THE NUTRITIVE VALUE OF WATER HYACINTH (*Eichhornia crassipes*) AND ITS UTILISATION IN FISH FEED

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ABSTRACT

Analyses of five different parts of water hyacinth, viz.: leaves, petioles, roots, whole plant without roots and whole plant were carried out at NIFFR Central Laboratory. This is to evaluate their potentials in animal feed composition.

The proximate analysis shows that the moisture content ranged from 92.13% in the roots to 85.15% in the leaves with a mean of 90.39%. The ash content ranged from 39.80% in the roots to 16.79% in the leaves. For the crude lipids, the least value of 1.24% came from the roots while the petioles had the highest value of 2.10%. The percentage crude fibre ranged from 12.15 in the roots to 21.97% in the whole plant without the roots with a mean value of 14.41%. The percentage crude protein ranged from 7.11 in the petioles through 7.67 in the whole plant to 15.27% in the leaves. The leaves therefore had almost twice the values obtained for the other parts of the plant.

Using water hyacinth leaves to formulate feed might increase the crude protein level of the feed and might aid in the digestibility of the feed. Its crude protein level compares favourably with the crude protein content of cassava leaves, potato leaves and pawpaw leaves and could be used to replace those leaves in fish diet.

The mineral composition showed that the whole plant without the roots had more potassium (K^+) closely followed by the petioles. Sodium (Na^+) was however highest in the petioles.

INTRODUCTION

Since the emergence of water hyacinth to Nigerian water bodies in 1984 through the Benin Republic (via Port Novo Creek), the weed had continued to plague the coastal waters and other riverine areas of Lagos, Ogun, Ondo, Delta and Edo States (Akinyemiyu, 1987). Shortly after this surge, the plant was further reported on Kainji Lake with the continued arrival of the weed with the annual flood from the upper reaches of River Niger in Mali and Niger where the established water hyacinth had not been controlled (Ayeni and Daddy, 1994).

Water hyacinth is a pleustophytic hydatophyte, a cosmopolitan aquatic weed which can tolerate a wide range of environmental conditions such as temperature, illumination, pH, salinity, wind, current and drought. The plant is morphologically very plastic with a rapid mode of vegetative propagation which makes it well adapted to long distance dispersal and successful colonization of diverse ecological niches. It is one of the most prolific aquatic plants which spreads at an alarming rate having spikes of large blue flowers and roundish leaves with inflated bladder - like petioles.

The disadvantages associated with this alarming growth rate include nuisance to fisheries, water transportation (navigation), blocking of water supply system and hydro-electric power generation. This plant however has some positive uses. Studies have shown that the plant serves as industrial raw material for paper making, biogas production, organic manure (compost), potash and fish feed formulation (Little, 1979). Also, in its natural form and at low infestation, it serves as fish food, where herbivorous fishes are stocked and cultured in combination with other non-predatory species to promote the growth of fish (Ling, 1960). In China for example, presence of small quantities of water hyacinth is encouraged in fish ponds because fish find food among the roots. The use of water hyacinth in fish feed will reduce the present dependence on other competitive agricultural crops used in compounding feeds. Fish feed is expensive and can account for 60% of the variable cost in a fish culture operation and this has forced nutritionists to consider alternative sources of plant based protein source such as Soy beans, groundnut cake and others at low cost for fish (Akinyama, 1988).

To enhance the full utilisation of this weed, the evaluation of its nutritive value in this study has the following objectives:

i. To determine the chemical composition of the various parts of the water hyacinth.

ii. To evaluate based on its nutritive value, its potentials in fish feed.

MATERIALS AND METHODS

Experimental Site

The experimental plant, water hyacinth, was harvested from the National Institute for Freshwater Fisheries Research (NIFFR), aviary which is situated in the Aquatic Weed Control Centre. Samples of the plant were collected from the open clean concrete tanks without any form of fertilisation. The plants were taken to the Institute's Central Laboratory for analyses. The plant was categorised into five samples, viz. leaves, petioles, roots, whole plant without roots and whole plant.

