Bajopas Volume 8 Number 1June, 2015

http://dx.doi.org/10.4314/bajopas.v8i1.1

Bayero Journal of Pure and Applied Sciences, 8(1): 1 – 5
Received: September, 2014
Accepted: January, 2015
ISSN 2006 – 6996

NUTRITIONAL COMPOSITION, ANTINUTRITIONAL FACTORS AND ELEMENTAL ANALYSIS OF *NYMPHAEA LOTUS* (WATER LILY)

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ABSTRACT
The study is aimed at evaluating nutritional composition, antinutritional factors and elemental analysis of three parts (roots sample RS, seed sample SS and leave sample LS) of Nymphaea lotus (water lily) using standard methods. The plant parts were analyzed for the content of crude lipid, crude fiber, crude proteins, ash, moisture and carbohydrate was estimated by difference. Crude lipids and carbohydrate were higher in seeds, while crude protein was exceptionally higher in the leaves. There are moderate amount of both antinutritional factors and heavy metals. The vitamin E content was high in the seeds sample while other vitamins determined were present in all plant parts respectively. Considering the potential nutritive and health benefits of the underutilized water lily, it is suggested that utilization of water lily should be encouraged so as to ameliorate the problem of malnutrition, since it is rich in nutrients.
Keywords: Nymphaea lotus, Nutritional, antinutritional factors, water lily, elemental analysis

INTRODUCTION

In Nigeria, the Hausas call it *Bado*, Yoruba *Iyeye* and the Igbo *Ijikara* in Southern Nigeria. Water lily has many other common names which include, cow lily, cow cabbage, fragrant water lily etc (Jethro, 1994). In Nigeria water lily is a wild plant found scattered in different ponds where it floats on top of water bodies throughout the year. The seeds are consumed raw by infants and other category of people. The roots are cooked and eaten as green or dried and ground into powder for use as thickening agent or flour (Skinner, 2006). *Nymphaea lotus* an indigenous wild crop plant belongs to herbaceous aquatic plant widely distributed in the stream, rivers and ponds (Fulckar, 2005). It is a plant with perennial rhizomes or stock anchored with mud, floating or submerged leaves solitary showy flower (Conard, 1905).

The medicinal benefits of water lily are ascribed to a large number of nutritional components or constituents it contains. A tea made from the roots makes a good gargle for irritation or inflammation in the mouth and throat. It is used as a lotion, helps to heal sores, soften skin and sometimes both leaves and roots are sometimes made into poultice for wounds, cut and brushes (Steven and James, 1974 and Edith, 1990). According to Alma (1974), Native American use the roots tea for cough, tuberculosis treatment, inflamed glands and mouth sore to stop bleeding. Also the mixture of roots with lemon juice served to remove freckles and pimples. The search for the lesser known and underutilized crops which includes water lily, many of which are potentially valuable as human and animal food has been intensified in order to bridge the gap between population growth and agricultural productivity particularly in insecure Africa and south East Asia (FAO, 1989). This study mainly aimed at nutritional, antinutritonal and elemental analysis of water lily (*Nymphaea lotus*)

MATERIALS AND METHODS

Collection and Identification of Plant Materials

Nymphaea lotus was collected from different water ponds of five wards in Sabon birni Local Government area of Sokoto State Nigeria. The samples were identified according the identification protocols of Dutta (2011). The samples were coded RS (root samples), SS (seeds samples) and LS (leaves samples) after sorting them.

Preparation of Sample

The water lily parts were thoroughly washed to remove sand and the drained parts were later air dried. The samples were ground using wooden mortar and pestle until powder was obtained to ensure homogeneity. The powdered sample was passed through a fine (2mm mash) sieve to remove any remaining residue. The fine powdered sample was then stored into labeled plastic containers prior to use.

Proximate Composition Analysis

Proximate analysis was determined using methods of the Association of Official Analytical Chemists (AOAC (2003). Determining the percentage moisture content involve loss of weight due to drying the samples in an oven at (50-60^{o}) for 5 hours, by relating the weight of an empty bottle at initial stage, weight of empty bottle plus the sample.

