Preference of Different Terrestrial Plants as Food for *Tilapia rendalli* and *Oreochromis shiranus**

FREDSON J. CHIKAFUMBWA
BARRY A. COSTA-PIERCE
JOHN D. BALARIN**
ICLARM/GTZ Africa Aquaculture Project
P.O. Box 229, Zomba, Malaŵi

Introduction

Tilapias are generally opportunistic, omnivorous feeders, but the species of interest to fish culturists fall approximately into two groups with respect to feeding preferences: herbivorous macrophyte and microphagous feeders (Pullin 1986). There is a wide range of terrestrial and aquatic macrophytes which could be utilized in the culture of herbivorous tilapias (*Oreochromis* spp.). Macrophytophagous tilapias could be fed terrestrial and aquatic vegetation at low cost to the farmer (Edwards 1987).

Fish have distinct preferences for plants (Edwards 1980) and there is need to identify those that will lead to good growth and production, especially in Africa where there is abundant natural and agricultural waste vegetation. Some plants may also be useful as substitutes for animal protein components in formulated fish feeds (Payne 1981; Edwards 1987).

The objective of this study was to identify terrestrial plants acceptable to *Tilapia rendalli* and *O. shiranus*, the main tilapias cultured in Malaŵi.

Materials and Methods

Preference testing of different plants to *T. rendalli* and *O. shiranus* was conducted in 200-m^2 ponds (1 m deep) at the National Aquaculture Centre (NAC), Zomba, Malaŵi, from 14 February to 27 April 1989. Fish were stocked at 5/m^2; 1,000 *T. rendalli* were stocked in pond A and 1,000 *O. shiranus* in pond B. Overall mean body weight (MBW) of fish was 20 ± 5 g (MBW ± 1 SD).

Different terrestrial (natural and cultivated) plants were collected fresh from around the NAC and tied with string into 50-g bundles (Table 1). Each plant was given to the fish in three bundles per pond on four occasions (12 data points). Bundles of different plant species were randomly tied with wire to two 8-m long bamboo poles at 30-cm spaces. Poles were suspended horizontally in the pond, 3-5 cm below the surface by fastening them to vertical poles staked into the pond bottom. Plant bundles were thereby fully submerged at all times. As controls, three 50-g bundles for each plant species were put into buckets with tap water to correct for any weight losses or gains due to leaching or hydration.

Plant remains were removed from ponds and buckets after 24 hours, oven dried at 90-100°C to constant weight ± 0.1 g. Per cent dry matter (DM) consumed was determined on the treatments and compared to the DM of the control, and expressed as per cent DM consumed per day:

Table 1. Plants presented to *Tilapia rendalli* and *Oreochromis shiranus* in 200-m^2 ponds and the amount consumed after 24 hours on a dry matter basis.

Scientific name	Common name	% Dry matter content	% Dry matter consumed by *T. rendalli*	% Dry matter consumed by *O. shiranus*
Luffa cylindrica	Loofah	11	90.0	0
Cucurbita maxima	Pumpkin	15	83.4*	59.8*
Galinsoga parviflora	NA	12	81.5	0
Manihot spp.	Cassava	74	77.1	0
Tridax procumbens	NA	8	75.1*	28.7*
Commelina spp.	Spiderwort	10	70.6	0
Ipomoea batatas	Sweet potato	15	70.1*	65.6*
Leucaena leucocephala	Leucaena	32	69.6	0
Biden pilosa	Black jack	10	69.4*	25.0*
Rottboellia exaltata	NA	22	67.6	0
Echinochloa pyramidalis	NA	24	67.1	0
Mucuna pruriens	Buffalo beans	17	65.5*	17.9*
Pennisetum purpureum	Napier/Elephant grass	22	64.1	0
Morus nigra	Mulberry	29	60.3	0
Ageratum houstianum	NA	10	52.3	0
Amaranthus spp.	Wild blite	19	47.2	0
Emilia citrina	NA	8	46.3	0
Trichodesma zeylanicum	NA	11	41.8	0
Rhynchelytrum spp.	NA	20	38.4	0
Musa paradisiaca	Banana	22	37.2	0
Carica papaya	Papaya/Pawpaw	17	32.8*	23.6*
Hyparrhenia rufa	Zebra/Giant grass	31	14.1	0
Brachiara arrecta	NA	17	8.6	0
Tephrosia vogelli	Fish bean	ND	0	0
Cassia obtusifolia	NA	ND	0	0
Ludwigia erecta	NA	ND	0	0
Vernonia petersii	NA	ND	0	0
Vernonia cinerea	NA	ND	0	0
Tithonia diversifolia	NA	ND	0	0

* Significantly different at P<0.01 using paired t-test.
NA = Not available.
ND = Moisture and dry matter content were not determined on plants not eaten by fish.

*ICLARM Contribution No. 696.
**Present address: Oxbow Lake Small Scale Fishermen Project c/o DANIDA, G.P.O. Box No. 2056, Dhaka, Bangladesh.

$$\% \text{ DM consumed} = \frac{\text{DM control} - \text{DM uneaten}}{\text{DM control}} \times 100$$

where

DM = dry matter of plants after oven drying;

DM control = plant bundles in controls soaked in a bucket of water; and

DM uneaten = plant bundles after they were given to fish for 24 hours in ponds.

Differences in plant consumption of *T. rendalli* and *O. shiranus* were determined using paired t-test at ($P<0.05$). A multiple regression analysis was performed: the plant consumption data was the independent variable and nutritional and moisture contents of the plants were the dependent variables (Table 2).

Results

Of the 29 plants tested, 23 were eaten by *T. rendalli* and six by *O. shiranus* (Table 1). The amount of plant dry matter consumed by *T. rendalli* was significantly higher ($P<0.01$) than that consumed by *O. shiranus*.

