Arab Gulf J. Scient. Res., Agric. Biol. Sci., **B5** (1), pp. 13-21 (1987)

Tilapia nilotica Culture Using Drainage Water in Al-Hassa Region of Saudi Arabia

Abdul Qayyum Siddiqui and Ahmad El-Badawy Adam

College of Agricultural Sciences and Food,
King Faisal University, P.O. Box 380,
Al-Hassa 31982, Saudi Arabia

ABSTRACT. *Tilapia nilotica* were cultured for 156 days in three 8 × 5 × 1 m concrete outdoor tanks. 250 fingerlings were stocked in each tank. Water at the rate of 200 l/min was continuously pumped through tanks 1 and 2 (single reuse), and 200 l/min through tank 3 (single pass). Two types of feed, one with 21.6% dietary protein and the other with 30% dietary protein, were fed to the fish. Both feeds had the same ingredients with 3.0 Kcal/g digestible energy.

Average weight of fish and yield were 150 g and 33.9 kg, 152 g and 34.5 kg, and 209 g and 46.9 kg, in tanks, 1, 2 and 3, respectively. Growth rates of fish fed 30% protein feed were greater than for those fed 21.6% protein feed. The food conversion ratio for 30% protein feed was lower than that for the 21.6% protein feed. In view of these observations tilapia culture prospects in Saudi Arabia are discussed.

During recent years tilapia have received considerable attention as a pond culture fish because of the following qualities: It is easy to handle and resistant to diseases (Hickling 1963), grows fast and multiplies rapidly; it flourishes under crowded conditions with low oxygen demand (Uchida and King 1962, Denzer 1968); it is tolerant to high temperature (Allanson and Noble 1964, and Denzer 1968), and a wide range of salinity (Lotan 1960; Chervinski 1961a, 1961b, 1966; Fukusho 1969, Job 1969a, 1969b). It is a herbivorous species and accepts artificial feed from the initiation of feeding. Because of these qualities tilapia have become popular and are cultured in many countries of the world.

In Saudi Arabia the surface water resources are meagre. However, in Al-Hassa region ground water is abundant. There are many natural springs which discharge water continuously. Al-Hassa area receives an average daily freshwater flow of 1.6 million cubic meters; approximately 90% of which is used for

agriculture. An elaborate drainage system has been established parallel to that of the irrigation system to drain the agricultural land while leaching excess salt from the soil. There are three main drainage canals, in which the water discharge ranges from 2 to 7 m^3/sec.

In view of the limited supply and great demand for fresh water for agricultural, domestic and industrial uses, the possibility was considered of utilizing drainage water, which presently goes to waste. The ecology of D1 (drainage canal) was investigated for 12 months, and in view of its physio-chemical properties and rich flora and fauna, the water was found to be suitable for fish culture (Siddiqui 1981, 1983, 1984). However, a salinity range of 3.0 to 3.8 parts per thousand, morning water temperature from 14 to 28 C, and diurnal oxygen variation in June 1981 from 2.0 to 11.5 mg/l put a limitation on the choice of culturable species, so *Tilapia nilotica* was selected for culture.

Material and Methods

Experimental Tanks

Three outdoor concrete tanks measuring 8 × 5 × 1 m were used. The surface area of each tank was 40 m^2, and each tank had a water volume of about 20 m^3 when the tanks were kept half full. The water inlets and outlets were at opposite ends. Tanks bottoms were sloped for quick drainage of water. The tanks were covered with a canopy of meshed nylon.

Treatments

Tank 1 - 250 fingerlings, feed with 21.6% dietary protein, direct water supply from the drainage canal.

Tank 2 - 250 fingerlings, feed with 21.6% dietary protein, receives water from tank 1 (single reuse).

Tank 3 - 250 fingerlings, feed with 30% dietary protein, direct water supply from the drainage canal.

Water Supply

Drainage canal water was used in these experiments. Three Honda 5 HP petrol water pumps were used to pump water into the tanks. Only one pump was used at one time. Each pump had a capacity of 1100 l/min water. The pump was used at its half capacity and about 400 l/min water. A flow-through system was maintained between tank 1 and tank 2. About 200 l/min water was flowing from tank 1 to 2, and then flowing out. Tank 3 received 200 l/min directly from the canal. The water in each tank was replaced after every three hours.

Water Analysis

Surface water temperature, dissolved oxygen, biochemical oxygen demand, total alkalinity and total dissolved solids of the drainage water, of the water in the three tanks were determined during the period of the experiment. All the measurements were made between 630 and 730 hr in the morning.

