PRODUCTION AND ECONOMICS OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) INTEGRATED CULTURE WITH ALFALFA (*MEDICAGO SATIVA*) IN RACEWAY SYSTEM IN KUWAIT

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Abstract

The present study examined the integrated culture of tilapia in a flow through recycling system with alfalfa production. The investigation included both the feasibility of fish production and the performances of alfalfa irrigated with fish farm effluent. Production was carried out on a year-round basis with stocking and harvesting every 70 days. Good results were obtained in terms of daily weight gain, feed conversion ratio, survival rate and yield compared to published research. Maximum fish production seemed to occur at optimum male ratio of about 60%. Average production of 2325 kilograms of fish per 2.7 hectares of alfalfa was achieved using established irrigation schedules. Differences in the final fish harvest among different batches were due to the sex ratio of each batch. The raceway system was adequate for good fish growth (1.19 g / fish / day). Market size fish (243.6 grams) was produced within 222 days. Based on one season data, growth and forage production of alfalfa were not influenced by effluent from fish culture. Economically, it has been concluded that integrated tilapia culture with alfalfa farming is profitable.

Keywords: integrated culture, Nile tilapia, alfalfa

INTRODUCTION

Development of a simple intensive tilapia culture system that can be integrated with crop production was initiated using tilapia (*Oreochromis niloticus*) culture with alfalfa (*Medicago sativa*) production. The purpose of this project was to establish, test and demonstrate a combined system for production of fish and crop at Al-Wafra experimental farm. Farmers integrating fish culture in their farms are utilizing conventional fish production systems. Although these systems are simple, inexpensive and successfully used in fish culture, their production rate is limited (10 – 15 kg/m3) due to the small farm size in Kuwait. At the moment, the government is allocating only small areas (5 ha) per farm.

A flow-through simple recycling system is presumed to be the most promising as a potential practical technology for fish and crop culture integration. While this system has lower production output per unit volume of water used than does the potential re-circulating system, it requires less capital input, less technical know-how and feasible.

The project was formulated to fulfill the following research objectives

1- Test the feasibility of producing 1.750 kg of fish per ha of alfalfa using established irrigation schedules.

2- Assess the performance of alfalfa irrigated with fish farm effluent compared with direct irrigation with well water.

MATERIALS AND METHODS

The design of the fish culture facilities was based on rearing *Oreochromis niloticus* from 1-7 g to market size of about 250 g in seven months, considering water temperature and water quality to be at optimum levels all the time. The basic assumption was that the well has a pumping capacity of 500 liter per minute on a year-round basis and could produce approximately 2.5 t of tilapia per year. Maximum density was 50 kilograms of fish per cubic meter. A raceway system was used to efficiently utilize the water. A greenhouse measuring 20x5x3 m (L x W x H) and covered with corrugated fiberglass sheets and shade nets was constructed. Inside the greenhouse, two raceways were installed. Each raceway consisted of three fish tanks of different sizes and a sand filter. The tanks were elevated and arranged in tiers.

The first, second and third tanks in each raceway had capacities of 1.5, 4.5 and 6.0 m3, respectively, and measure 1.5 x 1.0x I. 2m, 4.5 x 1.0 x 1.2m and 6.0 x1.0 x1.2 m and 6.0 x 1.0 x 1.2m, respectively. These tanks were made of fiberglass. At the outlet of the third tank, a sand filter was installed. The sand filter tank measured 2.0 x 1.0 x 0.6 m and was supplied with 4 "diameter PVC drain pipe and 3" diameter PVC spillway, which were centrally located at the lower and upper portion of side of tank. The sand filter tank was supplied with a false bottom at 15 cm above tank bottom.

Fresh well water discharged into first tanks, then flowed by gravity to the second tanks and then through the third tanks, and ultimately through the sand filter before it went to the sump, where the water was collected. From the sump, the water was either recycled or delivered to alfalfa by a low pressure pump. Air tubes were installed from the blower to the fish tanks. Diffusers (air stones) connected by PVC tubing were installed at the bottom of the tanks at intervals of one meter.

