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Nutritive value of aquatic plants of Head Baloki on Ravi River, Pakistan

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Abstract

The present study was carried out at Head Baloki on Ravi river Pakistan. The nutritional potential of some selected aquatic plants including water hyacinth (*Eichhornia crassipes;* Emergent), water primrose (*Ludwigia peploides;* Emergent), Phragmites (*Phragmites australis;* Emergent), water Lilly (*Nymphea lotus;* Floating), Dalla (Cape Cod Grass; Submerged) and Vallisneria (*Vallisneria spiralis;* Submerged) were evaluated through proximate composition. Protein content was highest in leaves (11.85%) for water hyacinth, in stem (20.12%) for phragmites, in whole plant (25.4%) for water lilly and in whole plant (12.11%) for water primrose. Ash content was highest in roots (21.33%) for water hyacinth, in whole plant (12.24%) for phragmites, in leaves (13%) for water lilly and in whole plant (6.4%) for water primrose. Fiber content was highest in stems (20.80%) for water hyacinth, in whole plant (13.73%) for phragmites, in leaves (15.23%) for water lilly and in whole plant (11.13%) for water primrose. Fat content was highest in roots (4.01%) for water hyacinth, in leaves (5.4%) for phragmites, in leaves (4.32%) for water lilly and in whole plant (0.39%) for water primrose. Highest moisture was observed in leaves (6.46%) for water hyacinth, in roots (7.2%) for phragmites, in leaves (6%) for water lilly and in roots (4.3%) for water primrose. Our study suggests that these aquatic plants can be incorporated as a good source of protein and other nutrients in animals' feed. Exploitation of these aquatic plants will not only be of economic importance but would be a step toward better utilization of these plants for additional feed production. This will also help in solving the weed eradication problem.

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Introduction

Aquatic plants are of real interest from quite a few perspectives. One of these aspects is their nutritive value. These plants are used as one of the main food sources for a variety of aquatic fauna including many invertebrates such as insects, and many vertebrates such as moose, beaver, muskrat and many waterfowls etc. It simply means that aquatic plants have valuable potential as a livestock forage.

Aquatic plants grow copiously in different aquatic bodies such as lakes and waterways all around the world (Muhammed *et al.,* 2012). Some of these are floating plants, some are submerged and some are emerged ones. Aquatic plants have been employed as food by both humans as well as animals. Different parts of these edible plants are used as a source of protein and other nutrients. In previous few decades' special emphasis has been given all over the globe to explore all the possible ways to use these plants as an ingredient in animal feeds (Tacon *et al.,* 2009).

Since last few decades research has been conducted in order to prepare cost effective fish feed. This is done by making trials with incorporating cheaper protein sources in these feed. This specific research is also conducted to search for readily available and nutritious protein source. One prominent approach of these is utilizing plant sources, of both aquatic and terrestrial macrophytes. Different parts of these plants have been studied by many researchers to look for alternative less expensive sources of nutritive feed (Bairagi *et al.,* 2002, Bairagi *et al.,* 2004).

Research conducted in past have shown that these aquatic weeds contain substantial amount of proteins and minerals. As these weeds remain unutilized and also make aquatic bodies unfavorable for fish culture, these can be converted into valuable fish flesh through incorporating into fish diets. However several constraints are there, such as low protein contents, amino acid imbalance, presence of anti nutritional factors, excess amount of crude fibers in some plants and presence of cellulose, hemicelluloses and lignin (Kar and Ghosh, 2008; Khan and Ghosh, 2012). Therefore some processing means has been adopted to enhance the nutrient value of these plants' ingredients. Trials have also been made in order to increase the bioavailability of these nutrients, to reduce or remove anti nutritional factors and crude fibers and also to add certain known deficient additives required.

Pakistan is abode to quite various types of aquatic plants. Public concern that aquatic plants be removed mechanically from water rather than killing them by herbicides. It may make them available as livestock feeds in a large quantity. But their utilization as feedstuffs is dependent upon knowledge of nutrient composition of these plants, as aquatic plants vary in their chemical composition depending upon species, season and location (Eviner, 2004).