Temperature was measured with an ordinary thermometer with 0.1°C graduations. Dissolved oxygen was determined with a Beckman oxygen meter and pH with a field pH meter. Ammonia nitrogen was determined according to the method of Boyd (1979). All these measurements were made daily. Total alkalinity, total dissolved solids and biochemical oxygen demand were determined at weekly intervals following standard methods (Golterman *et al.* 1978).

Stocking of Fish

Tilapia nilotica fingerlings were obtained from the King Abdul Aziz City for Science and Technology, Riyadh, on March 15, 1982. For 10 days the fingerlings were kept in one of the tanks with flowing water. The tanks were stocked with 250 fingerlings in each tank on March 24, 1982. The fingerlings were from comparable stock and average sizes and weights were: tank 1, 5.7 cm, 4.0 g; tank 2, 5.1 cm, 3.8 g; tank 3, 4.9 cm, 3.9 g.

Feeding

In tank 1 and 2 a feed with 21.6% dietary protein, and in tank 3 a feed with 30% dietary protein were offered at the rate of 5% of the body weight. The feeding rate was changed to 3.5% on July 19, 1982. The fish were fed twice daily, morning and evening. In all three tanks ground food was offered. At about 2-4 week intervals, the ponds were completely drained and cleaned; the fish were counted, about 15% of the fish were measured, and weighed as a group. Feeding rates were subsequently adjusted. Both feeds were isocaloric with 3.0 Kcal/g digestible energy.

Results and Discussion

Growth, Survival and Feed Conversion

Data for stocking rate, survival, growth rate, feeding rate and feed conversion ratio are given in Table 1; and a summary of the data is given in Table 2. The survival rate was 90.4%, 90.8% and 89.6% in tanks 1, 2 and 3, respectively. Most of the fish mortality took place during and after draining and cleaning the tanks.

In 156 days average weight of *T. nilotica* was 150.0 g, 152.0 g and 209.37 g in tanks 1, 2 and 3, respectively (Fig. 1), with total biomass of 33.9 kg, 34.5 kg and

Table 1. Growth of *Tilapia nilotica*

Date	Number of days	Number of fish	Total biomass kg	Average Weight g	Average length cm ± SD	Total food consumed kg	% Food of total biomass	Weight gained kg	Feed conversion ratio
a) Tank 1									
24.3.1982	Started	250	1.000	4.00	5.70 ± 1.08				
7.4.1982	14 14	238	1.362	5.72	5.87 ± 1.21	0.700	5.0	0.362	1.93
29.4.1982	36 22	226	2.554	10.87	7.16 ± 1.50	1.498	5.0	1.192	1.25
18.5.1982	57 21	226	4.662	20.63	9.21 ± 1.67	3.426	5.0	2.108	1.15
19.6.1982	88 31	226	10.700	47.34	12.23 ± 1.59	7.459	5.0	6.038	1.23
19.7.1982	118 30	226	18.850	83.41	15.56 ± 1.85	16.050	3.5	8.150	1.96
26.8.1982	156 38		33.900	150.00	18.13 ± 2.18	25.070	3.5	15.050	1.66
						53.203			1.569
b) Tank 2									
24.3.1982	Started	250	0.94	3.77	5.09 ± 1.0				
7.4.1982	14 14	241	1.31	5.45	5.41 ± 0.79	0.660	5.0	0.369	1.78
28.4.1982	36 22	239	2.14	8.94	6.56 ± 1.0	1.444	5.0	0.824	1.75
19.5.1982	57 21	234	3.94	16.82	9.14 ± 1.2	2.444	5.0	1.799	1.25
19.6.1982	88 31	231	9.80	42.42	13.08 ± 1.2	6.100	5.0	5.864	1.04
19.7.1982	118 30	230	20.45	89.91	15.61 ± 1.3	14.700	3.5	10.650	1.38
26.8.1982	156 38	227	34.50	152.00	18.76 ± 2.2	27.198	3.5	14.050	1.93
						52.346			1.51
c) Tank 3									
24.3.1982	Started	250	0.97	3.88	3.8 ± 0.90				
7.4.1982	14 14	235	1.41	6.03	5.40 ± 1.14	0.679	5.0	0.440	1.54
28.4.1982	36 22	230	2.71	11.78	6.12 ± 1.20	1.551	5.0	1.299	1.19
19.5.1982	57 21	228	5.18	2.71	8.74 ± 1.40	2.844	5.0	2.468	1.15
19.6.1982	88 31	227	12.49	55.00	13.16 ± 1.47	8.024	5.0	7.308	1.09
19.7.1982	118 30	226	26.22	116.00	16.89 ± 2.0	18.727	3.5	13.731	1.36
26.8.1982	156 38	224	46.90	209.37	21.21 ± 1.74	34.867	3.5	20.684	1.68
						66.692			1.42