Fry production was carried out continuously to supply the project grow-out facilities with 2500 *O. niloticus* fry at size of 1-7g every 70 days. Production was carried out on a year-round basis with stocking and harvesting every 70 days. The fingerlings were transferred to Al-Wafra and stocked in two raceways (A1 and B1), one was the replicate of the other. Each raceway consisted of three sequential tanks (1.5, 4.0, and 6.0m3). Each raceway received a flow rate of 250 L/minute.

The water delivery time was from 8 am to 4 pm. The water was recycled when no new water was being delivered. Only one pump was used to deliver water to alfalfa, drawing effluent from two compartments of the sump. Two low-pressure pumps (Grundfos kp-300, 2 m head, flow = 250 1/ minute) were used for recycling, one for each raceway. The pump delivering new water to the fish tanks from the reservoir was running only during irrigation time. The tanks were continuously aerated by diffused air situated at the bottom of fish tanks.

The production schedule started with stocking 1250 fingerlings of 1 – 7 grams each in the first two tanks (A1 and b1) of each raceway. Every 70 days, the fish were transferred to the consecutive tanks and the first tank was restocked with a new batch of fingerlings. After 210 days, the fish were harvested from the third tanks (A3 and B3). With harvesting and stocking and stocking every 70 days, five crops were possible during a normal production year. For the two raceways, 500 kg per crop of fish were expected to be produced or a total yield of 2.500 kg per year.

The fish were fed with 2.0 mm crumble until the fish reached an average weight of 10 g, 2.0 mm pellets from 10 to 50 g 3.2 mm pellets from 50 g to 100 g and 4.5 mm pellets for fish bigger than 100g. Water temperature and dissolved oxygen from the well and the fish tanks were recorded daily. Ammonia, nitrite, nitrate and PH were measured biweekly.

A simple economic analysis was done to compare the profitability of the project in terms of profit, rates of return and break-even cost of tilapia culture in an alfalfa farm (Shang, 1981).

RESULTS AND DISCUSSION

Fish production

For the two raceways, only batches 1, 3, 4, 5, 6 and 7 were considered. The total annual yield was 2, 474.9 kg and the average feed conversion ratio was 1.8. Batch 2 was not considered due the very high mortality as a result of a power failure during the culture of the batch. As a result, back up generator had to be purchased.

The fish at harvest were easily categorized into two size groups: lager (> 250 g) and small (<250 g). This was explained due to differences in growth rate between males and females. Therefore, it was suggested that sorting (grading) of large fish from small fish would lead to a better growth rate for the small individuals. At the same time, large fish can be harvested at earlier stages, thus leaving more space in the culture tanks for small fish to grow. Both factors were expected to yield better overall production rates than when both size categories (sexes) were reared together.

Therefore, it was decided to introduce these two management practices (sorting and early harvesting of large fish) in the production of each batch.

Table 1 presents stocking and harvest data of the first batch. Average survival rate after 169 days of culture was 84.1%. Fish daily gain in weight and feed conversion ratio were 1.41 g and 1.22, respectively. However, when males and females were separated, a significant difference in growth between the two sexes was observed. The average daily weight gain for males was 3.2 g per day and was only 0.82 g per day for females. Feed conversion ratio was 0.98 for males and 4.02 for females.

Table 1. Average gain in weight, feed conversion ratio and survival rate of the first batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data:			
Average fish weight (g)	2.89	2.89	2.89
Total weight (kg)	3.72	3.72	3.72
Number	1287	1287	1287
Harvest data:			
Average fish weight (g)	231.0	217.1	224.0
Total weight (kg)	231.2	252.7	241.9
Number	1001	1164	1082
Survival (%)	77.8	90.4	84.1
Daily weight gain (g)	1.35	1.47	1.41
FCR	1.27	1.16	1.22
Duration (days)	169	169	169

Table 2 presents stocking and harvest data of the third batch. After 156 days of rearing fish together, they were graded into two categories: large and small. Thereafter, each category was grown separately. Large fish were harvested after only 30 days of rearing separately. The mean body weight of large fish was 262.2 g. the total period of time needed to attain this size was 186 days. The results of batch 3 did not show any significant improvements in the growth and production rates with the introduction of grading and early harvesting of large fish practices. Although the average harvested fish size in batch 3 was 200.9g, the longer growing period applied to batch 3 contributed adversely to daily growth rate and FCR data.

