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Use of Waterhyacinth in Feeding Trials with Matrincha (*Brycon* Sp.)

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ABSTRACT

Experiments have been conducted to test the potential of diets containing different amounts of waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) meal as food for matrinchã (*Brycon* sp.). A recirculating system was used in the feeding trial (200 fish in each tank). Two diets with a similar protein content but with different percentage of waterhyacinth were tested and compared with a control ration. In 90 days, fish fed on a diet containing 9.5% of waterhyacinth (34.9% protein) grew from 87.9 to 208.0 g (1.2 g/d). The food conversion factor was 1.7. Fish fed on a second diet (18.9% waterhyacinth, 34.0% protein) grew during the same period from 84.5 to 190.3 g (1.1 g/d). The conversion factor was 1.8. Fish fed on a control ration (0% waterhyacinth, 34.0% protein) grew from 89.3 to 190.2 g (0.9 g/d). This experiment indicates that matrinchã grow well when fed diets containing waterhyacinth and apparently are not adversely affected by the addition of this material to the ration.

INTRODUCTION

The waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) is one of the most troublesome aquatic macrophytes in

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tropical and subtropical areas throughout the world (10, 15, 16). In the Amazon river system it is one of the many macrophytes which form floating meadows, however the annual fluctuations in water level of the Amazon river system (up to 15 m) prevent the massive development of the waterhyacinth as in other tropical regions (6). Where the natural fluctuation of water level is disrupted, as for example at the new hydroelectric dam of Curua-Una near Santarém, plant development in masses may occur (Junk, pers. comm.).

Studies of the chemical composition of the Central Amazonian macrophytes indicated their importance as nutrient reservoirs (4), and Junk (7) discussed their potential use for agriculture. The literature of all important aspects of utilization of aquatic plants is reviewed by Little (11). However, there is little information on the utilization of aquatic plants by fish.

Matrinchã (*Brycon* sp.), an indigenous species from the Amazon, is considered to be omnivorous, feeding on fruits, seeds, leaves, and insects (12). Studies by Goulding (2) indicated that this species prefers plant material when available. Preliminary feeding experiments conducted at INPA had shown promising results (18). The object of these experiments was to test the potential of diets containing different amounts of waterhyacinth meal as food for matrinchã.

MATERIAL AND METHODS

Young matrinchã alevins (average 1.5 g) were collected with seine nets in floating meadows close to Manaus (see (6) for a detailed description of those meadows). The fish were transported to INPA's fish culture station in fiberglass tanks with supplementary oxygen. The fish were acclimated to the holding conditions for several weeks before the experiment.

The feeding trials were carried out in a commercial system of suspended cloth ponds (Wasser-Chemie & Technik KG, K. Schunke, Bergheim, Federal Republic of Germany), consisting of 4 ponds of 3.5 m³ of water content each (type HTT 600), which were connected to a water treatment unit thus forming a recirculating system. The total water volume of the system was 16 m³, the turnover time was 1.5 hrs.

The daily changes of temperature and electric conductivity were determined with a WTW Chemograph LF 256 E, the oxygen content with a WTW Chemograph Oxi 256 XE.

Each tank was stocked with 200 fish and there was no significant difference between the mean weights of the fish in each tank. Fish were fed several times a day to a total of 1.5% of the body weight daily during 90 days. Once a month 50 fish were measured, and mortality was determined by counting the total number.

Most of the waterhyacinth needed could be collected from those colonies which were used as a shelter for the fish in the ponds. Occasionally this had to be supplemented with plants. The whole plants were sundried for approximately 7 days. However rainfall sometimes prolonged the drying process. During this time, the initial water content of about 96% by weight, diminished to an average final content of 12.8%. The dried plants were cut and grounded with a chaff-cutter (screen size 5 mm) and the meal was then used as an ingredient of the test diets.

Nitrogen was measured by Micro-Kjeldahl digestion. Crude protein was calculated as Kjeldahl N x 6.25. Crude fat was measured following continuous petrol ether extraction for 18 hrs in a Soxleth apparatus and crude fiber was determined by the Pearson method (14). The moisture content was calculated after heating the material for 24 hrs in an oven at 110 C. Ash values were obtained by burning samples at 540 C in a muffle oven for 3 hrs. The total energy of the diets was calculated (3). The crude nutrient analyses and the composition of the pelleted diets used are summarized in Table 1.

TABLE 1. COMPOSITION OF THE CONTROL AND THE WATERHYACINTH DIETS USED IN THE FEEDING TRIAL WITH MATRINCHA (*Brycon* SP.).

