Nutritional Compositions, Elemental Compositions and Antinutrient Factor in Different Varieties of Water Lily

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Abstract

Flowers and stalks of three different species of water lilies *viz*., blue water lily (*Nymphaea nouchali* Burm.f), white water lily (*Nymphaea lotus* L.) and Chinese water lily (*Nelumbo nucifera* Gaertn. f) from Min-Hla Lake,Singaing Township, Mandalay Region were analyzed for their nutrients and antinutrient factor (phytate). Phytochemical tests revealed that all flowers and stalks of water lilies contained phytonutrients like glycoside and phenolic compounds. Saponin was absent in all these water lilies. Nutritional compositions such as moisture, ash, crude fibre, crude protein, crude fat and available carbohydrate were determined by AOAC methods. AAS analysis revealed that K was the highest concentration among other elements. High contents of total phosphorus (220 mg / 100 g – 450 mg / 100 g) were observed in water lily samples. High results were also recorded for antinutrientphytate. Phytate contents in stalks (323 mg / 100 g – 475 mg / 100 g) were higher than those in flowers (304 mg / 100 g – 456 mg / 100 g). The results suggested that the bioavailability of the minerals of these water lily plants, when consumed is low due to their high phytate content. Ca / P ratios of three different varieties of water lily were found to be very much less than 1..

Keywords:*Nymphaea nouchali*Burm.f., *Nymphaea lotus* L., *Nelumbo nucifera* Gaertn.f., water lily

Introduction

Water lilies are aquatic, rhizomatous herbs. Water lilies live in freshwater areas in temperate and tropical climates around the world. The family contains five genera with about 70 known species (Christenhusz and Byng, 2016). Water lilies are rooted in soil in bodies of water, with leaves and flowers floating on the water surface. Water lilies are classified as hardy and tropical. Tropical water lilies do not like cold conditions, while hardy water lilies are cold-tolerant. Hardy water lilies bloom during the day, while tropical ones can bloom either during the day or night. Flowers of the hardy varieties generally float on the surface of the water while flowers of the tropical water lily are held high above water level. Most water lilies bloom during the hot part of the day. Night blooming tropical water lilies are available (usually at a higher price) and are just as beautiful as those that bloom during the day.

Figure 1 Water lily flowers (a) blue water lily (b) white water lily and (c) Chinese water lily

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The botanical descriptions of three types of water lily (Kress *et al*., 2003) in this study are as follows.

	Blue water lily	White water lily	Chinese water lily
Family	Nymphaeaceae	Nymphaeaceae	Nelumbonaceae
Botanical name	*Nymphaea nouchali* Burm.f	*Nymphaea lotus* L.	*Nelumbo nucifera* Gaertn.f
Common name	Water lily	Water lily	Water lily
Local name	Kyar pya	Kyar phyu	Padon-ma-kyar

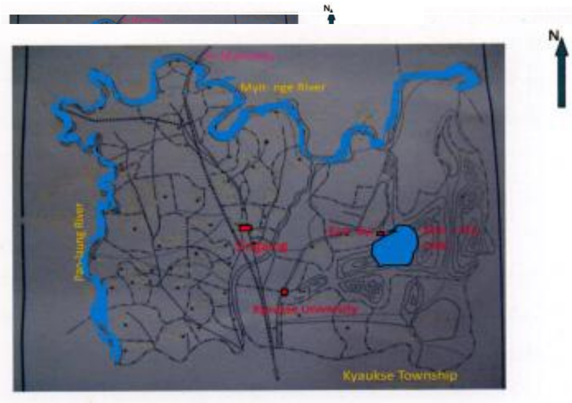
An anti-nutritional factor is a substance which, when present in human or animal foods, reduces growth. Examples are phytate, protease inhibitors (notably soybean trypsin inhibitor) and excessive dietary fiber. Phytates are phosphorus compounds found primarily in cereal grains, legumes and nuts. High intakes of phytate can have adverse effects on mineral uptake in humans. Dietary phytate was reported to prevent kidney stone formation, protect against diabetes mellitus, caries atherosclerosis and coronary heart disease as well as against a variety of cancers (Lopez,2002). A high phytate intake may also be an important factor in reducing the breast and prostate cancer mortality (Vucenik and Shamsuddin, 2003).

This paper was aimed to investigate the phytochemicals present in the flowers and stalks of three different varieties of water lily and to determine their nutrient contents as well as antinutrient content (phytate).

Materials and Methods

Sample Collection Site

Aquatic plants, *viz*., blue water lily, white lily and Chinese water lily were collected from Min-Hla Lake, Singaing Township in Kyaukse Township, Mandalay Region (Figure 2). In this lake, three different types of water lilies are grown around the year (Figure 3).



Township

Figure 3 Min Hla Lake of Singaing Township

Sample Collection and Preparation

From the Min-Hla Lake, three samples of water lily *viz*., blue water lily, white water lily and Chinese water lily were collected. These plants were washed with distilled water and then dried in shade. The flowers and stalks of each varieties were cut into pieces and then separately ground in blender and kept in air-tight container prior to analysis.