Table 2. Survival rate and production of *Tilapia nilotica*

Tank	Number of Days	Treatment					Net yield		Feed Conversion ratio
		Water flow l/min.	No. of day		Survival	Type of feed	Kg/tank	kg/m^3	
			Initial	Final					
1	156	200	250	226	90.4	21.6% dietary protein	33.9	1.69	1.57
2	156	200	250	227	90.8	21.6% dietary protein	34.5	1.72	1.51
3	156	200	250	224	89.6	30% dietary protein	46.9	2.34	1.42

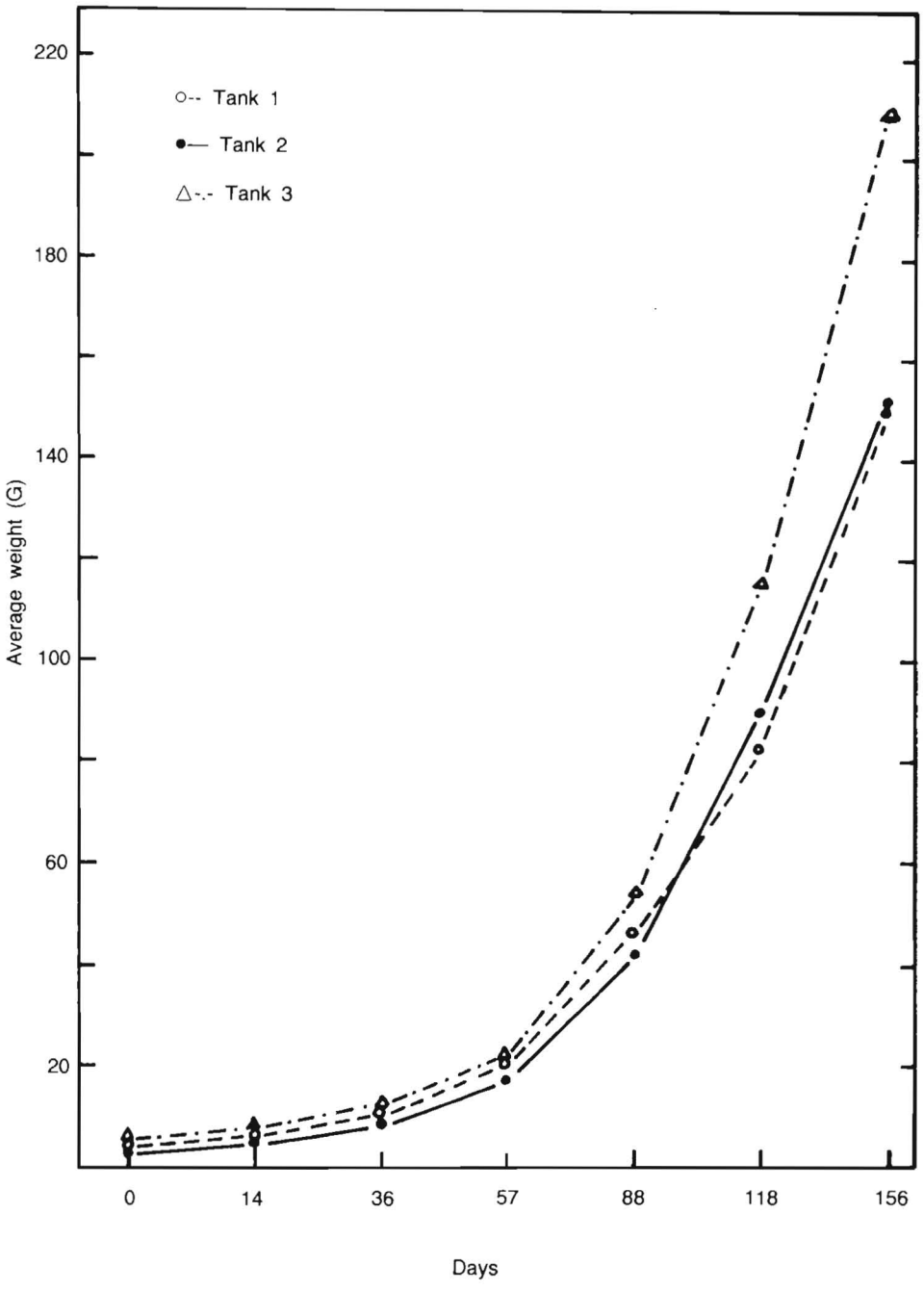

Fig. 1. Growth in weight (g) of *Tilapia nilotica*

46.9 kg (Table 2). In tank 3 fish reached marketable weight (> 200 g) within 156 days, while in tank 1 and 2 an average weight of over 200 g is expected in six months. The best growth rate was found in tank 3, where fish were fed with feed containing 30% protein. The feed conversion ratio (FCR) value was also low (1.42) in comparison to tank 1 (1.57) and tank 2 (1.51). Davis and Stickney (1978) made an extensive investigation on the growth of *T. aurea* and showed an increase in daily growth and a decrease in FCR as the protein contents of the feed were increased.

From the present observations it appears that by offering a feed with high protein content the average marketable weight of *T. nilotica* (about 200 g) can be obtained in 4-5 months, and two crops can be raised annually in the same tank. Feed conversion efficiency was best in tank 3 (70.42%) in which the fish received feed with 30% dietary protein. The feed with 21.6% dietary protein resulted in poor feed conversion efficiency in tank 1 (63.7%) and in tank 2 (66.2%).

Water Quality

The morning average temperature for 19 weeks, from March 24, to August 23, 1982, was 27.0±2.2°C. Diurnal variation in water temperature in the drainage canal in January was from 19 to 24°C, and in June 1981 from 25 to 30°C. In tank 2 in July, 1982, the daily temperature ranged between 26 to 33°C. From morning until 5 PM the temperature increased and reached about 30°C in summer months and in most of the other months as well. From the middle of December to middle of February the daily water temperature ranged between 18 to 24°C.

