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BIOCHEMICAL COMPOSITION OF SOME SELECTED AQUATIC MACROPHYTES UNDER *EX-SITU* CONDITIONS

HARICH AND HAZRA[1], MD. ALMUJADDADE ALFASANE[1*], SHARMIN KAUSER[2], UMME FATEMA SHAHJADEE[3] AND MONIRUZZAMAN KHONDKER[1],

[1]*Department of Botany, University of Dhaka, Dhaka 1000, Bangladesh*
[2]*BIRDEM, Dhaka, Bangladesh*
[3]*BCSIR Laboratories, Dhaka, Bangladesh*

Abstract

Ex-situ culture studies of five selected aquatic macrophytes, namely *Nymphaea nouchali* Burm. f., *Enhydra fluctuans* Lour., *Ipomoea aquatica* Forsk., *Hygroryza aristata* (Retz.) Nees *ex* Wight & Arn. and *Limnocharis flava* (L.) Buch. were carried out. Comparing the biochemical composition of the above mentioned five aquatic macrophytes, on an average, *Enhydra fluctuans* was found to contain highest amounts of proteins (18.20%) and *Ipomoea aquatica* contains highest amounts of carbohydrate (58.60%). Lowest amounts of proteins (14.35%) were recorded in *Hygroryza aristata* and *Limnocharis flava*. On the other hand lowest amounts of carbohydrates were obtained in *Nymphaea nouchali*. *Ipomoea aquatica* contained highest amounts of energy (321.23 kcal) and lowest amount was observed in *Limnocharis flava*. The five aquatic plants were low in fiber, fat and also in ash. Among all the five aquatic macrophytes, highest values of calcium and phosphorus were found to be present in *Limnocharis flava* and iron was highest in *Nymphaea nouchali*. Lowest values of calcium and phosphorus were present in *Ipomoea aquatica* and lowest amount of iron was present in *Limnochris flava*. The present study demonstrated that, these five aquatic macrophytes are the important sources of carbohydrate, protein and minerals, which are suitable for incorporation in human diet and feed also.

Key words: Biochemical composition, Aquatic macrophytes, *Ex- situ* culture

Introduction

Bangladesh, though very rich in wetland habitats with luxuriant growth of aquatic macrophytes, research work done in this field are not significant. Previous information of biochemical compositions of aquatic macrophytes are little. In Bangladesh, *exsitu* culture of different aquatic macrophytes were made by Alfasane *et al.* (2009, 2010 a,b,c,d and 2011) and biochemical composition of aquatic macrophytes, namely, *Euryale ferox* Salib., *Nelumbo nucifera* Gaertn. and *Trapa bispinosa* Roxb. were also studied by Alfasane *et al*. (2008, 2009 and 2011).

* Author for correspondence: Email: mujaddade@yahoo.com

Bangladesh is an over populated country and the people cannot satisfy their nutritional requirements. Although rice is the staple food in our country, exploration of other food source is very essential. Macrophytes of Bangladesh can be used as the source of vegetable nutrients and minerals. In rural area maximum population use these macrophytes as source of vegetable. Cattle largely depend on some common aquatic macrophytes. Study on the chemical composition and their adaptation in different habitats of macrophytes is very much essential.

People of Bangladesh traditionally eat or use these macrophytes without having any detailed knowledge on the biochemical composition of their products, because there is very little information on this aspect of aquatic plants of Bangladesh. The natural habitats of the plant have been decreasing at a high rate. Considering this decline an *ex situ* culture studies of the plants for their conservation and at the same time to know their food values, the biochemical composition of some selected aquatic macrophytes, namely *Nymphaea nouchali* Burm. f., *Enhydra fluctuants* Lour., *Ipomoea aquatica* Forsk., *Hygroryza aristata* (Retz.) Nees *ex* Wight & Arn., *Limnocharis flava* (L.) Buch. have been investigated.

Materials and Methods

The five species of aquatic macrophytes were selected and *ex situ* culture was made from June, 2011 to May, 2012 in the Botanical garden, Department of Botany, University of Dhaka (Figs. 1 - 5). Fresh leafy shoots of these species were collected for biochemical analyses. At first, these species were collected from the garden and then dried with the help of oven at 105°C for 5 hours. Then materials were crushed in a mortar with a pestle and the crushed materials were used to determine the amount of protein, carbohydrate, fat, moisture and ash contents according to the methods used by National Institute of Nutrition (1976). Moisture was determined with the help of a moisture meter (Chyo, Serial No.135252, 1B-30 CAPACITY) and protein was determined by Microkjeldhal method (National Institute of Nutrition 1976) . The ash content was determined in a Muffle furnace (CARBOLITE, Hope valley, S336RB, England, Serial No. 06/02/1539, Type-RHF 16/15). Digestion process of the ash was made for mineral contents. The ash after furnace is moistened with a small amount of glass-distilled water (0.5 - 1.0 ml) and 2 ml of conc. HNO_3 acid added to it. The mixture is evaporated to dryness in a muffle furnace and calcium, phosphorus and iron were determined with the help of a UV Spectrophotometer (Cintra 6, Serial No. V 3681, GBC, National Institute of Nutrition 1976). Biochemical composition of the selected aquatic macrophytes was determined by the method of National Institute of Nutrition (1976).