The weight of empty bottle plus the sample minus initial weight of empty bottle all over weight of empty bottle plus sample (2g) times one hundred after drying. The ash content was determined by heating the sample above the boiling point of water at a temperature of 550-570°C in order to burnt all the organic matter until the appearance of white ash. The content was obtained by relating the weight of crucible plus the sample weight (2g) minus weight of an empty crucible all over the weight of crucible after burning the organic matter minus initial weight of the crucible time's one hundred. The crude fiber and lipid content were determined by soxhlet extraction. In a case two gram (2g) of the samples were placed in an empty thimble and then extracted at lower temperature (40-60°C) using petroleum ether, 25% sulphuric acid and sodium hydroxide respectively. The two parameters weight were obtained by relating the weight of the thimble plus the initial weight of the thimble all over the weight of the thimble, sample and cotton wool minus the weight of the thimble after extraction times one hundred. Crude protein content was also measured by subjecting sample (2g) to digestion using concentrated sulphuric acid and Kjedahl catalyst tablet followed by distillation in 10% boric acid, ammonium hydroxide and which is finally back titrating the aliquot using 0.1N hydrochloric acid. The content of carbohydrate was estimated by subtracting out the sum of ash, crude fiber, crude protein and crude fat from one hundred.

Antinutritional Factors and Vitamins Analysis

The samples was subjected to antinutritional factors analysis to determine the tannins (Trease and Evans, 1978), oxalate, (Day and Underwood, 1986), phytate (Lucas and Markaka, 1975), saponin (El- Olemyl *et al*, 1994), cyanide (Railes, 1992) and nitrate (IITA, 1998).

Determination of Vitamin A, C and E

Vitamin A content was measured as Carotenoids equivalent by extracting it from the sample (2g) using 95% ethanol and distilled water. The extracted aliquot and vitamin A standard were measured spectrophotometically at 450nm. The intensity of the dichromate is directly proportional to the concentration of vitamin in the sample. The vitamin C content was measured by the visual titrating method whereby 2,6-dichlrophenolindophenol was reduced by an acid of ascorbic acid. The sample (10g) was first extracted with 6% monophosphuric acid solution and then filtered. The filtrate was then titrated 2,6-dichlrophenolindophenol to the pink end point that persisted for 15 seconds. The pink colour observed is directly proportional to the ascorbic acid content.

Vitamin E content was estimated based on the reduction of ferric ions to ferrous ions that gives red colour with α-α- dipyridyl which is measured spectrometrically at 520nm. The procedure involves addition of the sample (5g) into standard ethanol solution followed by adding distilled water, xylene and α-α- dipyridyl. The content was mixed thoroughly and absorbance was taken at 520nm respectively (Baker and Frank, 1968).

Determination of Elemental Concentration

The grounded sample (1g) was spread in a porcelain dish and placed in murffle furnance. The obtained ash was digested using 6N- HCl for Analysis of sodium and pottasium using (Alpha, 2005). To the sample solution flame was used to atomize a particular element. The amount of atomization is directly to the quantity of the element in the feeding solution. The intensity was measured with photocell in a selective wavelength range corresponding to the given element.

In metal elements determination a dried powdered sample (0.2g) was accurately weighed into platinum crucible. Followed by adding few drops of de-ionized water were added to dampen the sample. Six (6) cubic centimeter (6cm^3) concentrated HCl acid and one cubic (1cm^3) of hydrofluoric acid were added. The mixture was heated on a hot plate in a fume cupboard. For 2 hours. The reminants concentrated HCl acid was heated on a bath at temperature of 200- 230°C until the acid evaporated to dryness. Six cubic centimeter (6 cm^3) hydrochloric acid was added after cooling filtered, made up to mark with de-ionized water in a 25 cm^3 volumetric flask. The sample solutions were analyzed using AA-240FS of Atomic Absorption Spectrophotometer (Varian, U.S.A California) with air acetylene flame (Jimoh and Mohammad, 2011).

Statistical Analysis

ANOVA (Version 3) Standard software was used to compute data for statistical significance. The three plant parts were analyzed for descriptive (ie mean, sum of standard deviation).

RESULTS AND DISCUSSION

The nutritional compositions of the three parts of *Nymphaea lotus* are presented in Table 1. It can be seen that root sample have significant highest percentage ($p<0.05$) of ash, moisture, and fiber content than leaf and seed samples. Leaf had the significant highest percentage ($p<0.05$) of protein content than seed and root and also seed sample possessed higher amount of lipids and carbohydrates. The moisture content was moderate in leaf and seed due to dry state condition. The ash content of both leaf and seeds exceeds the range reported by Sofowora (1993). The fat content is within the range reported by Borges *et al*. (2008) and Imam *et al*., (2013), which promotes the fat soluble vitamins absorption. The roots had significant high percentage ($p<0.05$) of fibre content than seed and leaves, the consumption of significant quantities would therefore not constitute a risk factor to some pathogenic stages such as diabetic mellitus, obesity and coronary heart diseases. Past studies have linked low fibre content in the diet with health problems like heart disorder, bowel cancer and appendicitis (Pyke, 1979). The nutrient information and antioxidant properties would enhance efforts to promote wide use of plants because of their nutritional benefits and medicinal properties (Wasagu *et al*., 2013).