The growth rate of tilapia increases with water temperature up to 28 to 30°C (Balarin and Hatton 1979). The water temperature in the drainage canal and in the tanks remained optimum for fish growth for about 10 months; therefore, a long growing season is available. This opportunity needs to be exploited by raising two fish crops each year.

Average morning concentrations of dissolved oxygen ranged from 6.3 to 8.0 mg/l in the drainage canal water and in the tanks. Diurnal fluctuations in oxygen concentrations in canal water were from 6.0 to 10.1 mg/l in January, 1981, and from 2.2 to 12.0 mg/l in July, 1981. In tank 2 on July 1-2, 1982, oxygen fluctuated from 2.2 to 9.0 mg/l. During summer months the fish may be exposed to low oxygen concentrations (about 2.2 mg/l) for about 2 to 3 early morning hours. However, *T. nilotica* will not be under stress because this species has been found to have a very low oxygen demand (Denzer 1968). Otherwise, the water in the tanks was very well oxygenated. Maximum growth was obtained from June to August, and this showed that the metabolic rate of fish was not affected and food conversion efficiency remained high.

pH, total alkalinity and ammonia nitrogen concentrations were within acceptable limits of tilapia growth. The ammonia excreted by fish never built up in tanks as the water was continuously flowing.

Acknowledgements

Senior author is thankful to King Abdul Aziz City for Science and Technology, Riyadh, for funding this Project AR-1-013. Our sincere thanks are also due to Mr. Hamad Al-Hanty, Director Fish Culture Project, KACST, Riyadh, for providing tilapia fingerlings.

References

Allanson, B. and **Noble, R.G.** (1964) The tolerance of *Tilapia mossambica* Peters to high temperature, *Trans. Amer. Fish. Soc.* **94:** 323-332.

Balarin, J.D. and **Hatton, J.P.** (1979) *Tilapia, a guide to their biology and culture in Africa*, Unit of Aquatic Pathobiology, University of Stirling, Scotland.

Boyd, C.E. (1979) *Water Quality in Warm Water Fish Ponds*, University of Alabama Press, Auburn.

Chervinski, J. (1961a) Laboratory experiments on the growth of *Tilapia nilotica* in various saline conditions, *Bamidgeh* **13:** 8-14.

Chervinski, J. (1961b) Studies on the growth of *Tilapia galilaea* (Artedi) in various saline conditions, *Bamidgeh* **13:** 71-74.