(a)

Fig.1a. *Ex situ* culture of *Enhydra fluctuans* in an earthen bin.

(b)

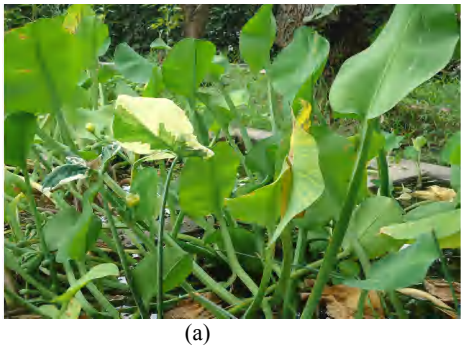
b. Many small cut pieces of *Enhydra fluctuans*.

(a)

Fig. 2a. *Ex situ* culture of *Ipomoea aquatica.*

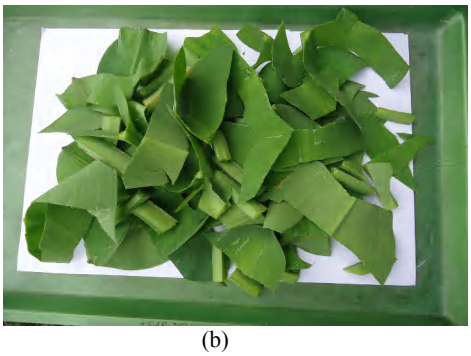
(b)

b. *Ipomoea aquatica* was chopped into many small pieces.



(a)

Fig. 3a. *Ex situ* culture of *Limnocharis flava* in the culture pit.



(b)

b. Leafy shoots of *Limnocharis flava* chopped into many pieces.

4(a)

4 (b)

4(c)

(5)

Figs 4a. *Ex situ* culture of *Nymphaea nouchali* in the culture pit. b. Red flower of *Nymphaea nouchali* with its long pedicel. c. Many small cut pieces of the pedicels of *Nymphaea nouchali*. 5. *Ex situ* culture of *Hygroryza aristata* in the culture pit.

Results and Discussion

Biochemical analyses of the biomass of *Enhydra fluctuants* showed that young shoots are extremely nutritious, containing 56.60% carbohydrate, 18.2% protein, 11.54% fibre, 14% ash and 1.14% fat. The mineral contents were 224.45 mg/100g calcium, 175.22 mg/100g phosphorus, 30.48 mg/100g iron of dry weight of sample (Table 1). *Enhydra fluctuans* contained a significant amount of P in their leafy shoots. Dried plant materials produced 317.28 kcal/100 g of energy. Similar observations were also made by Dewanji *et al*. (1993). The tissue chemistry of aquatic plants has been reported to show considerable variation in mineral composition which may be attributed to the age and type of plants sampled, and the fertility of the aqueous environment (Boyd 1968.). When plants are considered as a feed source calcium and phosphorous ratio constitutes an important parameter.

The biochemical analyses of *Ipomaea aquatica* showed that young shoots contained 58.60% carbohydrate, 16.8% protein, 10.30% moisture, 12.33% fibre, 13% ash and 1.30% fat. Dried plant materials were found to produce 321.2 kcal/100 g of energy. The mineral contents of this plant were as follows: calcium 128.26 mg/100 g, phosphorus 173.22 mg/100 g and iron 27.70 mg/100 g on dry weight basis. In the present material protein and ash contents were more or less to the value obtained by Yadav and Agarwala (2011). According to them submerged plants having higher amounts of ash may be due to extraneous mineral deposition from surrounding habitats.

The biochemical analyses of *Hygroriza aristata* showed that young plants contained 58.10% carbohydrate, 14.35% protein, 12.70% moisture, 25% fibre, 13.86% ash and 1.00% fat (Table 2). In 100 g dry plant parts produced 306.34 kcal of energy. The mineral content of *H. aristata* showed that they consist of 208.4 mg/100 g calcium, 228 mg/100 g phosphorus and iron 20.58 mg/100 g on dry weight basis. Previously similar observation on biochemical analyses of seeds of *Euryale ferox* showed that seeds consisted of 61.2% carbohydrate, 15.6% protein, 1.3% fat, 7.6% fibre, 1.8% ash and 12.5% moisture on dry weight basis (Alfasane *et al.* 2008).

Pedicels of *Nymphaea nouchali* were found to contain 55.50% carbohydrate , 17.15% protein, 12.30% moisture, 23% fibre, 14% ash and 1.50% fat (Table 2). Dry pedicels produced 307.33 kcal/100 g of energy. The mineral contents of this plant were 328.66 mg/100 g calcium, 250 mg/100 g phosphorus and 95.13 mg/100 g iron on dry weight basis. Another experiment on biochemical composition of seeds of another aquatic macrophyte namely, *Nelumbo nucifera* consisted of 63.8% carbohydrate, 16.4% protein, 1.6% fat, 4.5% fibre, 1.9% ash and 11.8% moisture on dry weight basis (Alfasane *et al.* 2009).