Table 2. Average gain in weight, feed conversion ratio and survival rate of the third batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data:			
Average fish weight (g)	5.03	5.03	5.03
Total weight (kg)	6.54	6.54	6.54
Number	1300	1300	1300
Harvest data:			
Average fish weight (g)	262.2	262.2	262.2
Total weight (kg)	140.3	193.9	167.1
Number	535	1403	969
Survival (%)	--	--	74.9
Daily weight gain (g)	1.38	0.59	0.99
FCR	3.6	5.8	4.7
Duration (days)	187	226	206

Results of the fourth batch of fish are presented in Table 3. After 69 days of rearing, all fish in tanks A1 and B1 were transferred to tanks A2 and B2, respectively. The average survival rate was 91.4% and the average body weight/fish was 31.90g. Fish were grown in tanks A2 and B2 for another 74 days, after which they were transferred to tanks A3 and B3. At this transfer, the fish were graded into two groups. Small fish were stocked in tank A3, whereas large fish were stocked in tank B3. Small fish contributed about 53.8% of the total number of transferred fish, whereas large fish contributed the other 46.2%. After a total growing period of 215 days, the average survival rate was 79.9% and the average body weight/fish was 280.41 g.

Table 3. Average gain in weight, feed conversion ratio and survival rate of the fourth batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data:			
Average fish weight (g)	2.12	2.12	2.12
Total weight (kg)	2.65	2.65	2.65
Number	1250	1250	1250
Harvest data:			
Average fish weight (g)	246.81	314.0	280.41
Total weight (kg)	270.5	282.6	276.6
Number	1096	900	998
Survival (%)	87.7	72.0	79.9
Daily weight gain (g)	1.14	1.45	1.3
FCR	1.8	1.9	1.85
Male population (%)	75.8	78.1	77.0
Duration (days)	215	215	215

Results of the fifth batch of fish are presented in Table 4. After 76 days of rearing, all fish of tanks A1 and B1 were transferred to tanks A2 and B2, respectively. The average survival rate was 94.4% and the average body weight was 46.22 g / fish. Fish were grown in tanks A2 and B2 for another 76 days, after which they transferred to tanks A3 and B3. At this transfer, fish were graded into two size groups. Small fish were stocked in tanks A3, whereas large fish were stocked in tank B3. Grading results indicated that there was a significant difference between the two size groups. Small fish contributed about 67.1% of the total number of transferred fish, whereas large fish contributed only 32.9%. The average body weight of small fish was 144.87 g, whereas it was 217.77 g for the large fish.

Table 4. Average gain in weight, feed conversion ratio and survival rate of the fifth batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data			
Average fish weight (g)	1.91	1.91	1.91
Total weight (kg)	2.39	2.39	2.39
Number	1250	1250	1250
Harvest data:			
Average fish weight (g)	183.87	309.39	246.63
Total weight (kg)	267.53	193.68	230.61
Number	1455	626	1041
Survival (%)	--	--	83.3
Daily weight gain (g)	0.82	1.39	1.11
FCR	2.3	1.7	2.0
Male population (%)	30.8	77.8	54.6
Duration (days)	222	222	222

Results of the sixth batch fish are presented in Table 5. After 80 days of rearing, all fish in tanks A1 and B1 were transferred to tanks A2 and B2, respectively. The average survival rate was 97.5% and the average body weight was 64.29 g / fish. Fish were grown in tanks A2 and B2 for another 80 days, after which they were transferred to tanks A3 and B3. At this transfer, fish were graded into two size groups. Small fish were stocked in tank A3, whereas large fish were stocked in tank B3. The average body weight of the small fish was 112.17g, whereas it was 177.49g for the large fish. Small fish contributed about 55.5% of the total number of transferred fish, whereas large fish contributed the other 45.5%. After a total growing period of 238 days, the average survival rate was 89.9% and the average body weight was 257.54g/ fish.