Laboratory Analyses

The five samples were washed thoroughly and analysed for the following:

(a) Moisture Content

Fresh samples were weighed and oven dried at a temperature of 80° C for 48 hours. The loss in weight using the formula below gave the moisture content of the original sample.

$$Moisture\ content = \frac{B-C}{B-A} x \frac{100}{1}$$

where: A = Weight of the empty beaker
B = Weight of beaker + sample before oven drying.
C = Weight of the beaker + sample after oven drying at temperature of 80°C for 24 hours (Little *et. al.* 1967).

(b) Ash Content

Known weight of each sample was subjected to a red muffle furnace at a temperature of 500°C for 6 hours. The loss in weight using the formula below gave the ash content of the original sample.

$$\text{Ash Content } (\%) = \frac{D-A}{C-A} \times \frac{100}{1}$$

where: A = Weight of the crucible

C = Weight of the crucible + sample after oven drying.

D = Weight of the crucible + Ash after oven drying at a temperature of 5000C for 6 hours.

(c) Crude Protein Content:

The crude protein content was determined using the modified micro-kjeldahl method (AOAC, 1980) using the formula below (Chow, 1980).

$$\frac{M \times 0.014 \times D \times T \times 6.25 \times 100}{\text{Weight of sample (g)}}$$

where: M = Molarity of Acid used
0.014 = Nitrogen constant per 1000 ml (wt of N_2 in g, 14 in mg)
D = Volume after dilution (100ml)
T = Titre of sample
6.25 = Protein conversion factor (1mg of N2 = 6.25mg of 100 = Percentage conversion factor.

(d) Crude Lipid/Fat Content

Each sample was subjected to petroleum ether extraction method of AOAC (1980) using Soxhlet apparatus at a temperature of 40°C for 6 hours. The formula below was used to calculate the percentage crude lipid/fat content of the sample.

$$\frac{\text{Weight of flask x Fat} - \text{Weight of Flask}}{\text{Weight of Sample (g)}} \times \frac{100}{1}$$

(e) Crude Fibre Content

This involved treating each sample with dilute sulphuric acid and dilute sodium hydroxide before subjecting it to ash content treatment at 500°C for 6 hours. The ash was weighed and the difference in weight gave the amount of crude fibre in the sample, using the formula:

$$\frac{B-C}{A} \times \frac{100}{1}$$

Where: A = Weight of the sample (g)

B = Weight of the crucible + residue after oven drying

C = Weight of the crucible + residue (ash) after oven drying.

(f) Preparation of Plant for Exchange Cation

Out of the exchangeable cations only Na^+ and K^+ were determined. A flame photometer was used to take the record of potassium ion (K^+) and Sodium ion (Na^+) after percentage emission (% E) had been determined. The potassium ion (K^+) and Sodium ion (Na^+) content in the plant tissue was calculated using the formula (AOAC, 1980).

For K^+ and Na^+ %

$$= \frac{C\ (ppm) \times \text{Solution volume (ml)}}{10^4 \times \text{Sample Weight (g)}}$$

where C = Cation reading for the sample in the standard curve.
10^4 = Constant

RESULT AND DISCUSSION

Table 1 shows the mean of percentage moisture content, crude protein content, crude lipid/fat content, fibre content, potassium ion (K^+) and sodium (Na^+) for the five samples of water hyacinth which consists of leaves, petioles, roots, whole plant without roots and whole plant. The leaves had the least moisture content of 85.15% while the roots which are constantly in contact with water had the highest water content of 92.13%. Though there was no significant difference ($P \geq 0.05$) among the replicates, the same trend was obtained by Little (1967) while working in unfertilized medium in Sudan and got the following results: 88.1, 86.7, 93.9 and 91.7% for leaves, roots, petioles and whole plant respectively. In another similar study, Little (1979) obtained a range of moisture content of 80.95% as against 85.15 – 92.13 obtained in this study.

The percentage ash content on dry matter basis of the five samples ranged from 16.79 in the leaves to 39.80 in the roots with a mean of 23.75. The high value obtained for the roots might be attributed to their direct contact and accumulation of absorption nutrients of the growing media. The root system possesses a lot of fibrious roots that aid absorption of nutrient materials from its environment. According to Boyd (1974) the concentration of most chemicals in aquatic species varies when harvested at similar stages of maturity but from different sites/ environment.

