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Proximate Nutrient Content Analysis of Some Aquatic Weeds of Dal Lake Srinagar

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Abstract
The current study was carried out in Dal lake Kashmir, one of the famous and largest water bodies of Srinagar city. The aquatic weeds including *Nelumbo nucifera*, *Lemna minor*, *Azolla* sp., *Salvinia natans, Trapa natans, Potamogetton crispus, Potamogetton lucens, Hydrilla verticillata, Ceratophyllum demersum, Myriophyllum spicatum* and *Myriophyllum verticillatum* were selected to evaluate the proximate nutritional potential. The moisture content of aquatic weeds was found to be in the range of 83-96% and ash content was found to be in the range of 8-28%. The highest moisture content was found in case of *Salvinia natans* (96.58±0.46) while the lowest moisture content was recorded in case of *Myriophyllum spiciatum* (83.70±1.50). Highest values for ash content was observed in *Myriophyllum verticillatum* (28.830±1.23) and *Nelumbo nucifera* showed the lowest (8.93±1.23). Highest value for lipids was obtained from *Ceratophyllum demersum* (6.04±0.15) while *Salvinia natans* gave the lowest value of (0.88±0.25). The crude protein and crude fibre values were observed highest in case of *Azolla* sp. (23.23±0.52) and *Potamogeton crispus* (23.15±0.18) respectively while the lowest values were seen in *Myriophyllum spiciatum* (10.13±0.26) and *Nelumbo nucifera* (1.69±0.18) respectively. In current study, the nutritional potential of the selected aquatic macrophytes harvested from Dal lake was evaluated through proximate compositions and analyzed in percentage. Therefore, this study suggests that these plants could be used as a good source of protein and other nutrients for incorporation in animal diet. Exploiting these macrophytes may be of great economic importance and a step to harvest these plants for feed production and better utilization in medicinal uses. Moreover, this could be also helpful in solving the problems attributed with weed eradication.

Keywords
Macrophytes, Dal lake, Nutritional, Weed, Eradication.

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INTRODUCTION

Aquatic weeds are defined as unwanted and undesirable plants which grow and reproduce in an aquatic environment [1]. These plants grow abundantly in lakes and waterways around the globe and play a pivotal role in nutrient cycling [2]. Their limited growth may be useful in maintaining water quality and may serve as shelter and food substrate for aquatic organisms but their uncontrolled growth may cover the surface of the water bodies leading to numerous problems. These plants grow profusely in water bodies and have become weedy in many lakes and ponds. The uncontrolled growth of these weeds is one of the primary causes associated with accelerated eutrophication in lakes. The alarming growth rate of aquatic plants have perceived as a nuisance over the years rather than resource with their eradication almost impossible, difficult to control, block canals, hinder boat traffic, nuisance to fishing and increase water borne diseases [3]. These plants however have some positive uses and their productive use would be desirable if it would partly offset the costs associated with their mechanical removal. Macrophytes are being considered as a good source of food and fodder for humans, aquatic herbivores and farm animals. They are also used as fertilizers like mulch, ash, green manure, compost etc. for the production of crops, flowering beds and also serve as a base of aquatic food chain [4-8]. Also, numerous workers all over the globe have shown considerable interest in recent past to explore the possibilities of using these plants as a source of feed for livestock and medicinal plants [9-11] including herbivores and fish feed formulation. It has also been reported that these plants serve as phytoremediation agents [12], as biosorbents for toxic metals [13] for power fuel production [14, 15] as compost [16] and as medicinal plants [11]. For management of lake ecosystem, it sometimes becomes a pre-requisite to control water weeds where mechanical harvesting offers several ecological and practical advantages as it helps in the removal of nutrients and avoids the deleterious effects of herbicides [17]. The expenses involved in the removal of macrophytes from the lake could however, be balanced potentially by the utilization of the harvested materials as food, fodder, fuel and fertilizer. This would require an investigation into the gross composition of aquatic weeds. Moreover, water weeds have high xanthophyll content and high food value thus can impart excellent yolk coloration when fed to poultry. It is with these backdrops the present study regarding some dominant aquatic weeds occurring in Dal lake was undertaken to evaluate their nutritional potential.