Table 5. Average gain in weight, feed conversion ratio and survival rate of the sixth batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data			
Average fish weight (g)	6.96	6.96	6.96
Total weight (kg)	8.71	8.71	8.71
Number	1250	1250	1250
Harvest data:			
Average fish weight (g)	309.51	205.57	257.54
Total weight (kg)	309.51	256.14	282.83
Number	1000	1246	1123
Survival (%)	80.0	99.7	89.9
Daily weight gain (g)	1.27	0.83	1.05
FCR	1.2	2.3	1.8
Male population (%)	82.4	39.9	61.2
Duration (days)	238	238	238

Results of the seventh batch of fish are presented in table 6. After 82 days of rearing, all fish in tanks A1 and B1 were transferred to tanks A2 and B2, respectively. The average survival rate was 95.0% and the average body weight was 37.0g/ fish. Fish were grown in tanks A2 and B2 for another 78 days. At time of transfer, fish were graded into two size groups. Small fish were stocked in tank A3, whereas large fish were stocked in tank B3. The average body weight of the large fish was 144.0 g and was 138.0 g for the small fish. After a total growing period of 231 days, the average survival rate was 72.4% and the average body weight was 233.3g / fish.

Table 6. Average gain in weight, feed conversion ratio and survival rate of the seventh batch of *O. niloticus*

Item	Raceway A	Raceway B	Mean
Stocking data			
Average fish weight (g)	3.26	3.26	3.26
Total weight (kg)	4.08	4.08	4.08
Number	1250	1250	1250
Harvest data:			
Average fish weight (g)	278.2	188.3	233.3
Total weight (kg)	217.0	194.0	205.5
Number	780	1030	905
Survival (%)	62.4	82.4	72.4
Daily weight gain (g)	1.2	0.8	1.5
FCR	2.0	2.3	2.2
Male population (%)	71.7	32.4	52.1
Duration (days)	231	231	231

The findings of this study on the daily gain in weight, feed conversion, survival and yield were comparable with those reported by Balarin (1983), Balarin and Haller (1982), Zohar and Rappaport (1985) and Balarin *et al.* (1986).

The final results of batches 3, 5 and 7 revealed that about 70-75% of the harvested fish were smaller than 200 g body weight, whereas only 25-30% of the harvested fish reached market size of more than 250 g body weight. With such a size ratio, it was not possible to achieve the production of 500 kg fish/ batch every 210 days.

These results suggested that the main cause of these differences in the final fish harvest seems to be the sex ratio of each batch. Since Tilapia females are slow growing fish compared with the males as reported by Bardach *et al.* (1972), Bondari (1982), Carro-Anzallota and Mc Ginty (1986). The Al-Wafra production schedule necessitated the availability of 2,500 fry of uniform size to be stocked in production tanks every 70 days. Since tilapia is low fecundity fish, meeting such an objective with one spawning is difficult. With such a practice, it would be very possible to combine fry from different females, spawning and ages in one group. The relationship between male ratio and fish size seems to be linear, the higher male ratio, the bigger size of harvested fish. These results suggested that the optimum male ratio for maximum production in the system was about 60%.

Water quality

Water temperature in fish tanks was recorded daily. The lowest recorded temperature was 25.5 °C in February 1998, whereas the highest recorded temperature was 31.3 °C in September 1997. Generally, temperature fluctuated between 27 and 30 °C most of the time. Placing the fish tanks inside the greenhouse and the use of ground water kept the water temperature within optimum range for optimum growth and yield of tilapia as reported by Balarin and Hatton (1979), Stickney (1979) and Meske (1985).

Dissolved oxygen (DO) levels in well water and fish tanks were recorded weekly. The lowest Do recorded level in water was 1.88 ppm, whereas the highest was 4.31 ppm. Generally, well water DO fluctuated between 2.0 and 2.5 ppm. In addition to air blowers, two water aeration columns were fixed at the inlet of each raceway. Water supply was from top and an aeration stone was placed on the bottom.