Among the plants eaten by *T. rendalli*, distinct preferences were noted (Table 2). Some plants were not eaten by either fish: *Tephrosia vogelli*, *Cassia obtusifolia*, *Ludwigia erecta*, *Vernonia petersii*, *V. cinerea* and *Tithonia diversifolia*.

Discussion

Junor (1969) concluded that *T. rendalli* is a voracious and largely nonselective feeder on submerged aquatic macrophytes. In this study, *Tilapia rendalli* ate a wide range of terrestrial plants. Among the terrestrial plants eaten here, however, *T. rendalli* preferred some over others, as did *O. shiranus*. Although *O. shiranus* ate up to 65% of the dry matter of some of the plants tested, all DM consumption rates were significantly lower than those of *T. rendalli*. It is surprising that *O. shiranus*, considered a microphagous fish (Trewavas 1983), ate some of the higher terrestrial plants tested.

Nutritional values of plants eaten by *T. rendalli* and *O. shiranus* are shown in Table 2. Grasses (*Rottboellia exaltata*, *Pennisetum purpureum* and *Hyparrhenia rufa*) have low crude protein (CP) contents; while leafy plants (*Manihot* spp., *Ipomoea batatas* and *Leucaena leucocephala*) have higher CPs. A multiple regression showed that plant consumption by *T. rendalli* and *O. shiranus* was not related to the nutritional status of the plants ($r = -0.29$ to 0.14; $P>0.05$).

Some of the plants eaten by *T. rendalli* and *O. shiranus* may not be suitable as fishpond inputs as they may be scarce (Boyd 1968). Others may contain toxins or antidigestive factors; e.g., *Leucaena leucocephala*, which contains mimosine that can inhibit fish growth if not leached before incorporated into feeds. Cassava (*Manihot* spp.) and sweet potato leaves (*Ipomoea batatas*) are also used as human food. On the other hand, napier grass (*Pennisetum purpureum*) has a good potential as a pond input. Napier grass is commonly available in all ecological zones in Malaŵi all year-round (Williamson 1975). It grows naturally near streams or in *dambos* and can also be cultivated. Yields of 80-100 t/ha/year under rainfed conditions, or up to 250-300 t/ha/year under good management, fertilization and irrigation have been recorded (Hegde 1974).

Table 2. Plants ranked according to consumption by *Tilapia rendalli* in 200-m² ponds and their nutritional values.

Scientific name	DM	Nutritional composition as % of dry matter: CP	CF	Ash	EE	NFE
Manihot spp.	16.5	25.9	20.6	8.1	5.6	42.3
Ipomoea batatas	10.8	19.4	10.2	25.9	3.7	40.8
Leucaena leucocephala		21.0	18.1	8.4	6.5	46.0
Rottboellia exaltata		11.1	32.9	10.9	2.3	42.8
Echinochloa pyramidalis		7.0	31.4	8.6	1.1	51.9
Pennisetum purpureum	22.0	10.2	32.9	13.4	1.8	42.8
Morus nigra	38.3	17.6	7.4	20.4	11.5	43.1
Amaranthus spp.		19.9	21.0	17.0	1.5	40.6
Musa paradisiaca	94.1	9.9	24.0	8.8	11.8	45.5
Carica papaya	22.1	26.8	10.9	13.2	7.7	42.0
Hyparrhenia rufa	30.0	6.0	31.3	15.5	2.1	45.8

Nutritional values from Gohl (1975).
DM = Dry matter; CP = crude protein; CF = crude fiber; EE = ether extract; NFE = nitrogen free extract.

Acknowledgements

This work comprised a portion of a Master of Science study in the University of Malaŵi by the senior author through the International Center for Living Aquatic Resources Management (ICLARM) with funding from the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH, Federal Republic of Germany. We thank the Department of Fisheries for the provision of the facilities at NAC.

References

Boyd, C.E. 1968. Freshwater plants: potential source of protein. Econ. Bot. 22(4):359-368.

Edwards, P. 1980. Food potential of aquatic macrophytes. ICLARM Stud. Rev. 5, 51 p.

Edwards, P. 1987. Use of terrestrial vegetation and aquatic macrophytes in aquaculture, p. 311-335. *In* D.J.W. Moriarty and R.S.V. Pullin (eds.) Detritus and microbial ecology in aquaculture. ICLARM Conf. Proc. 14, 420 p.

Gohl, B. 1975. Tropical feeds. FAO, Rome. 661 p.

Hegde, D.M. 1974. The fodder called kamadhenu. Int. Agric. 12(5):5-100.

Junor, F.J.R. 1969. *Tilapia melanopleura* Dum. in artificial lakes and dams in Rhodesia with special reference to its undesirable effects. Rhod. J. Agr. Res. 7:61-69.

Payne, W.J.A. 1981. The desirability and implications of encouraging intensive animal production enterprises in developing countries, p. 1-10. *In* A.J. Smith and R.G. Gunn (eds.) Intensive animal production in developing countries. Occas. Publ. 4, British Society of Animal Production.

Pullin, R.S.V. 1986. Culture of herbivorous tilapias, p. 145-149. *In* H.H. Chou, K.J. Ang, A.T. Law, M.I.H. Mohammed and I.H. Omar (eds.) Development and management of tropical living aquatic resources. Universiti Pertanian Malaysia, Selangor, Malaysia.

Trewavas, E. 1983. Tilapiine fishes of the genera *Sarotherodon*, *Oreochromis* and *Danakilia*. British Museum (Natural History), London. 583 p.

Williamson, J. 1975. Useful plants of Malaŵi. Revised and extended edition. University of Malaŵi, Zomba, Malaŵi. 336 p.