

Azolla as a Fish Food

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Azolla, a tiny aquatic plant, is seen by some agricultural scientists as a means of biological replacement of part or all of the inorganic nitrogenous fertilizers currently required to fuel high-yielding rice crops.

With increasing attention being given to integrated-farming activities, such as rice-fish culture, there is need to examine the potential of *Azolla* as food for fish.

Azolla represents a 'free' food source, being rapidly self-propagating. If a fish can be found which efficiently utilizes *Azolla* or an economical *Azolla* derivative, the impact on tropical aquaculture would be considerable.

Tilapias are prime candidates for increasing aquaculture yields in the tropics. Can tilapias grow on an *Azolla* diet?

Background

Azolla is an aquatic fern genus with six species distributed widely throughout warm-temperate and tropical zones. Its most remarkable feature is its symbiotic relationship with the nitrogen-fixing blue-green alga *Anabaena azollae* within its leaf cavities. *Azolla* has been used for centuries in Asia as a green manure, fertilizer for rice fields and a supplement to diets for pigs and poultry. Some strains of *Azolla* can fix as much as 2-3 kg of nitrogen/ha/day; *Azolla* contains around 27% crude protein and 10% carbohydrates on a dry weight basis (see Table). As a fish food, however, *Azolla* is an unknown quantity.

The International Rice Research Institute (IRRI) at Los Baños, Laguna, Philippines is investigating the use of *Azolla* in rice culture with a research team under Dr. Iwao Watanabe, who has recently compiled a review of *Azolla* biology. During 1981 and 1982 *Azolla* was widely distributed throughout the Philippines. *Azolla* doubles its biomass in 3-10 days depending on conditions and easily reaches

a standing crop of 8-10 tonnes/ha fresh weight in Asian rice fields: 37.8 t/ha fresh weight (2.78 t/ha dry weight) has been reported for *Azolla pinnata* in India.

Nutrients present in *Azolla pinnata*.

Constituent	% dry weight
Nitrogen	4.5
Phosphorous	0.7
Calcium	0.7
Potassium	3.3
Magnesium	0.6
Manganese	0.1
Iron	0.2
Crude protein	27.0
Crude fat	3.2
Soluble sugars	3.5
Starch	6.5
Chlorophyll <i>a</i>	0.5
Ash	10.5
Crude fiber	9.1

Research Cooperation

In 1981, IRRI and ICLARM discussed the possible use of *Azolla* in rice-fish and other multicrop-fish integrated farming systems. Literature searches and the ICLARM-IRRI discussions soon showed a dearth of information on *Azolla* in fish nutrition. Basically, all that was known was that some fish will consume it. ICLARM therefore sought the cooperation of the University of the Philippines in the Visayas College of Fisheries (UPVCF) in a research project to determine the value of *Azolla* in Nile tilapia (*Oreochromis niloticus*) nutrition given fresh, dry, or as a protein source in compounded diets. The UPVCF and its research arm, the Institute of Fisheries Development



Experimental *Azolla*-rice plots at IRRI, Los Baños, Philippines.



Research Assistant Mr. Ramon Agbayani (IFDR) demonstrates a small-scale solar drier for the preparation of dried *Azolla* for inclusion in tilapia diets.

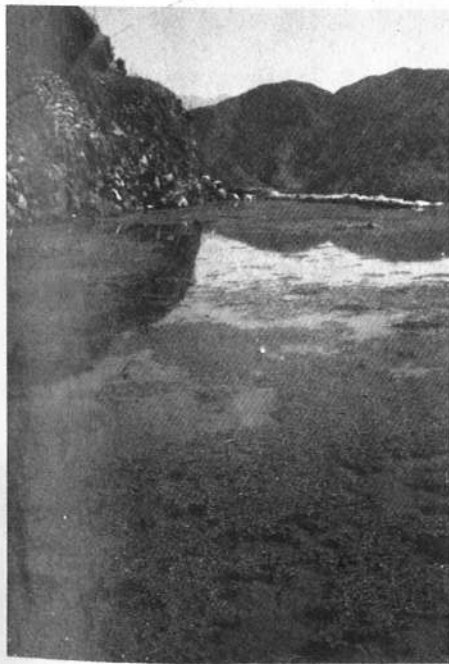


Research aide Ms. Aurora Angeles demonstrates the mass culture of *Azolla* in plastic pools at IFDR.