Research has been carried out throughout the world on this specific topic. Khan *et al.* (2002) in Bangladesh, Thompson *et al.* (1997) in Central England, Dewanji and Matai (1996) in India, Dewanji (1993) in India, Duarte (1992) in Spain, Banerjee and Matai (1990) at Culcatta, Linn *et al.* (1975) at Minnesota, Boyed (1970) at Savannah, and Boyd (1968) at Albama conducted studies on Aquatic plants. Despite being the vitality and abundance of such aquatic plants in the study area, not even a single study has been conducted yet. Therefore the present preliminary study was undertaken with an objective to evaluate the acceptability and nutritional effectiveness of some selected aquatic plants found at Head Baloki on Ravi river, Pakistan.

Materials and methods

Study Area

All plants were collected from Head Baloki on River Ravi which is located 65 Km away of Lahore and 15 km away of a Small city named Bhai Pharu in Punjab province of Pakistan.

Pysico-Chemical Parameters

Some physico-chemical parameters of the water from study area was also evaluated. Dissolved Oxygen (DO), Electrical conductivity (EC), Salinity, Temperature, Total Dissolved Solids (TDS), pH, Nitrate, Phosphate and Sulphate were evaluated following standard procedures.

Test Species

The species collected were Water hyacinth (*Eichhornia crassipes;* Emergent), Water primrose (*Ludwigia peploides;* Emergent), Phragmites (*Phragmites australis;* Emergent), Water Lilly (*Nymphea lotus;* Floating), Dalla (Cape Cod Grass; Submerged), Vallisneria (*Vallisneria spiralis;* Submerged) and Cuttail (*Typha latifolia;* Emergent). Whole Plants having roots, stems and flowers were preferred during specimens' collection.

Sample preparation

All Plants were washed with clean water and then dried under sunlight for 3 to 5 days. The plants were separated in terms of roots, stems and leaves and were dried in oven at 100˚C for 2 days. Plants after dried were introduced to Blander to make their powder**.** After making the powder of plants were subjected to proximate analysis to determine the Nutritive value.

Proximate analyses

The experimental aquatic plant analyzed for, moisture, crude proteins, crude lipids, ash, and crude fiber following AOAC (2005) methods.

Ash contents

The ash content of aquatic plant samples were determined by incinerating approximately 1.0 g of the samples. The dry samples were incinerated in a muffle furnace (Thermolyne, Dubuque, Iowa, USA) at 550°C overnight. The oven was started at 250°C and temperature slowly increased of 50°C every 30 minutes to avoid explosion of samples. The ash produced were then cooled down to room temperature in desiccators and then reweighed. The ash content was calculated as:

Ash % = Ash weight (g) / Weight of dry sample x 100

Crude protein

Crude protein of aquatic plant samples were determined through Kjeltec Auto 1030 analyzer Tecator (FOSS, Hoganas, Sweden) by digesting the sample at high temperature (415 °C) in concentrated sulphuric acid (15 ml) in the presence of potassium sulphate and copper sulphate (a catalyst). After digestion the solution is brought in basic medium by the addition of sodium hydroxide to the sulphate of ammonia produced by digestion in order to release ammonia. After distillation it is collected in boric acid solution with bromo cresol green and methyl red indicator and a 0.1 N HCl titrant. The percentage of crude protein is obtained by multiplying by a factor the percentage of nitrogen determined by titration.

% age of Crude Protein= (Volume x 0.875)/ Sample weight

Volume = Volume for titration of sample

0.875 = factor for protein

Sample weight = weight of sample used for digestion

Crude fat (Ether extract)

Crude fat aquatic plant samples were determined through Soxtec System (Model: HT 1043 Extraction Unit Tecator, Hoganas, Sweden) using diethyl ether as solvent.

Crude fiber

Crude fiber content of aquatic plant was determined by digesting dry sample with 1.25% H_2SO_4, followed by 1.25% NaOH solutions in Ankom Fiber Analyzer (Ankom 200/ 220, Model: A200, Macedon, NY, USA). Briefly 0.95-1.00g of prepared samples was weighed directly in filter bag. The upper edge of the filter bag has been heated to completely seal the filter bag. The fat was extracted from samples by placing all bags into a 250 ml container and by the addition of petroleum ether for 10 min. The samples were then removed and allowed to air dry. The bags were then put in the fiber analyzer vessel and 2000 ml of ambient temperature acid (0.255 N H_2SO_4) solution was added. Samples were extracted for 40 minutes with constant shaking and heating. The samples were then rinsed with hot water and submerged in 2000 ml of 0.313 N NaOH. The samples were extracted again for 40 minutes with heat and shaking. The samples were rinsed again with hot water to remove NaOH and soak for 3-5 min. in acetone. The bags were then allowed to air dry and completely dry in oven at 102 ± 2 °C overnight. The day after, the samples were allowed to cool down to room temperature and weighed. Finally the samples were incinerated in pre-weighed porcelain cup for 18 hrs at 600±15 °C, cooled in desiccators and weighed to calculate loss of weight of organic matter.