Analysis (%)	% waterhyacinth in the ration		
	0	9.5	18.9
Crude protein	34.0	34.9	34.0
Crude fat	8.0	7.4	7.5
Crude fiber	4.4	5.2	6.7
Ash	13.4	8.6	11.3
Moisture	5.0	5.2	6.1
N-free extract	35.2	38.7	47.8
Kcal/100 g[a]	430	447	486
Diet composition (%)			
Fishmeal	27.3	27.3	27.3
Wheatmeal	5.0	5.0	5.0
Soybean meal	34.5	31.2	31.2
Cornmeal[b]	27.8	21.6	12.2
Soybean oil	4.7	4.7	4.7
Waterhyacinth meal	0	9.5	18.9
Vitamin mixture[c]	0.5	0.5	0.5
Mineral mixture[d]	0.1	0.1	0.1

[a] Calculated (3).
[b] Precooked.
[c] Vitamin mixture contains in 5 g: 2500 I.E. vitamin A; 500 I.E. vitamin D_3; 150 mg vitamin E; 1 mg vitamin K_3; 50 mg vitamin B_1; 150 mg vitamin B_2; 35 mg vitamin B_6; 75 mg vitamin B_{12}; 500 mg vitamin C; 2.5 mg vitamin H; 1.75 g Choline; 500 mg Inositol; 350 mg p-Aminobenzoic acid.
[d] Mineral mixture contains in 1 g: 202 mg Ca; 101 mg P; 70 mg Fe; 0.5 mg Mg; 26 mg Na; 15 mg S; 41 mg Cl; 4 mg Cu; 4 mg Co; 17 mg Mn; 114 Mg Zn; 2 mg I; 0.5 mg K.

RESULTS

Daily changes of temperature and electric conductivity in the recirculating system during the feeding trial are shown in Figure 1. Conductivity rose with increasing residence time of the water in the system. The decrease on sampling days indicated by arrows in the figure, is due to the partial water exchange of the system. The water temperature during the experiment at noon was 25.9 ± 0.1 C while the average air temperature was 28.0 ± 0.2 C. The pH varied between 4.6 and 5.7. The average oxygen concentration of the inlet water was 5.7 ± 0.1 mg/l, which equals 70.4% of saturation. The minimum oxygen concentration, measured at the tank outlet did not reach values lower than 2.6 mg/l. Nitrite concentrations never exceeded 0.5 mg/l.

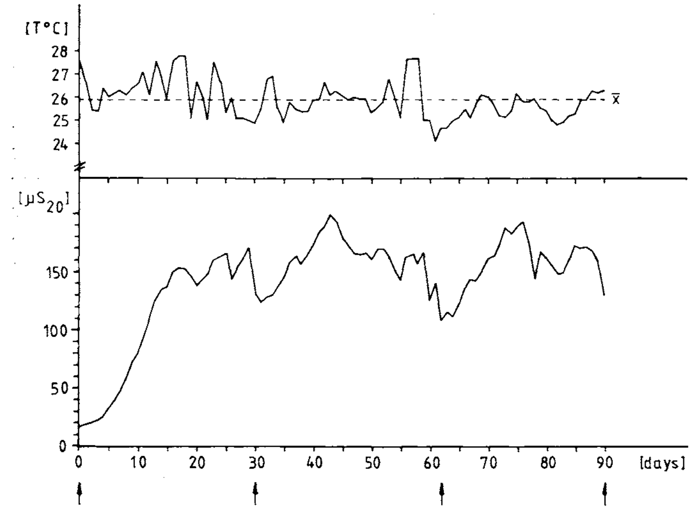

Figure 1. Daily changes of temperature and electric conductivity in the recirculating system during the feeding trial with matrinchã (*Brycon* sp.). The arrows indicate a partial water exchange at measuring days.

The growth rates are presented in Table 2 and 3. The fish fed the control diet grew from 89.3 ± 4.5 g to 190.2 ± 8.9 g. Individual weight gain was 100.9 g (0.9 g/d), corresponding to a specific growth rate (5) of 0.8%/d. The food conversion was 1.9. The fish fed the 9.5% waterhyacinth diet grew from 87.9 ± 3.9 g to 208.0 ± 8.8 g, corresponding to an individual weight gain of 120.1 g (1.2 g/d). The specific growth rate was 1.0%/d and the food conversion 1.7. The growth rate of the group fed the second test diet containing 18.9% waterhyacinth was 105.8 g individual weight gain (1.1 g/d), with a food conversion of 1.8. There was no significant difference at the 5% level in the initial and final mean weights of the three groups. The theoretically calculated weight-growth curves are presented in Figure 2.