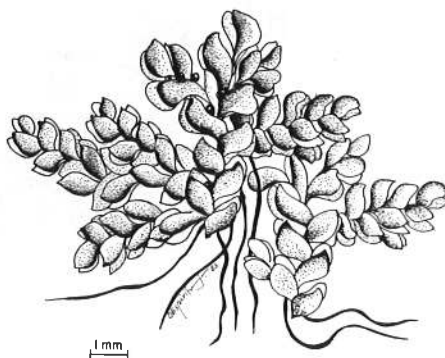
and Research (IFDR), commenced work on this with ICLARM in May 1982 using IFDR facilities. IRRI supplied the seed cultures of a high temperature-tolerant strain of *Azolla pinnata*, known as 'Bangkok strain' from its extensive pure culture collection. The Philippine Bureau of Fisheries and Aquatic Resources tilapia hatchery on the campus of Central Luzon State University supplied broodstock and fingerlings of a good strain of Nile tilapia used in commercial Philippine aquaculture, known as 'SEAFDEC strain.'

Research Progress

Azolla cultures and experimental tilapia stocks have been established in outdoor plastic pools. The fish are maintained on a diet well-proven at IFDR: 40% rice bran; 40% fish meal; 10% corn starch; 9% corn meal and 1% afsillin (a micro-nutrient premix). In the plastic pools, natural plankton soon develops and supplements the diet of these microphagous fish even with frequent water changing. A standard nutritional assay for *Azolla* diets has therefore been developed using fingerlings in shaded glass aquaria, which are kept stringently



Azolla growing in rice terraces near Banaue, Ifugao Province, Philippines, where rice-fish integrated farming is under consideration (see ICLARM Newsletter, July 1982, p. 24).



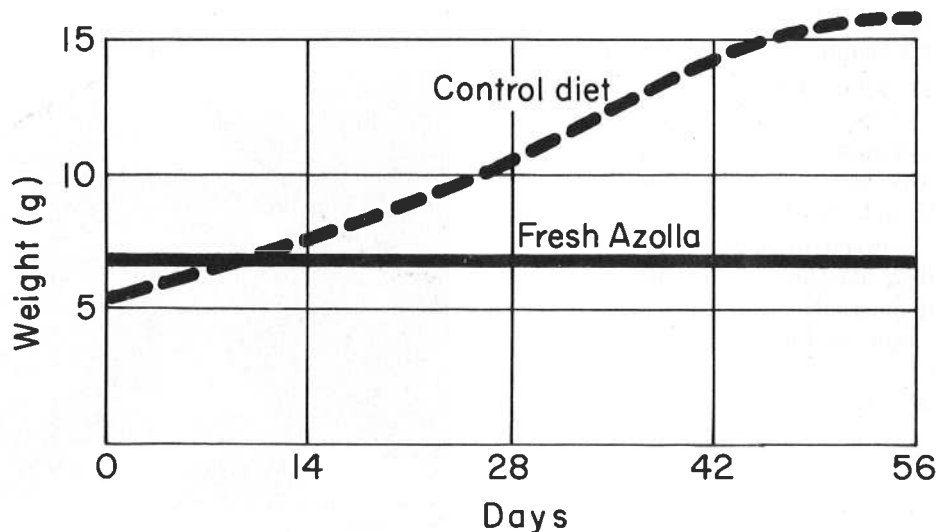
Azolla pinnata

clean. The standard assay chosen was 7 days acclimation followed by 28 days growth fed at 5% body weight/day. The first assays used fresh *Azolla* alone. Fish with an average initial weight of 6.8 g weighed 6.9 g after 28 days and only 7.0 g after 49 days feeding with an

excess of fresh *Azolla*. Feeding at 10% and 20% body weight/day gave almost identical results. This lack of growth is perhaps not surprising. *Azolla* probably lacks essential macro- and micronutrients. It is also 92-95% water which must add significantly to the water excretory load for a freshwater fish such as tilapia—one of the energy-consuming features of osmoregulation.

Therefore, it seems that Nile tilapia cannot thrive on fresh *Azolla* alone: a result which appears to disqualify the use of fresh *Azolla* in integrated farming systems with this and possibly with other microphagous tilapias. Macrophyte feeders such as *Tilapia zillii* and *Tilapia rendalli* may respond differently to fresh *Azolla*.

Dried *Azolla*, however, could be a useful food even for microphagous tilapias, provided that there are no deficiencies with respect to essential amino acids,



Growth of Nile tilapia fed on fresh *Azolla* even when fed in excess was negligible against that on the control diet fed at 5% body weight using the standard nutritional bioassay developed during the ICLARM-IFDR project.



Nile tilapia (*Oreochromis niloticus*)

essential lipids and micronutrients. In the current series of assays dried *Azolla* is being used in a variety of test diets compared with the IFDR diet as a control. Parallel studies are in progress giving single *Azolla* test meals to individual fish and following their passage through the gut with measurements of the well-known acid secretion cycle of the tilapia stomach. The stomach acidity can be measured with narrow range pH papers. The results of the dried *Azolla* assays are eagerly awaited not only by the project team but also by fish feed manufacturers. ●