% Crude Fiber = 100 x (W3 - (W1 x C1)) / W2

Where W1 = Bag tare weight, W2 = Sample weight, W3 = Weight of Organic Matter (Loss of weight on ignition of bag and fiber), C1 = Ash corrected blank bag factor (running average of loss of weight on ignition of blank bag / original blank bag).

Results and discussion

Physico-chemical analysis

Water sample from the study area was analyzed for selected physico-chemical parameters. These are given in Table 8. The observed physico-chemical factors' values were falling within the suggested range, hence favoring the growth of the studied aquatic plants.

Table 1. Proximate analysis of Water Hyacinth.

Water hyacinth	Leaf	Stem	Root	Whole
Protein	11.85	9.96	2.56	6.85
Fat	1.16	2.10	4.01	2.55
Ash	13	16	21.33	17.76
Moisture	6.46	4.5	2.81	5
Fiber	13.73	20.80	8.89	11.34

Proximate composition

The proximate compositions of the studied plants are given in Table 1-7. Table 1 and Figure 1 are showing the proximate composition of water hyacinth, Table 2 and Figure 2 are showing phragmites, Table 3 and Figure 3 are showing water Lilly, Table 4 and Figure 4 are showing water primrose, Table 5 and Figure 5 are showing cod grass, Table 6 and Figure 6 are showing Vallisneria and Table 7 and Figure 7 is showing the proximate composition of cuttail. For some plants there were no significant differences for the studied parameters between the plants' parts studied. Specifically the emergent plants were exhibiting approximately the similar values for the studied parts. Similar results were also observed by Little (1979) in emergent plants.

Table 2. Proximate analysis of Phragmites.

Phragmites	Leaf	Stem	Root	Whole
Protein	18	20.12	12.2	19.65
Ash	9.4	7.3	9.2	12.24
Fiber	7.4	9.12	6.4	13.73
Fat	5.4	3.9	2.99	4.45
Moisture	3.2	6.4	7.2	1.65

Crude protein

Mean crude protein values were varying in the range of 6.88%-31.25%. This may be due to micro-habitat variation in the study area. Mean protein content in Vallisneria was 31.25±0.35, in water primrose was 6.88±0.04, in water lilly was 25.60±0.28, in phragmites was 19.67±0.03, in cuttail was 24.70±0.28, in cod grass was 17.50±0.14 and in water hyacinth was 12.12±0.02. The protein content value for water lilly in our study was higher than that of Muhammed *et al.* (2012), Okeye *et al.* (2000), Eyo (1994) and Anjana and Matai (1990), while close enough to that of Mbagwu and Adeniji (1988).

Table 3. Proximate analysis of Water Lilly.

Water Lilly	Leaf	stem	whole
Protein	18.9	16.24	25.4
Ash	13	7.2	11.4
Fiber	15.23	9.2	10.59
Fat	4.32	3.39	3.01
Moisture	6	4.5	4.6

Table 4. Proximate analysis of Water primrose.

Water primrose	Leaf	Stem	Root	Whole
Protein	4.5	6.9	4.6	12.11
Ash	3.9	4.9	3.2	6.4
Fiber	4.3	6.3	2.3	11.13
Fat	0.21	0.19	0.12	0.39
Moisture	2.1	2.6	4.3	2.4

Utilization of aquatic plants as food can alleviate protein shortages in current scenario, especially in many developing countries, but their degree of contribution is still doubtful. Some plants in our study are having cosmopolitan distribution but suitable species may vary regionally. Research regarding exploring these plants to assess their food and nutritive value should be motivated in order to cope with the current severe protein shortages (Boyd, 1968).

Table 5. Proximate analysis of Cod Grass.

Cod Grass	Whole Plant
Protein	17.4
Ash	8.4
Fiber	9.6
Fat	5
Moisture	3.2

Table 6. Proximate analysis of Vallisneria.