MATERIAL AND METHODS

Study Area

Dal lake is multi-basined and probably originated from the River Jhelum with Hazratbal, Boddal, Gagribal and Nagin as its four basins. It is situated at an altitude of 1586 m above sea level between 34°5'–34°9' N latitude and 74°49'–74°52' E longitude, in Srinagar city, the heart of Kashmir valley. The lake has shrunk in area to less than half, which once was 22 km^2 is only 10.4 km^2 at present due to the formation of floating gardens, land masses and marshes. Water quality of the lake is also deteriorating, posing serious health hazards to people living in its catchment. There has been a growing concern about the Dal Lake in the past few decades which is getting choked up by unstoppable growth of macrophytes due to cultural eutrophication. Therefore, some processing means are being adopted to explore and enhance the nutrient value of these plants and their ingredients. The plant materials for present study were collected at different sites of Dal lake for a period of six months during May to October 2018. Eleven species of macrophytes belonging to different systematic forms were chosen for the study (Table 1). The selection was made considering the abundance of macrophytes at the sampling sites and the easiness for recognition and collection.

Weed analysis

The macrophytes were collected from their natural habitats, washed thoroughly with water and placed in polybags and transported to the laboratory where they were incised to include only leaves and shoots. The washed plant materials were air dried for a couple of days and stored in plastic containers at room temperatures until use.

Total moisture

For determining the moisture content of aquatic weeds, the wet samples were put in pre weighed dry Petri dishes and then weighed again. The Petri dishes with wet samples were kept in digital hot air oven for drying at 105°C for about 24 hours or until the constant weight was obtained [18]. Then dry samples were taken out from oven and put in desiccators, after 30 minutes the weight was taken, the difference in weight was calculated and expressed as percentage moisture content of the sample by using the following formulae.

$$\textbf{Moisture (\%)} = \frac{\text{Wet weight of sample (g) - Dry weight of sample (g)}}{\text{Wet weight of sample (g)}} \times 100$$

Total ash

The moisture free dried weed samples were grinded and finely powdered with the help of mortar and pestle, converting samples into fine powder for the analysis of ash content. The fine powdered samples were taken in clean pre-weighed silica crucibles and weighted again along with samples. The crucibles containing samples was then placed in a muffle furnace at 650°C for about 4-6 hours or till the residue became completely white [19]. The samples were then allowed to cool in desiccators for about 20-30 minutes, reweighed and the amount of ash was calculated as the difference in weight. The percentage of ash was obtained by using the following formulae.

$$\textbf{Total ash (\%)} = \frac{\text{Weight of ash (g)}}{\text{Weight of sample (g)}} \times 100$$

Protein

The moisture free samples were used to determine crude protein content by Kjeldahl method [19]. The value of Nitrogen was multiplied by i.e. 6.25 to obtain respective protein value.

Fibre

Crude fibre content of the sample was estimated as per [19] by acid base digestion method. The residue was ignited after digestion, in the muffle furnace at 500º C for 3 hours.

$$\textbf{Crude fibre (\%)} = \frac{\text{Weight of dry residue - Weight of ash residue}}{\text{Weight of sample}} \times 100$$

Lipid

The method of Floach [20] was used to determine the lipid content and expressed in percentage of weight of sample analyzed.

$$\textbf{Crude lipid (\%)} = \frac{\text{Weight of extract}}{\text{Weight of the sample}} \times 100$$

RESULTS AND DISCUSSION

The present study revealed profound variations in the moisture and ash content among 11 different aquatic weeds chosen for the study. The data of proximate nutrient content analysis of the weeds is presented in the Table 2. The results from the analysis revealed that the moisture content of aquatic weeds was found in the range of 83-96%. The values for the highest moisture content was recorded in case of *Salvinia natans* (96.58±0.46) followed by *Azolla* sp. (94.70±0.27) while lowest moisture content was recorded in case of *Myriophyllum spiciatum* (83.70±1.50). The ash content shows the amount of inorganic substance that would remain after complete combustion of the biomass. The ash content was found to be in the range of 8-28% and the ash content of submerged plants was found to be higher as compared to emergent or floating types. *Myriophyllum verticillata* has shown the highest ash content (28.83±1.23). The lowest ash content was observed in case of *Nelumbo nucifera* (8.93±1.23) followed by *Trapa natans* (11.22±2.20). It is generally accepted that the component of aquatic plants is similar to those in plants adapted to grow on land [21]. Little and Henson [22] stated that a typical water content of a floating aquatic plants is about 92%. However, the moisture contents in the results given showed variations and are lower than as those reported for water plants. The crude protein values were in the range of 10.13-23.23%. This could be due to micro-habitat variation in the study area. The protein content was seen highest in *Azolla sp*. (23.23±0.52) and *Myriophyllum spiciatum* has shown the lowest values for crude protein content i.e., (10.13±0.26). Our study supports the work of [23, 24] who have got the similar results. The high protein content in Nelumbo emphasizes its value as a vital source of nutrients. The values for crude fibre ranged from 1.69 to 23.15%. Highest crude fibre content was obtained in *Potamogeton crispus* (23.15±0.18) while the lowest values were recorded in *Nelumbo nucifera*. The aquatic plants alter their structure in respect that they have lower values for crude fibre than that of the terrestrial plants in order to maintain buoyancy in water and may increase with maturity. The results of our study are supporting the work conducted [25-28]. Crude lipid content was found in the range of 0.88 to 6.04%. The highest value was obtained in *Ceratophyllum demersum* (6.04%) and the lowest lipid content was recorded in that of *Salvinia natans* (0.88%). The differences in the proximate composition of plants could be attributed to different processing techniques, plant species type, variations in climate and soil chemistry [29]. It has been also reported that disparity in nutritive value among different plants may be attributed to differences in environmental conditions, such as soil composition, harvesting methods, ingredients varieties and temperature [30, 31]. The comparative nutrient contents of the studied plant species are shown in the Fig. 1-5.