Chervinski, J. (1966) Growth of *Tilapia aurea* in brackish water ponds, *Bamidgeh.* **18:** 81-83.

Davis, E.M. and **Stickney, R.R.** (1978) Growth response of *Tilapia aurea* to dietary protein quality and quantity, *Trans. Amer. Fish. Soc.* **107:** 479-483.

Denzer, H.W. (1968) Studies on physiology of young Tilapia, *FAO Fishery Reports* **44:** 357-366.

Fukusho, K. (1969) The specific differences of salinity tolerance among cichlid fishes of genus *Tilapia* and histological comparison of their kidneys, *Bulletin Japanese Society Science Fisheries* **35:** 148-155.

Golterman, H.L., Clymo, R.S. and **Ohnstad, M.A.M.** (1978) *Methods for Physical and Chemical Analysis of Freshwater*, IBP Handbook No. 8, Blackwell Scientific Publication, Oxford.

Hickling, C.F. (1963) The cultivation of Tilapias, *Sci. Am.* **208:** 143-152.

Job, S.V. (1969a) The respiratory metabolism of *Tilapia mossambica*. 1. The effect of size, temperature and salinity, *Marine Biology* **2:** 121-126.

Job, S.V. (1969b) The respiratory metabolism of *Tilapia mossambica*. 2. The effect of size, temperature, salinity and partial pressure of oxygen, *Marine Biology* **3:** 222-226.

Lotan, R. (1960) Adaptability of *Tilapia nilotica* to various saline conditions, *Bamidgeh* **12:** 96-100.

Siddiqui, A.Q. (1981) Distribution of three species of snails (Gastropoda, Mollusca) in an inland marsh and in a drainage canal in Al-Hassa region, *Proc. Saudi Biol. Soc.* **3:** 347-360.

Siddiqui, A.Q. (1983) Ecology of an inland marsh in the Al-Hassa region, *Proc. Saudi Biol. Soc.* **5:** (in press).

Siddiqui, A.Q. (1984) *An ecological investigation of Al-Hofuf main drainage canal and the marsh to find out the possibility of utilizing the water for fish culture*, Final Report to SANCST, Riyadh, May 1984.

Uchida, R.M. and **King, J.E.** (1962) Tank culture of Tilapia, *Fishery Bulletin.* **62:** 21-52.

(Received 12/01/1985;
in revised form 09/04/1985)

تجارب أولية لتربية أسماك البلطي النيلي باستخدام مياه الصرف بمنطقة الإحساء بالمملكة العربية السعودية

عبدالقيوم صديقي و أحمد البدوي آدم

كلية العلوم الزراعية والأغذية ـ جامعة الملك فيصل ـ الأحساء
المملكة العربية السعودية

تمت تربية أسماك البلطي النيلي لمدة ١٥٦ يوماً في ثلاثة أحواض أسمنتية مشيدة في العراء، حجم كل منها ٨ × ٥ × ١م كما تم تخزين ٢٥٠ من صغار هذه الأسماك متوسط وزن كل منها ٤ غرام في كل حوض. كما ضخ الماء في الحوضين الأول والثاني بمعدل ٢٠٠ لتر في الدقيقة، عن طريق إعادة استخدامه مرة واحدة ثم تفريغه. هذا وقد تمت تغذية الأسماك على نوعين من الغذاء المتساويين في السعرة الحرارية، يحتوي أحدهما على ٢١,٦٪، والآخر على ٣٠٪ من البروتين الغذائي.

بلغ متوسط وزن السمكة ١٥٠ و١٥٢ و٢٠٩ غرام في الأحواض رقم ١ و٢ و٣ على التوالي، كما بلغت الإنتاجية ٣٣,٩ و٣٤,٥ و٤٦,٩ كيلو غرام في الأحواض الثلاثة على التوالي. وكانت معدلات نمو الأسماك المغذية على غذاء يحتوي على ٣٠٪ بروتين أعلى من تلك المغذية على غذاء يحتوي على ٢١,٦٪ من البروتين الغذائي. كما كانت نسبة تحويل الغذاء إلى لحوم ادنى بالنسبة للغذاء الذي يحتوى على ٣٠٪ بروتين من الغذاء الذي يحتوى على ٢١,٦ بروتين.

هذا وقد تم بحث ودراسة إمكانية تربية الأسماك في المملكة العربية السعودية في ضوء هذه الملاحظات.