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E.D. Abarike

Department of Fisheries & Aquatic
Resources Management, University for
Development Studies, P. O. Box TL
1882, Tamale-Ghana.

C. F. Atsu

Department of Forestry and Forest
Resources Management, University for
Development Studies, P. O. Box TL
1882, Tamale-Ghana

E.H. Alhassan

Department of Fisheries & Aquatic
Resources Management, University for
Development Studies, P. O. Box TL
1882, Tamale-Ghana

Novel feed for fingerlings of *Oreochromis niloticus*

E.D. Abarike, C. F. Atsu, E.H. Alhassan,

ABSTRACT

A five week study was to observe the performance of *Oreochromis niloticus* fingerlings stocked in hapas and fed on Mango leaf meal a pond. *Oreochromis niloticus* of average weight 8.49 g were fed with mango leaves and compared to farm feed. Fish fed on the farm feed recorded significantly higher weight, 20.73 g than fish fed on the Mango leaves with an average weight of 11.23 g. Mean weight gain, specific growth rate and survival rates were higher for fish fed the farm feed but not significantly different as feed conversion ratio was higher and significantly different among treatments. It cost less to produce a kilogram of Mango leaf meal than that of farm feed. Temperature, turbidity and pH were not adversely affected by the use of Mango leaves. Mango leaves can be used as supplementary feed and incorporated in the formulation of farm feed for the raising *O. niloticus*.

Keywords: Mango leaves, Incidence cost, Profit index, Weight gain, fingerlings.

1. Introduction

The ever increasing need for cheap sources of protein to meet the world's growing population problem has in recent times increased the need for fish farming^[1, 2]. Aquaculture has grown to become the panacea of fish production to the fishery industry. Rapid growth in the aquaculture industry has helped to alleviate some of the human dependence on depleted natural fish stocks^[3]. Although fish forms an important component of the diet of many people in Ghana, farther away from the coast of Ghana, fish is relatively scarce and expensive. This situation is worse within the rural settlements of Northern Ghana. With requisite information on proper management; dugouts, small reservoirs and large inland water bodies in Northern Ghana, has the potential of increasing the availability of fish through fish farming^[4]. However, fish farming is still at its infancy, paramount among the constraints to its growth and development is the absence of nutritionally rich low cost feed^[5].

Novel feed has being the fore of many researchers^[1, 6, 7]. With the omnivorous nature of *O. niloticus*, mango leaves have the potential of being used as a feed item because it is nutritionally rich, very abundant and not widely used perhaps due to inadequate knowledge about its potential use as feed. Therefore the study looks at the potential of using mango leaves as a supplementary feed for fingerlings of *O. niloticus*.

2. Materials and Methods

2.1 Study site

This study was carried out at Tono in the Kassena-Nankana Municipality of the Upper East Region. Tono is located in the Guinea Savannah ecological zone of Ghana. Its lies on geographic coordinates 10° 51' 21.47" N, 1° 07'04.79" W.

2.2 Procurement of feed item

Dried mango leaves were collected from mango plantations in the Nyankpala locality, crushed into powder at the mill and stored in a bag while farm feed was the feed that was used on the farm at the study site.

2.3 Chemical analysis of feed item

Proximate analyses of feed item was carried out at the biology laboratory of the University for Development, Nyankpala campus to determine percentages of **crude protein** (CP), **ether extract** (EE), **ash**, **crude fibre** (CF) and **moisture content** following the procedures that broadly adhere to the Association of Official Analytical Chemists [AOAC] (1990) cited in^[6].

Correspondence:**Ajibare AO**

Department of Fisheries & Aquatic
Resources Management, University
for Development Studies, P. O. Box
TL 1882, Tamale-Ghana.

2.4 Experimental system and fish

The experiment was carried out in out-door hapas (mosquito net sew into a cuboid like structure) a set in an earthen pond at Tono. Six (6) fine mesh hapas of dimension (3 m × 1 m × 1 m) were installed in the pond (50 m × 40 m) in triplicate such that three quarters (¾) of the height of the hapas were submerged and one quarter (¼) above the water surface to prevent the fish from escaping. The hapas were suspended by means of nylon ropes tied to tree poles, inserted into the bed of the pond. Fingerlings of *O. niloticus* with average weight (8.49 g ± 0.02) were obtained and were bulk weighed with a digital scale (model DIGI DS 671) and stocked in triplicate groups at 5 fingerlings per meter cube in well labelled hapas.

2.5 Feeding regime

Fish were fed three times daily at 0800, 1200 and 1600 GMT and at 30% of their body weight. After every 1 week, fingerlings from each replicate were collected, weighed and the average wet weight recorded. Based on the weight measurement, feed was adjusted accordingly. The total quantity of feed used was also recorded.

2.6 Biological parameters

Based on the measurements, the following biological parameters were calculated.