Phytochemical Investigation on Three Different Water Lilies

Phytochemical investigation of three different water lilies was carried out according to the reported methods (Trease and Evans, 1989).

Determination of Nutrient Compositions of Three Different Water Lilies

Nutritional compositions of three different water lilies were carried out according to standard methods (AOAC, 1990).

Determination of Metallic Elements by Atomic Absorption Spectroscopy (AAS)

The amount of trace elements were quantitatively determined by using AAS method by using a Perkin Elmer AA analyst 800 atomic absorption spectrometer (England) at Universities' Research Center, Yangon.

Determination of Phosphorus by UV-Visible Spectrophotometric Technique

Sample (10 g) was dissolved in concentrated hydrochloric acid, heated nearly to dryness on a water bath, mixed with distilled water, and then heated for a few minutes. The solution was filtered into a 50 mL volumetric flask, cooled and the volume was made up to the mark with distilled water. The above solution (5 mL) was pipetted into a 100 mL volumetric flask and then the volume was made up to the mark with distilled water. The diluted sample solution (10 mL) was pipetted into a 50 mL volumetric flask and 5 mL of ammonium molybdate, 2 mL of hydroquinone, and 2 mL of sodium sulphite solutions were added. The mixture solution was shaken and kept 15 minutes for completion of colour development prior to the measurement of absorbance. The absorbance of the developed blue colour was measured at a wavelength of 660 nm using the visible spectrophotometer. A calibration curve was drawn using the different concentrations of standard potassium dihydrogenphosphate solutions.

Determination of Phytate

Phytate was determined by the titrimetric method using ferric chloride as standard (Reddy *et al*., 1982; Balogun, 2013).

Results and Discussion

Phytochemical Investigations on Water Lily Samples

According to the phytochemical tests, glycoside and phenolic compound were present in all three water lily plants studied whereas saponin was absent. Flavonoid was present in three water lily flowers, but absent in three water lily stalks. Alkaloid was present on flowers of white, blue and Chinese water lilies and stalk of white water lily but absent in stalks of blue and Chinese water lilies. Reducing sugar was present in both flower and stalk of blue water lily whereas it was absent in both flower and stalk of white water lily. The phenolic compounds may contribute directly to antioxidative compound action.

Nutrient Compositions of Three Different Varieties of Water Lily

From Table 1, the pH values of flower and stalk of blue water lily were nearly neutral whereas those of white and Chinese water lilies were found to be slightly acidic. It was observed that pH values of flower and stalk of each variety were nearly the same. Chinese water lily was found to have the lowest moisture content among others. It was obviously seen that protein contents in flowers were 1.4 times, 2.2 times and 2 times greater than those in stalks for all three varieties. Thus, flowers of water lilies in this study may be regarded as a rich source of protein. It was observed that fibre contents in stalks of three varieties of water lily were noticeably higher than those of flowers. High fibre content in food causes intestinal irritation and lower nutrient bioavailability. Apart from negative effect, intake of fibre can stimulate weakening hunger, stimulating peristalic movement, increasing excretion of bile acids, increasing moisture content of excrements, lower the serum cholesterol level, risk of coronary heart diseases, hypertension, diabetes, colon and breast cancer. Ash contents in water lily stalks (9.38-10.33%) were higher than those in water lily flower (8.19-8.93 mg/100g) indicating that minerals were higher in water lily stalk. High calorific values (273.11-276.44 kcal/100g) were observed in water lily flower and stalk. This indicates that water lily is a rich source of energy.

Table 1 Nutritional Compositions of Three Different Varieties of Water Lily

No	Sample	pH	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Available carbo-hydrate (%)	Calorific value (kcal/100g)
1.	Blue water lily (flower)	6.71	14.12	13.64	3.3	0.422	8.77	59.75	274.21
2.	Blue water lily (stalk)	6.73	14.03	10.07	3.4	0.638	9.38	62.48	276.13
3.	White water lily (flower)	6.53	13.31	15.63	2.9	0.316	8.93	59.89	276.39
4.	White water lily (stalk)	6.43	14.21	7.12	3.1	0.932	9.34	65.30	276.44
5.	Chinese water lily (flower)	6.26	14.17	14.12	3.2	0.974	8.19	59.35	273.11
6.	Chinese water lily (stalk)	6.27	10.93	7.17	2.08	1.25	10. 33	67.94	273.8

Elemental Concentrations by Atomic Absorption Spectroscopy (AAS)

The mineral compositions of the water lilies are depicted in Table 2. The highest amount of macrominerals (K and Na) were observed in this work. Furthermore, taken into consideration that potassium depresses blood pressure, thus, high amount could be an important factor in prevention of hypertension and atherosclerosis. Sodium was the next highest mineral component, which ranged from 207.9 – 317.7 mg / 100 g (DM). The trace minerals determined in three varieties of water lilies are apparently needed in smaller amounts for nutrition than major elements. The others micro mineral elements Ca, Mg, Fe, Mn and Zn were observed in three different water lilies. Copper was not detected in all of three varieties of water lilies studied in this work.