The proximate analyses of the species of *Limnocharis flava* showed that the leaves are nutritious, containing 57.3% carbohydrate , 14.35% protein, 13.10% moisture, 24% fibre, 14% ash and 1.25% fat (Table 1). Dry plants produced 305.39 kcal/100 g of energy. The amounts of calcium, phosphorus and iron were 493.18 mg/100 g, 262 mg/100 g, and 17.94 mg/100 g in dry weight of sample (Tables 1 and 2). Biochemical analysis of fruits of *Trapa bispinosa* was found to contain 71.55% carbohydrate and 10.80% protein on dry weight basis. The percentage of moisture, fibre, ash and fat were 7.30, 6.35, 8.50 and 1.85, respectively (Alfasane *et al.* 2011).

Comparing the biochemical composition of above mentioned five aquatic macrophytes, on an average, *E. fluctuants* was found to contain highest amounts of proteins (18.20%) and *I. aquatica* contained highest amounts of carbohydrate (58.60%). Lowest amounts of proteins (14.35%) were recorded in *H. aristata* and *L. flava*. On the other hand lowest

amounts of carbohydrates were obtained in *N. nouchali*. *I. aquatica* was found to contain highest amounts of energy (321.23 kcal/100 g) and lowest was observed in *L. flava*. The five aquatic plants are low in fiber, fat and also in ash (Table 1).

Table 1. Comparison of proximate composition of five different aquatic macrophytes.

Biochemical composition	Name of the aquatic macrophytes				
	Enhydra fluctuants	*Ipomoea aquatica*	*Hygroryza aristata*	*Nymphaea nouchali*	*Limnocharis flava*
Moisture (%)	10.06	10.30	12.70	12.30	13.10
Ash (%)	14.00	13.00	13.86	14.00	14.00
Protein (%)	18.20	16.80	14.35	17.15	14.35
Fat (%)	1.14	1.30	1.00	1.05	1.25
Fibre (%)	11.50	12.30	25.00	23.00	24.00
Carbohydrate (%)	56.60	58.60	58.10	55.50	57.30
Energy (Kcal/100 g)	317.28	321.23	306.34	307.33	305.39

Previously Alfasane *et al*. (2011) reported that the seeds of *T. bispinosa* contained 102.85 mg calcium, 3.8 mg iron and 325 mg phosphorus in 100 day mather. Dried seeds of *T. bispinosa* produced 354.85 kcal/100 g calories of energy.

Table 2. Comparison of mineral contents of different aquatic macrophytes.

Name of the aquatic macrophytes	Minerals (mg/ 100g)		
	Calcium	Phosphorus	Iron
Enhydra fluctuants	224.45	175.22	30.48
Ipomoea aquatica	128.26	173.22	27.7
Hygroryza aristata	208.4	228	20.58
Nymphaea nouchali	328.66	250	95.13
Limnocharis flava	493.18	262	17.94

Among all the five aquatic macrophytes, highest values of calcium and phosphorus were found to be present in *L. flava* and iron was highest in *N. nouchali*. Lowest values of calcium and phosphorus were recorded in *Ipomoea aquatica* and iron was present in *L. flava* (Table 2). One hundred g dried seeds of *Nelumbo nucifera* produced 343.70 calories of energy. The seeds are low in fiber, very low in fat and also in ash but high in carbohydrates and also protein. Dharmananda (2002) had also reported biochemical composition of *N. nucifera* and showed that in 100 g (yielding about 350 calories of energy), there were 63 - 68 g carbohydrate (mostly starch), 17 - 18 g of protein, and only 1.9-2.5 g fat; the remaining one is water (about 13%), and minerals (mainly sodium,

potassium, calcium, and phosphorus). Regarding the chemical composition the values obtained in the present investigation are close to the range reported by Dharmandra (2002) and Yadav and Agarwala (2011). Read (1946) had also reported biochemical composition of *Euryale ferox* and showed the chemical compositions as carbohydrate 75.7%, protein 9.9%, fat 0.3%, and ash 0.6%. Howard-Williams and Junk (1977) studied the nutritional values of 27 Amazonian macrophyte species and found 5.3 - 22.2% protein in the whole biomass on dry weight basis. The highest was found in *Azolla microphylla* Kaulf. and the lowest in *Scleria secans* (L.) Urb. and *Rhynchospora gigantea* Link.

Mineral nutrients are important aspects of nutritive quality. Execessive concentration of ash decreases the amount of organic constituents per unit weight and lowers food value. However, ash value below 15%, is of little value in evaluating the nutritive value of a feed since it is the individual element that is important in the metabolic processes. On the basis of an overall nutrient composition, the plants were found to contain sufficient quantities of nutrients and thus are safe enough to be considered as potential livestock feed. The amount of carbohydrate was also significant as a source of energy. The present study has demonstrated that, these five aquatic macrophytes may be the important source of carbohydrate, protein and minerals, which are suitable for incorporation in human diet and feed also.

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