Protein efficiency ration (PER), growth efficiency and conversion factor are presented in table 2. The best protein efficiency ration, defined as weight gain/unit time/quantity protein fed, was by the fish fed with the 9.5% waterhyacinth diet. The growth efficiency factor K_2 (13, 22) also gave best results for the 9.5% diet. Seventy-five percent of the diet was utilized by fish for weight gain. The other diets obtained slightly inferior values. The conversion factor which gives the weight gain per energy unit (Kcal) fed showed similar values for all diets.

The length-weight relationship of all fish during the experiment can be represented by

$$W = 0.0068 \cdot L^{3.2830}$$

TABLE 2. RESULTS OF THE FEEDING TRIALS WITH MATRINCHA (*Brycon* sp.).

Parameters	% waterhyacinth in the ration: 0	9.5	18.9
Stocking			
Initial number	200	200	200
Initial number	89.3±4.5	87.9±3.9	84.5±4.2
Initial weight ± SE (g)	17,860	17,580	16,900
Yield			
Final number	177	179	185
Final weight ± SE (g)	190.2±8.9	208.0±8.8	190.3±9.9
Total weight (g)	33,665	37,232	35,206
Individual weight gain			
Weight gain	100.9	120.1	105.8
Weight gain/day (g)	0.9	1.2	1.1
Specific growth rate (%/d)[a]	0.8	1.0	0.9
Mortality			
Number[b]	23	21	15
Percentage	11.5	10.5	7.5
Food utilization			
Number of feeding days	90	90	90
Daily ration as percentage of body weight	1.5	1.5	1.5
Total diet fed/fish (g)	185.0	200.2	192.4
Food conversion	1.9	1.7	1.8
P.E.R.[c]	1.60	1.72	1.62
Growth efficiency K_2[d]	0.68	0.75	0.69
Conversion factor (g/Kcal)	0.13	0.13	0.11

[a] Specific growth rate $= c(\sqrt[n]{\frac{W_n}{W_o}} - 1) \cdot 100$ (5).
[b] Including 6 fish of each group taken for analysis.
[c] Protein efficiency ration.
[d] $K_2 = \frac{\Delta W}{\Delta t \cdot 0.8 \cdot R}$ (22).

with r = 0.9671 (n = 599).

The condition factor

$$K = \frac{W \cdot 100}{L^{3.283}}$$

was calculated and, supposing that heavier fish of the same length are better conditioned (17, 20), compared between different groups. There was no significant difference at the 5% level in the initial of final condition factor of the three groups. Following the definition of K, all fish of the three test groups were in the same condition (Table 4).

DISCUSSION

There are two principal ways for utilizing aquatic plants

TABLE 3. TOTAL LENGTH AND WEIGHT GROWTH ($\bar{x}$ ± SE) OF MATRINCHA (*Brycon* SP.) DURING THE FEEDING TRIAL WITH WATERHYACINTH DIETS. VALUES WERE DETERMINED ON 50 INDIVIDUAL FISH FOR EACH DIET AND TIME PERIOD.

Feeding days	0% waterhyacinth: total length (cm)	0% waterhyacinth: weight (g)	9.5% waterhyacinth: total length (cm)	9.5% waterhyacinth: weight (g)	18.9% waterhyacinth: total length (cm)	18.9% waterhyacinth: weight (g)
0 (02/13/80)	18.3±0.3	89.3±4.5	18.1±0.3	87.9±3.9	17.9±0.3	84.5±4.2
30 (03/13/80)	19.4±0.3	118.5±4.5	19.5±0.2	118.0±4.0	19.9±0.3	128.0±6.1
62 (04/04/80)	20.6±0.3	144.8±6.5	20.8±0.2	152.7±5.4	21.0±0.2	149.5±5.0
90 (05/12/80)	22.1±0.3	190.2±8.9	22.6±0.3	208.0±8.8	22.2±0.4	190.3±9.9