2.6.1 Mean Weight gain (MWG)

Weight gain was the total weight gained with time. It was calculated as

$$\text{MWG} = \text{final mean weight (kg)} - \text{initial mean weight (kg)}^{[8]}$$

2.6.2 Specific growth rate (SGR);

Specific growth rate (SGR): This was computed as:

$$\text{SGR} = \frac{\ln W_2 - \ln W_1}{T} \times 100 \quad [8]$$

Where,

W_1 is the initial weight (g) at stocking;

W_2 is the final weight (g) at the end of experiment;

$\ln W_2 - \ln W_1$ is the natural logarithms of both the final and initial weight of fish;

T is the duration (in days) of trial

2.6.3 Survival rate

Survival of fish depends on the type of fish, water quality parameters, feed and environmental conditions. Survival rate (SR) was calculated as:

$$\text{SR} = \frac{\text{Initial number of fish stocked} - \text{Mortality}}{\text{Initial number of fish stocked}} \times 100 \quad [9]$$

2.6.4 Feed conversion ratio (FCR)

Feed conversion ratio was calculated as:

$$\text{FCR} = \frac{\text{Total feed given}}{\text{Total weight gain by fish}} \quad [8]$$

2.7 Water quality parameters

Temperature, conductivity and pH was determined by using HANNA pH meter (model HI 83141). This was done by dipping the electrode of the thermometer attached to the pH meter to a depth of 30 cm along each respective hapa for 20-30 seconds. The values displayed on the screen were carefully recorded to nearest degree Celsius (°C). This recording was done thrice per parameter and the mean value recorded as the value of the water quality parameter measured at that time. Turbidity was measured using a field turbid meter (model: LaMotte 2020). Water sample from each hapa was collected using a 3 mm glass container and sealed. The sample was fixed in the turbid meter and closed and allowed to analyze. The values displayed on the screen were recorded. This was done for all replicates for each treatment.

2.8 Economic analysis of feed

The cost effectiveness of diets used in a feed trial was calculated using market prices, taking into consideration the cost of feed and the transport fare with the assumption that all other operating costs remained constant (e.g. cost of constructing hapa, cost of fingerlings and labour) [6]. Indices computed for were incidence cost (IC) and profit index (PI)

2.8.1 Incidence cost

It was calculated as:

$$\text{IC} = \frac{\text{cost of feed}}{\text{Weight of fish produced}} \quad [5, 6]$$

2.8.2 Profit index

Profit index was calculated as:

$$\text{PI} = \frac{\text{Weight or value of fish produced}}{\text{Cost of feed}} \quad [5, 6]$$

2.9 Data analysis

Data was computed into averages using Microsoft excel for all parameters measured and a t-test conducted to determine the significant differences between the parameters.

3. Results

3.1 Chemical composition of feed ingredient

Table 1 below shows the proximate analysis of the mango leaves conducted in the laboratory. T- Test conducted for the feed items showed that crude protein was higher (36%) in farm feed ($P < 0.05$), indicating that it was highly significantly different from mango leaves. Crude fibre was higher (26.8 %) in mango leaves and highly significantly different ($P < 0.05$) from farm feed. Crude lipid was lower (3.2%) in mango leaves and significantly different ($P < 0.05$) from farm feed. Moisture was higher in commercial and significantly different ($P < 0.05$) from mango leaves. Farm feed contained the highest amount of ash and significantly different ($P < 0.05$) from mango leaves

3.2 Biological parameters

Growth of the fingerlings was measured weekly, with the experiment lasting for five (5) weeks. Table 2 indicate that, the average initial weights (AIW) of the test fish varied slightly but was not significantly ($P > 0.05$) different from each other. Upon termination of the experiment, the average

final weights (AFW), mean weight gain (MWG), specific growth rate (SGR) and percent survival rate (%SR) was higher for test fish fed the farm feed compared to the test fish fed on mango leaves but were not significantly ($P > 0.05$) different.

It is worth noting that survival for both treatments were below 50%. Feed conversion ratio (FCR) were significantly ($P < 0.05$) different for the test fish. Fish fed farm feed had higher FCR than those feed with mango leaves.