Generally, there was a declining trend in each raceway, where Do was the highest in the first two tanks (tanks A1 and B1) of each raceway, and lowest in the last two tanks (tanks A3 and C3). Although the Do levels were considered low, the growth rate, feed conversion ratio, survival rate and yield were not affected. This response to low Do levels might be due to the low oxygen demand of *Oreochromis niloticus* (Denzer. 1963).

Nitrogen (ammonia, nitrite and nitrate) levels were recorded bi-weekly. Ammonia level in inlet well water was not detectable. Nitrite level ranged from 0.099 to 0.132 mg/1, whereas nitrate level ranged from 4.4 to 8.8 mg/1. In fish tanks, generally, there was an increasing trend in ammonia and nitrite levels in each raceway, but not of nitrate. Nitrate level in fish tanks ranged from 8.8 to 13.2 mg/1. These values were below the nitrate lethal level for tilapia. Ammonia level in fish tanks was at detectable level. The lowest recorded total ammonia level was 0.128 mg NH4.N/1, whereas the highest level was 2.19 mg NH4.N/1. These values are well below the lethal ammonia level for tilapia. Generally, ammonia level was increasing in each raceway. Nitrite level, on the other hand, followed the same trend as ammonia. Nitrite level in fish tanks ranged from 0.099 to 0.759 mg NO2/1. These values are below the lethal level for tilapia.

Water is the most limiting resource for crop production in Kuwait. Open field crop production is primarily conducted using ground brackish water (3-9 ppt). Therefore, only crops that can tolerate the levels of salt in brackish water are planted. Although the use of brackish ground water for aquaculture is precluded by its large water requirements, approximately 14-20 cubic meter of water per one kilogram of tilapia (Leclercq and Hopkins (1985). Brackish water used to irrigate crops can first be used to culture fish. This integration would increase the efficiency of water use and the utilization of farm facilities and labor.

Alfalfa production

Alfalfa was selected as the crop for this study because it has good tolerance for brackish water and is produced continuously throughout the year. When year-round farming activities are conducted, it is possible to culture different sizes of tilapia at the same time. Thus, this would allow for at least five cropping per year or a total of 2.5 tons of tilapia per year. The original objective of this task was to compare the profitability of alfalfa farming with and without tilapia production. Except for nitrogen and protein levels at 203 and 230 days after planting, effluent from fish culture did not influence growth and forage production of alfalfa. However, this was based on one season data.

Economic analysis

An economic analysis of potential production systems and species for aquaculture development in Kuwait demonstrated that an integrated tilapia-crop framing system using a flow-through simple recycling system is the most profitable, even on a very small scale. An internal rate of return of about 27% was predicted at a production level of 2.5 tone / year (KISR, 1988).

Hopkins *et al.* (1984) indicated that integration of tilapia culture with agricultural crops would improve the economic viability of both crops by spreading the cost and usefulness of the water systems. The economics of tilapia culture at an existing farm indicated that at the sale price of KD 1.500 per kilogram fish, the profit was KD 0.298. The breakeven price per kilogram was KD 1.380/kg. Hence, tilapia production in an existing alfalfa farm was profitable.

CONCLUSION

Average production of 2,325 kg of fish per 2.7 ha of alfalfa was achieved using established irrigation schedules. Partial water recycling system was adequate for good fish growth (1.19g/ fish/ d). Market size fish (243.6 g) was produced within 222 days. Water quality parameters revealed that fish production could be doubled to 4,650 kg per 2.7 ha of alfalfa without demanding new water. This production can be achieved with an average male ratio of 61.23%. Increasing male ratio would increase production rate substantially.