Table 2 Elemental Concentrations in Water Lily Samples (Based on Dry Weight)

Concentration (mg/100g)								
Sample	Ca	Mg	Fe	Cu	Mn	Zn	Na	K
Blue water lily (flower)	47.76	50.99	8.10	ND	14.64	2.98	216.4	503.9
Blue water lily (stalk)	43.91	49.43	17.11	ND	24.41	2.07	317.7	503.4
White water lily (flower)	74.22	51.96	5.09	ND	14.52	2.18	210.2	505.6
White water lily (stalk)	63.38	50.23	5.83	ND	13.86	1.68	216.6	505.8
Chinese water lily (flower)	80.92	50.71	7.3	ND	15.50	2.14	220.7	505.9
Chinese water lily (stalk)	102.0	53.07	6.54	ND	17.67	3.54	207.9	505.6

Total Phosphorus, Phytate Phosphorus and Phytate of Three Different Varieties of Water Lily

Table 3 shows total P, phytate P and phytate expressed as percentage P. Total phosphorus contents in flowers of white and Chinese water lily were about 2 times higher than those in stalks. However, comparable amounts of total phosphorus in flower and stalk were observed is blue water lily. Thus, water lilies were observed as a rich source of phosphorus. Phosphorus is involved in the proper functioning of both muscles and nerves. It is needed for metabolic processes of all cells to activate many other nutrients, and to form energy-storage and energy-releasing compounds. The data also revealed that higher amount of phytate ranged from 304 mg / 100 g to 475 mg / 100 g were found in flowers and stalks of these three different water lilies. It was not surprising that higher phytate were found in these three different water lilies due to their higher fibre contents. The presence of the antinutritional factor (phytate) prevents the absorption of minerals such as iron, calcium and zinc in the body. In this research Ca/P ratios of three different varieties of water lily were found to be very much less than 1. These plants are good sources of P over that of Ca : consequently the diet based on these plants requires to be supplement with other food material rich in calcium.

Table 3. Total Phosphorus (P), Phytate P, Phytate and Phytate P (% of Total P) of Three Different Varieties of Water Lily

No.	Sample	Total P (mg/100)	Phytate P (mg/100)	Phytate (mg/100)	Phytate P (%) of
1.	Blue water lily (flower)	420	135	304	32.142
2.	Blue water lily (stalk)	450	115	323	25.555
3.	White water lily (flower)	420	169	456	40.238
4.	White water lily (stalk)	220	162	475	73.636
5.	Chinese water lily (flower)	430	163	304	37.674
6.	Chinese water lily (stalk)	280	108	456	38.571

Table 4. Ca/P ratio of Three Different Varieties of Water Lily

No.	Sample	Ca (mg/100g)	P (mg/100g)	Ca/P
1	Blue water lily (flower)	47.76	420	0.114
2	Blue water lily (stalk)	43.12	150	0.098
3	White water lily (flower)	74.22	120	0.18
4	White water lily (stalk)	63.38	220	0.28
5	Chinese water lily (flower)	80.92	130	0.19
6	Chinese water lily (stalk)	102.0	280	0.36

Conclusion

Three different water lilies (blue water lily, white water lily and Chinese water lily) from Min-Hla Lake, Singaing Township, Kyaukse District were investigated for their phytoconstituents, nutritional compositions, elemental compositions and antinutritional factor, phytate. Phytoconstituents such as glycoside and phenolic compound were present in all three varieties of water lilies. Blue water lily, white water lily and Chinese water lily were found to have pH value of 6.26 to 6.73 in flower and stalks. Protein contents in flowers were greater than those in stalks and thus, water lily flowers were found to be a rich source of protein. Fibre contents in stalks were higher than those in flowers in all three varieties. The results showed higher carbohydrate content in the leaves and stalks which gave a corresponding greater calorific (energy) values for this plant. Higher potassium contents in these plants make them better for hypertensive patient since potassium reduces blood pressure. Water lily was found to be a rich source of phosphorus. High contents of antinutrient phytate were observed in three varieties of water lily. All samples were found to have less than 50% of their total phosphorus linked to phytate. The bioavailability of the minerals of these water lily plants, when consumed is low due to their high phytate content. Ca/P ratio for three different varieties of water lily were found to be very much less than 1 and thus, the diet based on these plants required to be supplement with other food material rich in calcium. This work provides information about the phytoconstituents, nutrients, antinutrient (phytate) and elemental contents in three different varieties of water lilies from Min-Hla Lake.

Acknowledgement

The autors deeply acknowledge the Pro-rector Dr Nyunt Soe, Principle of Mohnyin Degree College, for his permission of this research paper. Thanks are also extended to Professor and Head, Dr Aye Aye Mon, Department of Chemistry, Mohnyin Degree College for her suggestion and encouragement.

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