Table 1: Proximate Composition of Water lily (*Nymphaea lotus*)

Parameters (%)	L S	R S	S S
Ash	12.67 ±1.26[a]	26.67 ± 1.89[b]	2.67 ± 0.29[c]
Moisture	7.500 ± 0.50[a]	9.00 ± 0.48[b]	6.00 ± 0.45[c]
Lipids	2.180 ± 0.29[a]	2.00 ± 0.50[a]	9.33 ± 0.29[b]
Proteins	5.820 ± 0.22[a]	1.02 ± 0.19[b]	1.04 ± 0.17[b]
Fibre	11.50 ± 0.50[a]	24.33 ± 0.58[b]	5.50 ± 0.50[c]
CHO	71.83 ± 1.63[a]	61.31 ± 1.86[b]	80.96 ± 0.37[c]

All values are expressed as mean ± standard deviation, any column /result with the same superscript are statistically not significant (p>0.05) while those with different superscript are statistically significant (p<0.05).
LS: leave sample, RS: root sample and SS: seed sample.

The antinutritional factors levels are presented in Table 2. The divalent elements chelators phytate is found in the leaf sample while oxalate was low in all samples. Tannin content was significantly (p<0.05) high in leaf and seed than root sample. It was reported to have astringent properties that hasten the healing of wounds and prevention of decay (Imam *et al*., 2013).

Table 2: Antinutritional Contents of Water lily (*Nymphaea lotus*)

Parameters (mg/%)	L S	R S	S S
Cyanide	0.108 ± 0.024[a]	0.070 ± 0.010[a]	0.08 ± 0.1000[a]
Phytate	3.94 ± 0.6500[a]	2.16 ± 0.5000[b]	1.41 ± 0.2400[b]
Nitrate	4.47 ± 0.2300[a]	0.19 ± 0.0700[b]	2.53 ± 0.1500[c]
Oxalate	0.012 ± 0.0010[a]	0.011 ± 0.0009[a]	0.004 ± 0.0007[b]
Tannins	5.10 ± 0.0010[a]	1.67 ± 0.0580 [b]	4.38 ± 0.2020[c]
Saponin	0.031 ± 0.003[a]	0.036 ± 0.001[a]	0.021 ± 0.002[b]

All values are expressed as mean ± standard deviation, any column /result with the same superscript are statistically not significant (p>0.05) while those with different superscript are statistically significant (p<0.05).
LS: leave sample, RS: root sample and SS: seed sample.

The study shows that *Nymphaea lotus* root and seed samples had significant (p<0.05) higher iron and zinc content than leave sample (Table 3) respectively, but with lower copper content. The presence of iron is highly important because of its requirement in blood formation, almost two – third of iron in the body is found in haemoglobin which helps in carrying oxygen to tissues (NIH, 2013). The world health organization considers iron deficiency as number one nutritional disorder in the world (CDC, 1998).

Table 3: Some Heavy Metals Contents of Water lily (*Nymphaea lotus*)

Parameters(ppm)	L S	R S	S S
Cadmium	0.010 ± 0.0001[a]	0.012 ± 0.0003[a]	0.012 ± 0.0003[a]
Lead	0.089 ± 0.0002[a]	0.015 ± 0.0004[b]	0.006 ± 0.0001[b]
Mercury	0.689 ± 0.0001[a]	0.694 ± 0.0004[b]	3.442 ± 0.0001[a]
Zinc	0.392 ± 0.0006[a]	0.325 ± 0.0010[b]	0.493 ± 0.0020[c]
Iron	25.32 ± 0.0002[a]	128.07 ±0.0034[b]	0.986 ± 0.0004[c]
Manganese	3.954 ± 0.0036[a]	2.188 ± 0.0002[b]	0.457 ± 0.0007[c]
Copper	0.101 ± 0.0002[a]	0.104 ± 0.0004[a]	0.145 ±0.0002[b]

All values are expressed as mean ± standard deviation, any column/result with the same superscript are statistically not significant (p>0.05) and those with different superscript are statistically significant (p<0.05).
LS: leave sample, RS: root sample and SS: seed sample.