REFERENCES

1. Balarin, J. D. 1983. Intensive tilapia farm developed in East Africa. Fish. Farming International, 10:6-7.
2. Balarin, J. D. and R. Haller. 1982. The intensive culture of tilapia in tanks, raceways and cages. In Recent Advances in Aquaculture. Edited by J.F. Muir and R.J. Roberts. London: Croom Helm, pp.266-355.
3. Balarin, J. D. and J. P. Hatton. 1979. Tilapia: A guide to their biology and culture in Africa. University of Stirling, Stirling, U.K.
4. Balarin, J. D., R. Horrer and A.T.C. Armitage. 1986. Research on intensive culture of tilapia in tanks. In Proceedings, African Seminar in Aquaculture. Pudoc, Wageningen, pp. 206-216.
5. Bardach, J. E., J. H. Ryther and W. O. McLarney. 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. New York: Wiley – Interscience.
6. Bondari, K. 1982. Interaction of sex and culture condition on growth, survival and quality traits of blue tilapia. Growth, 46:238-246.
7. Carro-Anzalotta, A. E. and A. S. McGinty. 1986. Effect of stocking density on growth of Tilapia nilotica cultured in cages in ponds. J. World Aquaculture Soc., 17:52-57.
8. Denzer, H. W. 1963. Studies on physiology of young tilapia. FAO fishery Reports, 44:357-366.
9. Hopkins, K. D., M. M. Hopkins, A. Al-Ameeri and D. leclerq. 1984. Tilapia culture in Kuwait: a preliminary analysis of production systems. Kuwait Institute for Scientific Research, Report No. KISR 1252, Kuwait.
10. Leclercq, D. I. and K. D. Hopkins. 1985. Preliminary tests of an aerated tank systems for tilapia culture. Aquaculture Engineering, 4:299-304.
11. KISR. 1988. The potential for aquaculture development in Kuwait. Vol. II: Detailed analysis. Kuwait Institute for Scientific research, Report No. KISR 2798, Kuwait.
12. Meske, C. 1985. Fish Aquaculture. Oxford: Pergamon press.
13. Stickney, R. R. 1979. Principles of Warm Water Aquaculture. New York: John Wiley and Sons.
14. Shang, J. C. 1981. Aquaculture Economics: Basic Concepts and Methods of Analysis. Boulder, Colorado: Westview press.
15. Zohar, G. and V. Rappaport. 1985. Intensive culture of tilapia in concrete tanks. Bamidgeh, 37:103-111.

إنتاجية و اقتصاديات الإستزراع التكاملي للبلطي النيلي مع البرسيم بنظام التربية المكثفة و اعادة تدوير المياة بدولة الكويت

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اجرى هذا البحث لدراسة الإستزراع التكاملي للبلطي النيلي بنظام التربية المكثفة مع إعادة تدوير المياة مع محصول البرسيم. حيث تناولت الدراسة جدوى انتاجية البلطي بهذة الطريقة و أداء محصول البرسيم المروي بمياة صرف الأحواض السمكية. و استمر الإنتاج على مدار العام مع إعادة تخزين الأحواض و الحصاد كل ٧٠ يوم.

تم الحصول على نتائج جيدة فيما يتعلق بمعدل النمو اليومي و معدل البقاء و معامل التحويل الغذائي و الإنتاج الكلي لأسماك البلطي النيلي المرباه بهذة الطريقة مقارنة بالنتائج المنشورة سابقا .حيث كان متوسط انتاج البلطي ٢٣٢٥ كيلوجراممن الاسماك لكل ٢،٧ هكتار من البرسيم و كان أعلى انتاجية للبلطي عندما كانت نسبة الذكور ٦٠%. و ترجع الفروق الفردية في إنتاج مجاميع البلطي الى اختلاف نسبة الذكور في هذة المجاميع.

و اظهرت الدراسة ان نظام التربية المكثف مع إعادة تدوير المياة مناسبا لتربية البلطي حيث امكن الوصول الى معدل نمو يومي لأسماك البلطي ١،١٩ جرام /سمكة / يوم و أحجام تسوئقية ٢٤٣و٦ جرام / سمكة خلال ٢٢٢ يوم. و في المقابل فإن انتاجية محصول البرسيم لم تتأثر باستخدام مياة صرف الاحواض السمكية كمصدر للري.

و في المحصلة من الناحية الاقتصادية فإن الاستزراع التكاملي للبلطي النيلي بنظام التربية المكثفة مع إعادة تدوير المياة مع محصول البرسيم يحقق ربحية جيدة.