Vallisneria	Whole Plant
Protein	31
Ash	2.01
Fiber	3.78
Fat	1.52
Moisture	2.2

Crude fat (Ether Extract)

Mean fats values were varying in the range of 0.40%-6.44%. This may be due to micro-habitat variation in the study area. Mean fat content in Vallisneria was 1.55±0.04, in water primrose was 2.57±0.02, in water lilly was 3.050±0.05, in phragmites was 4.58±0.02, in cuttail was 6.44±0.02, in cod grass was 5.04±0.02 and in water hyacinth was 0.4±0.02.

Table 7. Proximate analysis of Cuttail.

Cuttail	Whole Plant
Protein	24.70
Ash	6.65
Fiber	13.29
Fat	6.44
Moisture	1.67

Table 8. Water sample studied for Physico-chemical parameters for the study area.

S. No	Parameter	Value/Reading
1	DO	6.8 mg/l
2	EC	5.36 mS/cm
3	Salinity	0.5 ppt
4	Temperature	20.9 ^{o}C
5	TDS	300 mg/l
6	pH	7.5
7	Nitrate	0.43 ppm
8	Phosphate	0.009 ppm
9	Sulphate	7.01 ppm

Ash content

Mean ash contents were falling in the range of 2.15%-

17.49%. Considerable variations in ash contents of the studied plants are probably due to the crustations, soil and mud clinging to these plants specimens (Linn *et al.,* 1973). Mean ash content in Vallisneria was 2.15±0.21, in water primrose was 17.49±0.03, in water lilly was 11.65±0.35, in phragmites was 12.26±0.03, in cuttail was 6.65±0.35, in cod grass was 8.50±0.014 and in water hyacinth was 6.50±0.13. While comparing to the study of Muhammed *et al.* (2012), the level of ash content was quite lower than they observed (27.36±1.261%) for petiole, 22.55±1.030 for roots, 14.48±0.340 for leaves and 9.68±0.193 for rhizome.

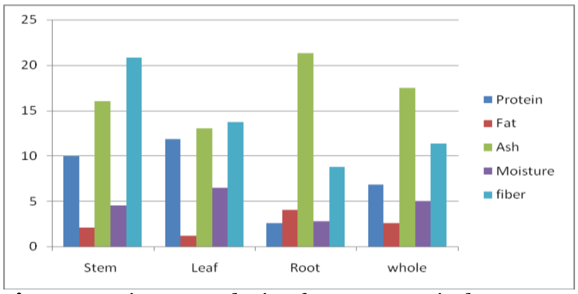

Fig. 1. Proximate analysis of Water Hyacinth.

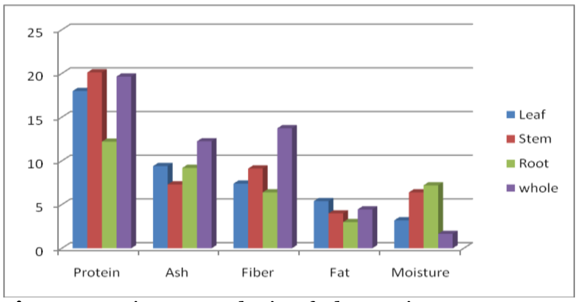

Fig. 2. Proximate analysis of Phragmites

Crude fiber

Mean crude fiber values ranged from 3.80% to 13.74%. Water buoyancy is probably replacing some of the need for structural material in aquatic plants. This result in lowering crude fiber values of aquatic plants as compared to terrestrial plants. Crude fiber may also increase with maturity, much as in the forage plants. Mean crude fiber in Vallisneria was 3.80±0.02, in water primrose was 11.38±0.05, in water lilly was 10.60±0.02, in phragmites was 13.74±0.02, in cuttail was 13.29±0.03, in cod grass was 9.75±0.021 and in water hyacinth was 11.14±0.02. While comparing our study to the previous ones on crude fiber, the results of our study was somewhat similar to that of Anjana and Matai (1990) and Muhammed *et al.* (2012).