Table 1: Systematic form of aquatic plants collected from Dal lake

Systematic form	Plant name	Common name
Emergents	*Nelumbo nucifera*	Indian lotus
Floating	*Lamna minor*	Water lens
	Azolla sp.	Mosquito fern
	Salvinia natans	Floating fern
Submerged	*Trapa natans*	Water chestnut
	Potamogetton crispus	Curly leaf pondweed
	Potamogetton lucens	Shining pondweed
	Hydrilla verticillata	Water thyme
	Ceratophyllum demersum	Hornwort
	Myriophyllum spicatum	Spiked water milfoil
	Myriophyllum verticillatum	Whorled water milfoil

Table 2: Proximate nutritional content analysis of selected aquatic weeds

Plant Name	Moisture (%)	Ash (%)	Protein (%)	Fibre (%)	Lipid (%)
Nelumbo nucifera	87.06±0.60	8.93±1.23	18.56±0.49	1.69±0.18	1.68±0.33
Lemna minor	91.25±0.65	15.94±1.50	11.94±0.27	14.44±0.64	1.09±0.08
Azolla sp.	94.70±0.27	15.89±0.23	23.23±0.52	14.16±0.34	1.88±0.25
Salvinia natans	96.58±0.46	14.80±0.92	14.65±0.56	16.32±0.40	0.88±0.25
Trapa natans	90.24±0.60	11.22±2.20	15.99±0.31	12.95±0.66	0.90±0.14
Potamogeton crispus	91.65±1.63	22.84±2.23	10.83±0.29	23.15±0.18	3.01±0.15
Potamogeton lucens	87.99±1.13	21.12±2.13	13.91±0.10	21.43±0.72	2.95±0.05
Hydrilla verticillata	90.20±0.92	18.32±1.23	20.00±0.08	13.02±0.19	5.05±0.14
Ceratophyllum demersum	92.98±0.23	24.37±3.63	22.03±0.24	20.86±0.73	6.04±0.15
Myriophyllum spiciatum	83.70±1.50	24.23±0.59	10.13±0.26	12.82±0.51	1.94±0.10
Myriophyllum verticillata	92.09±1.02	28.83±1.23	11.93±0.30	12.98±0.06	2.04±0.10

