mortality	$\bar{X}$ ± SE Body weight	Mortality	$\bar{X}$ ± SE Body weight	Mortality
Mono-culture:										
1/5-15/5	28.0 ± 0.0	7%	12.0 ± 0.0	5%	30.5 ± 0.7	9%	1.1 ± 0.1	25%	1.3 ± 0.4	18%
15/5-31/5	30.0 ± 0.0	3%	12.6 ± 0.1	2%	32.1 ± 0.1	3%	2.0 ± 0.1	10%	2.8 ± 1.0	6%
1/6-15/6	45.0 ± 0.0	1%	13.5 ± 0.6	1%	42.4 ± 2.7	0.0	5.9 ± 0.4	7%	8.2 ± 0.4	5%
16/6-30/6	50.3 ± 1.8	0.0	20.0 ± 0.7	1%	52.6 ± 3.4	1%	13.1 ± 0.8	3%	21.2 ± 1.2	4%
1/7-15/7	63.6 ± 2.2	2%	34.1 ± 1.5	1%	67.1 ± 0.8	1%	22.6 ± 3.5	1%	34.2 ± 1.3	0.0
16/7-31/7	82.5 ± 3.5	0.0	52.5 ± 3.2	0.0	81.3 ± 1.5	0.0	34.1 ± 1.3	0.0	41.3 ± 1.5	0.0
1/8-15/8	84.0 ± 5.7	1%	83.8 ± 5.3	0.0	88.4 ± 1.7	0.0	42.4 ± 1.4	0.0	56.8 ± 0.8	0.0
16/8-30/8	104.5 ± 0.7	2%	117.8 ± 3.2	0.0	93.0 ± 2.1	1%	52.7 ± 2.1	3%	67.6 ± 0.7	2%
1/9-15/9	108.0 ± 4.2	1%	179.8 ± 1.3	0.0	103.8 ± 2.3	0.0	58.8 ± 2.1	1%	79.9 ± 0.9	0.0
16/9-31/9	120.0 ± 0.71	1%	224.3 ± 6.0	0.0	116.9 ± 0.1	0.0	69.7 ± 0.6	0.0	104.4 ± 1.9	0.0
1/10	132.5 ± 3.5	0.0	260.0 ±14.1	0.0	121.3 ± 2.0	0.0	81.8 ± 5.2	0.0	123.3 ± 2.9	0.0
Poly-culture:										
1/5-15/5	27.8 ± 0.4	8%	12.2 ± 0.2	9%	31.6 ± 0.7	6%	1.0 ± 0.0	16%	1.0 ± 0.0	19%
15/5-31/5	29.3 ± 1.8	3%	14.9 ± 0.8	2%	33.1 ± 1.6	2%	2.0 ± 0.1	13%	3.9 ± 0.2	5%
1/6-15/6	44.7 ± 0.6	4%	17.9 ± 3.7	5%	42.7 ± 3.6	1%	4.2 ± 0.4	10%	8.8 ± 0.4	5%
16/6-30/6	57.3 ± 2.5	0.0	33.7 ± 5.6	2%	60.0 ± 0.7	0.0	12.9 ± 0.2	3%	25.2 ± 1.5	1%
1/7-15/7	71.3 ± 1.1	0.0	42.4 ± 2.3	1%	69.7 ± 0.7	0.0	19.1 ± 1.3	1%	33.8 ± 1.8	0.0
16/7-31/7	88.5 ± 1.4	0.0	67.0 ± 1.7	0.0	86.5 ± 1.6	0.0	31.0 ± 0.7	0.0	51.9 ± 4.5	0.0
1/8-15/8	107.9 ± 0.6	0.0	99.3 ± 1.1	0.0	94.7 ± 0.6	1%	37.9 ± 0.5	2%	59.5 ± 0.6	1%
16/8-30/8	122.1 ± 1.3	0.0	104.6 ± 2.1	0.0	147.6 ± 2.1	0.0	46.1 ± 1.4	0.0	70.3 ± 1.1	0.0
1/9-15/9	136.6 ± 2.1	0.0	195.3 ± 8.3	0.0	122.2 ± 4.5	0.0	53.4 ± 2.3	0.0	89.1 ± 1.8	0.0
16/9-31/9	157.1 ± 1.9	0.0	295.7 ±13.4	0.0	134.6 ± 5.1	0.0	64.7 ± 3.3	0.0	118.7 ± 2.1	0.0
1/10	164.6 ± 6.4	0.0	290.1 ±14.1	0.0	148.1 ± 3.8	0.0	72.6 ± 3.6	0.0	146.6 ± 1.9	0.0

Table (4): Production traits - Feeding parameter of different ponds studied along 153 days rearing period.

Item:	Oreochromis niloticus	Common carp	Mugil cephalus	Marona Labrax	Chysophyrus auratus
Mono-culture:					
Initial stocking rate per pond (840 m)	35000	35000	35000	35000	35000
Initial average body weight in grams	20 ± 0.0	12 ± 0.0	30.5 ± 0.7	1.1 ± 0.1	1.3 ± 0.4
Survival rate %	82	90	85	50	65
Final average body weight in grams	132.5 ± 3.5	260 ± 14.1	181.3 ± 2.0	81.8 ± 5.2	123.3 ± 2.9
Total feed/in Kg consumed during 153 days/ponds	19576.2	24413.9	19203.9	5341.3	9589.7
Total production Kg/pond	3802.7	8190.8	3608.7	1800.0	2805.1
Net production Kg/pond	2822.7	7770.8	2541.2	961.5	2759.6
Feed conversion ratio (FCR)	6.93	3.14	7.55	5.55	3.47
Poly-culture:					
Initial stocking rate per pond (840 m)	35000	35000	35000	35000	35000
Initial average body weight in grams	27.0 ± 0.1	12.2 ± 0.7	31.6 ± 0.7	1.0 ± 0.0	1.0 ± 0.0
Survival rate %	85	80	90	55	69
Final average body weight in grams	146.6 ± 6.4	290.1 ± 14.1	148.1 ± 3.8	72.6 ± 3.6	146.6 ± 1.9
Total feed/in Kg consumed during 153 days/ponds	4469.9	5095.8	4507.2	1842.1	2267.0
Total production Kg/pond	979.4	1624.6	933.0	279.5	708.1
Net production Kg/pond	787.8	1539.2	711.0	272.5	701.0
Feed conversion ratio (FCR)	5.69	3.30	6.33	3.82	3.23

Total production per pound poly culture = 4474.6 Kg
Net production per pound poly culture = 4009.4 Kg

Table (5) : Physico-chemical properties of the water :

Parameter	Range	Average	
Water temperature	26.0 - 32.0° C	29° C	
PH	7.0 - 9.0	8.0	
Dissolved oxygen	4.0 - 7.0	5.5	mg /L.
Salinity	200.0 - 400.0	300.0	ppm
Hardness	450.0 - 730.0	590.0	ppm
Alkalinity	200.0 - 312.0	256.0	ppm
Phosphate	0.15 - 0.45	0.3	ppm
Ammonia	0.05 - 0.13	0.09	ppm
Nitrate	0.0 - 0.002	0.001	ppm
Organic matter	250.0 - 420.0	335.0	ppm