The percentage crude protein varied from 6.67 in the roots to 15.27 in the leaves with a mean of 11.79 for all the samples. The crude protein level obtained in this study is higher than the 11.7, 0.7 and 1.2 obtained by Chalmer (1968) for leaves, petioles and roots respectively. The crude protein of water hyacinth leaves is higher than that of corn grit 'maize' (10.77) (Boyd, 1969); guinea corn (11.22) and very close to palm kernel cake (19.06) (Eyo, 1994) and duck weed (26.30) (Mbagwu and Adeniji (1988). These are ingredients either taken directly by fishes or used as major ingredient in fish feed formulation.

The percentage crude lipid/fat varied from 1.24 in the roots to 2.10 in the petiole with a mean of 1.62. There seems to be not much difference in the fat content of the various samples. The petiole possesses both xylem and phloem tissues for storage and transportation of food materials and this is responsible for the high fat content. The roots showing the lowest value means that no food manufactured during photosynthesis is stored there. The mean value of the lipid content (1.67) compares favourably with the result of Hossain (1959) working with similar specimens in unfertilized water body.

The value of crude fibre varies from 12.15 in the roots to 21.97 in the whole plant without roots. The fibrous structure material present is a combined factor of petiole and leaves.

The percentage potassium (K+) of the various samples in decreasing order is 2.69, 2.58, 1.57, 1.55 and 0.31 for whole plant without roots, petioles, whole plant, leaves and roots, respectively with a mean of 1.74. Sodium gave 0.76, 0.60, 0.47, 0.31 and 0.10 for petioles, whole plant, whole plant without roots and leaves, respectively with a mean value of 0.46. Water hyacinth is effective in removing excess nutrients in a water body. It will absorb nutrient than the body can utilize (Wolverton and McDonald, 1976) and that is why the leaves are always very luxurious in a rich water body. Richard and McLean (1963) reported that the analyses of plant materials for minerals generally ranged from 0.2 – 0.5 and 0.01 to 0.05 for potassium and sodium respectively. However, when compared with the results obtained in this study, the concentration of potassium and sodium in water hyacinth could be seen to be very high. This relative high mineral content could make water hyacinth a good additive for enriching the soil and as a dietary supplement.

Table 1: Means of Percentage Moisture Content, Ash Content, Crude Protein Content, Crude Fat/Lipid Content, Fibre Content, Potassium Ion (K^+) and Sodium Ion (Na^+) of the Samples of Water Hyacinth.

Analyses	Leaves	Petioles	Roots	Whole Plant Without Roots	Whole Plant
Moisture content	85.15	91.78	92.13	91.30	91.88
Ash content	16.79	18.48	39.80	19.01	24.68
Crude Protein	15.27	9.96	6.67	7.14	7.11
Crude lipid/fat	1.56	2.10	1.24	1.90	1.31
Crude fibre	15.23	20.80	12.15	21.97	16.90
Potassium ion (K^+)	1.55	2.58	0.31	2.69	1.57
Sodium ion (Na^+)	0.10	0.76	0.37	0.47	0.60

CONCLUSION

The proximate analysis of five different parts of water hyacinth plant was determined at the NIFFR Central Laboratory. It showed that the leaves had the highest percentage of crude protein level of 15.27 while the petioles gave lowest value of 7.11. The leaves equally had lowest values for moisture, ash and crude fibre as well as potassium and sodium.

The roots were low in crude protein level (6.67) and crude fat/lipid but high in moisture and ash. This eliminates the root in any form of feed supplement. The whole plant without the roots had the highest value for crude fibre and potassium.

Most aquatic plants have good potentials as animal feed. This includes *Azolla* species and *Lemna* species. Water hyacinth seems to be very nutritive based on this study since the protein content is higher than some feed ingredients used in fish feed formulation. Fishes may not accept them directly as in *Lemna paucicostata* or *Azzolla* species but the leaves and petioles can be incorporated in animal feed to provide all the protein, crude fat and minerals required daily at very low cost. Their regular harvesting for feed formulation could aid their removal from water bodies where they obstruct navigation or where they are regarded as nuisance. The petioles and leaves of water hyacinth could be tried as one of the non-conventional feedstuff.

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