The vitamins contents of the three samples are presented in Table 4. Vitamin E content was significantly (p<0.05) high in the seed than leave and root samples. Vitamin E intake was linked to a decreased incidence of prostate and breast cancer (George, 2009). Root sample had significant (p<0.05) higher concentration of vitamin A than seed and leave samples. Vitamin A protects the lining of respiratory digestion urinary tracts against infection and serves as a visual pigment of the vertebrate eye (Damon, 2009). The high lipid content may facilitate the absorption of the two vitamins. The leaf sample had significant (p<0.05) higher concentration of vitamin C content than seed and root sample. Ascorbic was earlier reported to enhance iron absorption (Wasagu *et al*., 2013), it also prevent debilitating diseases (Bjelakoni *et al*., 2007). Collagen, tendons and ligaments were reported to be dependent upon vitamin C to remain strong and serve healthy (John, 2009).

Table 4: Antioxidant vitamins Composition of water lily (*Nymphaea lotus*)

Parameters (mg/dl)	L S	R S	S S
Vitamin A	12.73 ± 0.208[a]	143.25 ±0.26[b]	21.04 ± 0.456[c]
Vitamin C	9.330 ± 1.528[a]	3.83 ± 1.258[b]	3.17 ±0.2890[b]
Vitamin E	67.36 ± 5.012[a]	103.84 ± 2.04[b]	371.18±1.252[c]

All values are expressed as mean ± standard deviation, any column/result with the same superscript are statistically not significant (p>0.05) and those with different superscript are statistically significant (p<0.05).
LS: leave sample, RS: root sample and SS: seed sample.

The mineral compositions of *Nymphaea lotus*contentare presented in table 5. The sodiumlevel was significantly (p<0.05) low in seed sample than in leaf and root samples and also sodium content of the root while, the potassium content was significantly (p<0.05) high in seed than leave and root samples. The low sodium and high potassium was suggested as a food source for hyperglycemic patients in addition to the increase in iron utilization (Adeyeye, 2002 and Hassan *et al*., 2005). Thus, *Nymphaea lotus* could serve complement in food formulation and pharmaceutical industries. This compliments the earlier report that herbs are significant nutritional sources of minerals (Hassan *et al*., 2007). The calcium content was significant (p<0.05) high in leave than seed and root samples. Calcium in conjunction with magnesium, chlorine and protein participate in bone formation (Abdullude, 2007). The availability of calcium in the body depends on calcium to phosphorus ration and presence of oxalate and phytate (Bentiff and Koster, 2006). The three samples of *Nymphaea lotus* significantly possess low phosphorus content.

Table 5: Mineral Elements Content of water lily (*Nymphaea lotus*)

Parameters (ppm)	L S	R S	S S
Phosphurus	0.310 ± 0.0010[a]	0.190 ± 0.002[b]	0.367 ± 0.006[c]
Calcium	123.267±0.0003[a]	31.127±0.005[b]	13.491±0.001[c]
Magnesium	36.346±0.346[a]	30.034±0.002[a]	19.676±0.001[b]
Potassium	6000 ± 400.009[a]	8800 ± 400.000[b]	3333.3 ± 461.880[c]
Sodium	533.33 ± 15.28[a]	966.67 ± 15.270[b]	146.67 ± 15.220[c]

All values are expressed as mean ± standard deviation, any column/result with the same superscript are statistically not significant (p>0.05) and those with different superscript are statistically significant (p<0.05).
LS: leave sample, RS: root sample and SS: seed sample.

CONCLUSION

The study shows that water lily (seed, leave and root) contains all classes of food such carbohydrate, protein, lipid and fibre and also some essential elements such as Na, K, Mg, Mn, Ca, Fe and Zn in addition to antioxidant vitamins (A, C and E). The concentration of hazardorous antinutritional factors in the aforementioned plant parts are reasonable low.

RECOMMENDATIONS

i. Further research should be carried out to evaluate medicinal properties and toxicological studies of all parts of water lily.
ii. Feeding trial of the plant parts should also be carried out
iii. Bakers should be introduced to the usage of water lily flour to reduce over dependence of wheat flour.

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