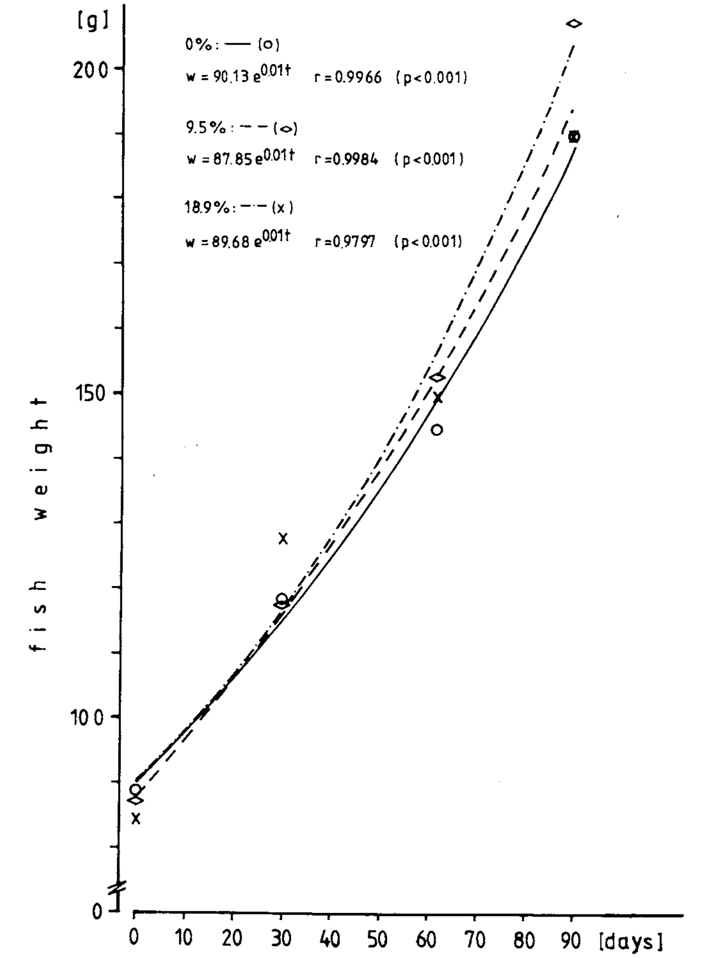

Figure 2. Weight-growth curve of matrinchã (*Brycon* sp.) fed with a control diet and a 9.5% and a 18.9% waterhyacinth diet respectively.

as fish food. The first is the use of herbivorous animals which eat the whole plant. Singh *et al.* discussed the efficiency of the grass carp (*Ctenopharyngodon idella,* Valenciennes, 1844) utilizing aquatic weeds in India (19). He pointed out that the fish did not feed on waterhyacinth, however in Thailand, grass carp were observed feeding on young roots and leaves of the waterhyacinth (9).

The second possibility is the utilization of aquatic plants as ingredients in rations. The successful use of sun-dried waterhyacinth as supplementary food for milkfish (*Chanos chanos,* Forskal, 1755) in the Philippines has been described (21). Liang and Lovell (8) tested the nutritional value of waterhyacinth in channel catfish (*Ictalurus punctatus,* Rafinesque, 1818) feeds. They used a protein extract

TABLE 4. CHANGES OF THE CONDITION EACTOR[1] OF MATRINCHA (*Brycon* SP.) DURING THE FEEDING TRIALS WITH WATERHYACINTH.

Feeding days	% waterhyacinth in the ration		
	0	9.5	18.9
0	0.62 ± 0.01	0.64 ± 0.004	0.63 ± 0.01
30	0.69 ± 0.01	0.68 ± 0.01	0.69 ± 0.02
62	0.69 ± 0.01	0.71 ± 0.01	0.69 ± 0.01
90	0.71 ± 0.01	0.72 ± 0.01	0.70 ± 0.01

[1] $K = \frac{W \cdot 100}{L^{3.283}} \pm$ SE

which was fed in increasing amounts until it constituted 40% of the fish diet. Best results were found using waterhyacinth added at a rate of 5 to 10% as a supplement to vitamin deficient diets.

Junk (7) was the first to suggest the addition of sun-dried, ground macrophytes to diets for Amazonian fish species. Results of initial trials with matrinchã indicated good growth rates, but the mortality during the experiment was so high that a repetition of the trial became necessary (18).

The fish fed in these studies on diets containing waterhyacinth showed identical growth rates as the control ration. Only the food conversion was slightly higher than in the initial studies, but this may be attributed to a higher quantity of food fed to the fish per day. The daily ration in the first trial was 0.8 to 1.1% of the body weight while in the second trial it was 1.5%.

Detailed studies on the tannin content of aquatic plants showed that high concentrations interfere with protein digestibility (1). As no negative effect on weight gain or other factors such as conversion rate were obtained in our experiments, it is concluded that matrinchã probably are not adversely affected by such chemicals in their diets. However, only long term experiments will prove whether this assumption is correct.

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