Table 1: Chemical analysis of test feed

Parameter	Mango Leaves (Parameter ± SEM)	Farm feed (Parameter ± SEM)	P-Value	Significance
% Crude protein	8.73 ± 0.09	36 ± 0.00	< 0.00	S
%Crude lipid	3.2 ± 0.32	5 ± 0.00	< 0.00	S
% Crude fibre	26.8 ± 0.88	3 ± 0.00	< 0.00	S
%Moisture	4.95 ± 0.26	10 ± 0.00	< 0.00	S
%Ash	11.14 ± 0.6	13 ± 0.00	< 0.00	S

Where: NS= non- significance difference, S = significance difference and SEM= standard error of mean. T=test for significance

Table 2: Growth parameters

Growth parameters	Mango leaves	Farm feed	P-value	Sign.
Average initial weight at stocking (AIW)	8.49 ± 1.46	8.56 ± 0.29	0.973	NS
Average final weight (AFW) at the end of experiment	11.79 ± 1.57	20.30 ± 3.53	0.214	NS
Mean Weight gain	3.3 ± 0.30	11.74 ± 3.32	0.145	NS
Specific growth rate (SGR) %	0.97 ± 0.13	2.3 ± 0.41	0.091	NS
Survival rate %	24.45 ± 9.69	33.28 ± 12.72	0.653	NS
Feed conversion Ratio(FCR)	1.14 ± 0.15	3.56 ± 0.01	0.000	S

Where: NS= non- significance difference and S = significance difference

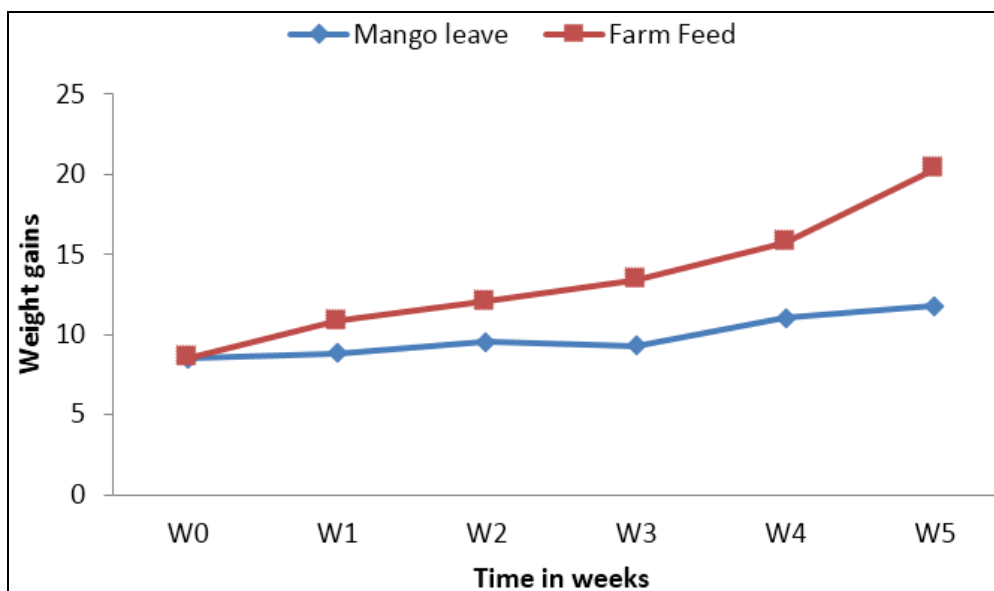


Fig 1: Growth performance of *O. niloticus*

In the figure above, growth of the test fish showed a gradual increase in weight gain for test treatment (test fish fed on mango leaves meal) and the control (test fish fed on farm feed). Although the test fish for both treatments started at the same level (average initial weight), growth was superior for fish fed on the control feed.

3.3 Water quality parameters

Table 3 shows the minimum, maximum and mean water quality parameters recorded during the five weeks of the experiment. Temperature values recorded for water in which mango leaves feed was administered showed slight variations compared with those fed with farm feed, though they were not

significantly different ($P > 0.05$). Changes in pH recorded in this study ranged from 6.76 to 8.00 indicated that, pH was between slightly acidic (6.76) to slightly alkaline (8.29) for mango leaves. pH recorded for commercial leaves showed that it was not significantly different ($P > 0.05$) from the mango

leaves. Turbidity recorded for the experimental period for both mango leaves and farm feed was below 50 NTU though there was no significant difference ($P > 0.05$) between them, farm feed was slightly higher. Conductivity was slightly higher for commercial but was not significantly different from the mango leaves.

Table 3: Water quality parameters

Parameter	Mango leaves Mean \pm SEM (range)	Farm feed Mean \pm SEM (range)	P-value	S / NS
Temperature °C	23.17 \pm 0.75 (20.70 - 26.03)	23.20 \pm 0.76 (20.55 - 26.30)	0.881	NS
pH	7.59 \pm 0.18 (6.76 - 8.00)	7.66 \pm 0.14 (7.4 - 8.29)	0.731	NS
Turbidity NTU	21.22 \pm 2.7 (14 - 32.67)	22.17 \pm 2.36 (16.33 - 31.67)	0.288	NS
Conductivity S/m	57.59 \pm 8.03 (33.33 - 78.77)	58.94 \pm 8.99 (31.33 - 81.33)	0.680	NS

Where: NS = non-significance difference and S = significance difference and SEM= standard error of mean