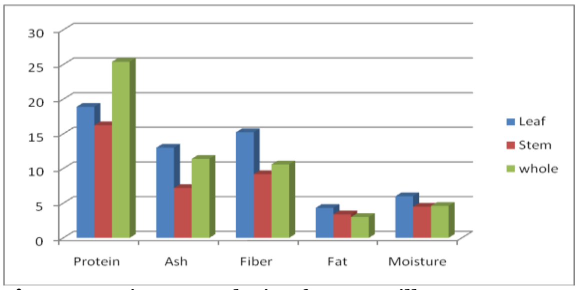

Fig. 3. Proximate analysis of Water Lilly.

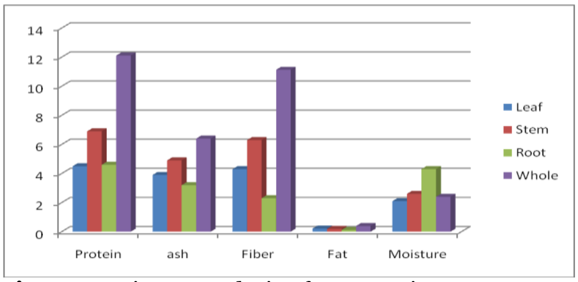

Fig. 4. Proximate analysis of Water primrose

Moisture

Most of the aquatic plants are having huge amounts of moisture. These would have to be at least, to some extent, dried prior its use as roughage. The cost of eliminating this large quantity of water by mechanical means would be exorbitant. Although there are certain methods developed for air drying. Yet for protein extraction, high moisture content is desirable because extraction is generally facilitated by addition of water (Boyd, 1968).

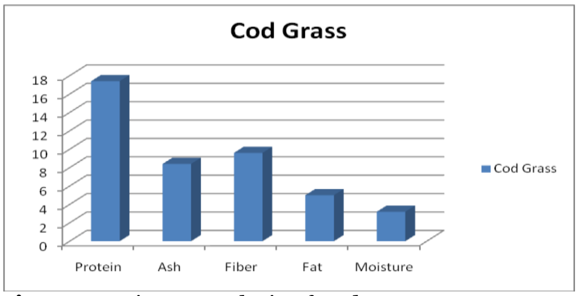

Fig. 5. Proximate analysis of Cod Grass.

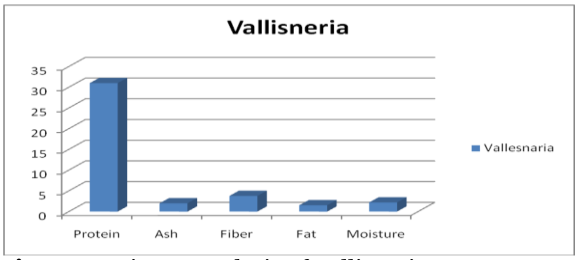

Fig. 6. Proximate analysis of Vallisneria.

Mean moisture values ranged from 1.67% to 5.2%. Mean moisture in Vallisneria was 2.4±0.28, in water primrose was 5.20±0.28, in water lilly was 4.75±0.21, in phragmites was 1.67±0.02, in cuttail was 1.67±0.02, in cod grass was 3.30±0.14 and in water hyacinth was 2.50±0.14. While comparing to study conducted by Muhammed *et al.* (2012) moisture content was quite less in our study. He concluded with rhizome having 20.40±1.241, leaves having 6.40±0.321, petiole with 6.17±0.344, roots with 4.85±0.377 and seed with 4.18±0.176%.

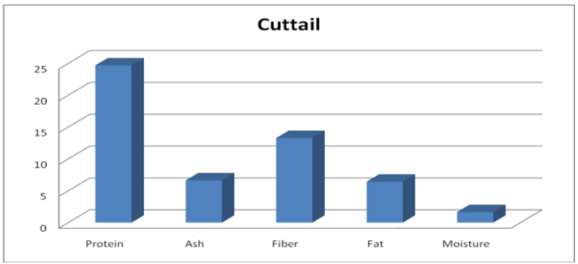

Fig. 7. Proximate analysis of Vallisneria.

Conclusion

The results of these analyses suggest that the plants studied may be useful forage. Although variation existed among the studied species yet some of these plants were high in crude protein while low in crude fiber. This result clearly indicates that these plant species are having high nutritive value. Exploitation of these aquatic plants will not only be of economic importance but would be a step toward better utilization of these plants for additional feed production. This will also help in solving the weed eradication problem. Though, some anti-nutritional factors may be there in these aquatic plants but these were not evaluated, so another study on these factors is needed to be carried out.

Disclosure

None of the authors have any conflict of interest.

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