3.4 Economic analysis

With the assumption that all other operating costs remained constant e.g. cost of constructing hapas, cost of fingerlings and labour, the incidence cost (IC) and profit index (PI) were computed. As shown in Table 4, the cost per kilogram of feed was highest for fish fed on farm feed (GH¢ 2.5) and lowest for fish fed on mango leaves (GH¢ 1.10). Total Feed administered

was highest for fish fed with farm feed (3.3 kg) and lowest for group of fish fed with mango leaves (2.3 kg). Between mango leaves and farm feed, farm feed recorded significantly ($P < 0.05$) the highest incidence cost (IC) (0.41 \pm 0.01) than mango leaves (0.21 \pm 0.01). The profit index (PI) was significantly higher ($P < 0.05$) for fish fed on mango leaves (4.71 \pm 0.01) than for fish fed on farm feed (2.46 \pm 0.01).

Table 4: Economic analysis of feeds

Parameter	Mango leaves	Farm feed
Total feed produced (kg)	4.6	22
Cost/kg (GH¢)	1.10	2.5
Total feed used (kg)	2.3	3.3
Incidence cost (IC)	0.21 \pm 0.01 ^b	0.41 \pm 0.01 ^a
Profit index (PI)	4.71 \pm 0.01 ^a	2.46 \pm 0.01 ^b

T-test for significance

4. Discussions

From Table 2, average final body weight was highest for fish fed on farm feed (20.30 g) and lowest (11.79g) for groups of fish fed on mango leaves. The increase in these growth parameters for *O. niloticus* fed with farm feed was because; it contained the highest crude protein level (36%). However, the average performance of *O. niloticus* fingerlings fed on mango leaves could also be attributed to its low crude protein percentage level of the feed. This agrees with ^[10] who reported that, weight gain increases with increasing dietary protein.

From Figure 1, the slight decline in the growth trend in week three of group of fish fed on mango leaves can be ascribe to sampling error. The best feed conversion ratio (FCR) obtained from mango leaves feed treatment suggests better feed utilization. This confirms the findings of ^[11] who reported that, the lower the FCR, the more efficient the conversion efficiency (i.e. better utilisation of the feed by the fish). Survival rates (SR) recorded was below 50% for both feed

administered. The lower SR recorded for both treatments can be connected to high mortality rates due to handling stress. This is in line with ^[12] who reported mortalities during the experimental period were subjected to handling stress and predation.

Average water temperature of the two treatments recorded ranged between 20 °C and 27 °C indicating they were within optimum range for survival of *O. niloticus*. Hence, the water was not affected negatively by the treatments administered. These values are confirmed in the report by ^[13] that the temperatures for Nile tilapia to survive range between 11-12 °C and 42 °C.

Changes in pH ranged between 6 and 9, showing they were slightly acidic (6.76) to slightly alkaline (8.29). A pH range of 7 (neutral) to 8 (basic) as optimum is recommended for the culture of *O. niloticus* ^[14]. Ross (2000) also reported that tilapia can survive in pH ranging from 5 to 10 but do best in a pH range of 6 to 9. Because turbidity recorded for the

experimental period was below 50 NTU, there were no observed effects of turbidity (14 to 23 NTU) on growth of *O. niloticus*. This confirms the study by ^[15] who reported that turbidity greater than 50 NTU reduced growth rate of the Jamaica Red. Generally, the ineffectiveness of the feed to affect the water quality parameters can be attributed to the periodic replenishment of the water in the earthen pond.

The calculations of economic efficiency depended on the average price of dietary ingredients in year 2013. The calculated figures in this experiment showed that the incidence cost was significantly ($P < 0.05$) higher for farm feed. This could perhaps be attributed to the high cost of feed. This confirms ^[16] who reported higher FCR values for *O. niloticus* fed on a commercially prepared diet. From Table 3, Profit index was significantly ($P < 0.05$) higher for the mango leaves and this proved to be profitable and economical, compared to the farm feed administered because it had the highest PI value. This also confirms ^[17, 5, 6] who reported that, the lower the IC values in the use of a diet, the higher profit index (PI) and the higher the returns.

5. Conclusion

Performance of *Oreochromis niloticus* increase weekly when fed with mango leaves. Feed conversion ratios, specific growth rate and survival rates were not affected by mango leaves administered in this study. In addition, water quality parameters recorded in this study did not affect the growth of fry of *O. niloticus* adversely. Economic analysis showed it would be economically wise to use mango leaves.

6. Recommendation

It is recommended that mango leaves, though has a lower crude protein level, can be mixed with other materials to help boost fish growth rate. This will not only boost fish production but also serve as means of utilizing mango leaves. There is the need for further studies to be carried out in a controlled tank to observe digestibility of Mango leaves by *O. niloticus* and other widely cultured fish to ascertain the extend of utilization for maximum benefits to the ripped from the novel sources of feed.

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