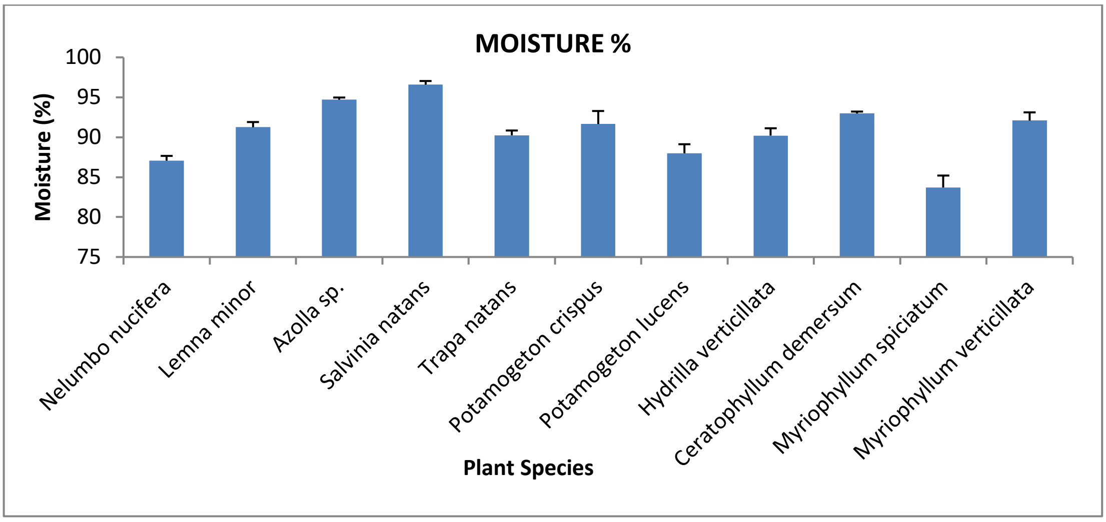

Figure: 1 Comparative moisture content of aquatic weeds

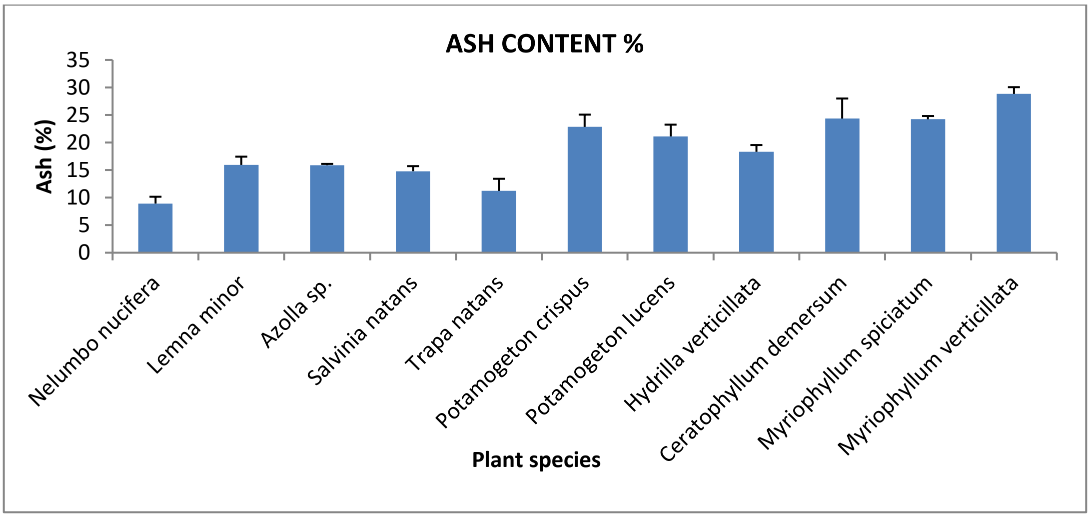

Figure: 2 Comparative ash content of aquatic weeds

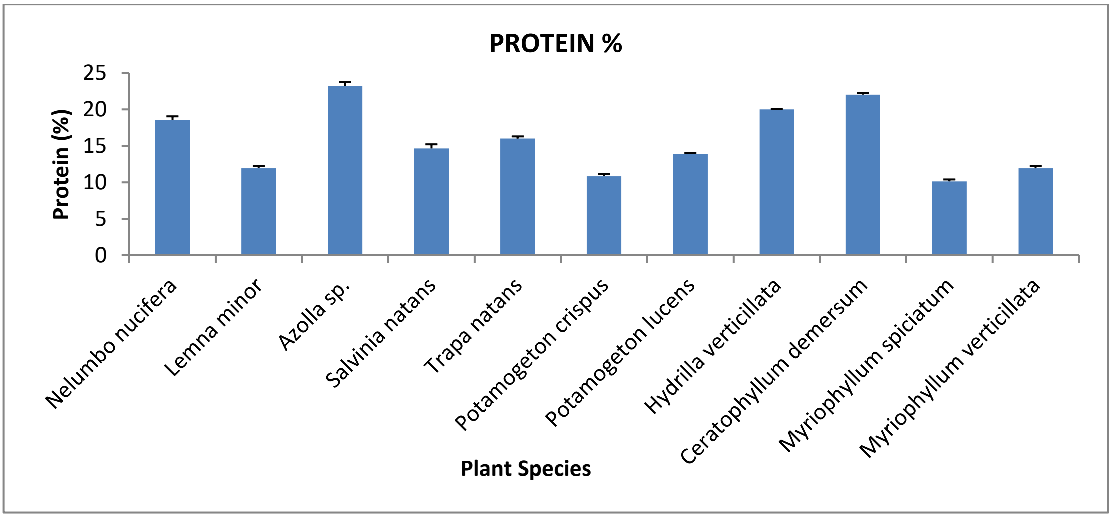

Figure: 3 Comparative protein content of aquatic weeds

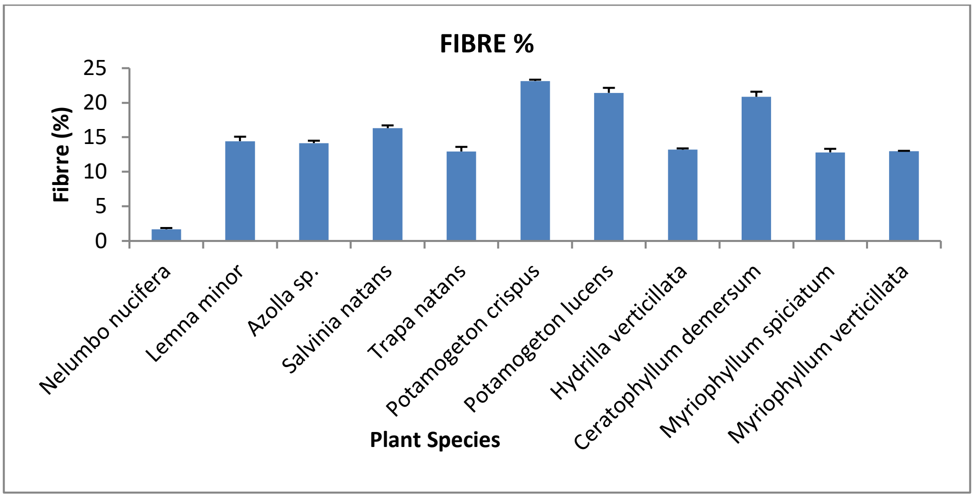

Figure: 4 Comparative fibre content of aquatic weeds

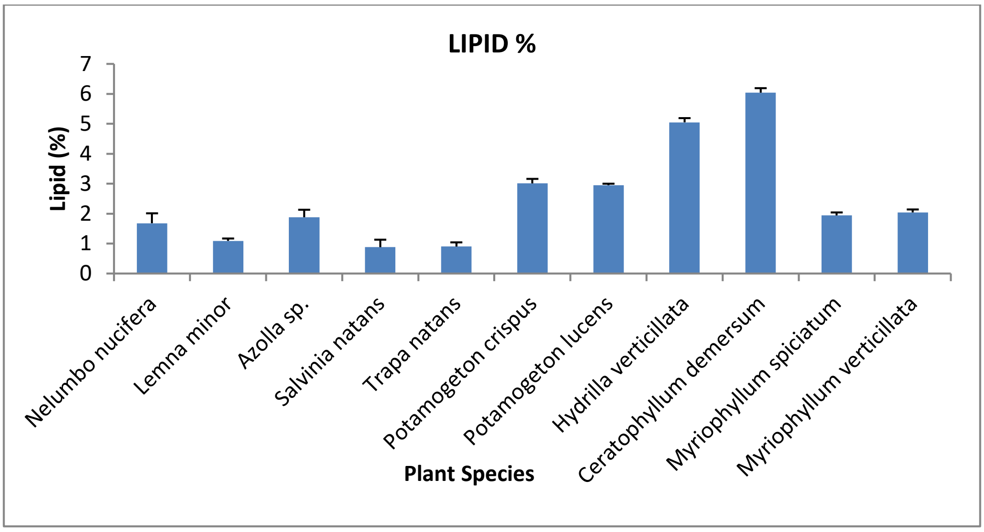

Figure: 5 Comparative lipid content of aquatic weeds

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CONCLUSION
Considering the fact of high accumulation of nutrients in fresh water macrophytes, it may be concluded that these plants could be useful in food production processes as human food, forage, fertilizer and food for various aquatic herbivores like fishes etc. The present analysis of various nutrient contents of fresh water macrophytes have shown that these plants could be used as supplementary source of food and fodder. Although variations existed among the studied species, still some of these plants were high in crude protein and other nutrients. The fluctuations in nutrient contents in the studied plant species recorded herein may be due to the influence of physic-chemical factors along with other variations related to growth metabolism, development and accumulation efficiency of the plant species. Exploiting these plants will be a step towards better utilization of such plants for food production and will be of great economic importance also. As when the demand of food and energy with every passing day is increasing due to population explosion and rising pollution of water ecosystems, which results in decreasing output of food resources from land due to urbanization and soil pollution. These macrophytes can serve as an alternate source of food to feed the world which is based on their high nutritive value. Moreover, harvesting these plants by mechanical means will not only help us in solving the

weed eradication problems, but also these plants when processed can be incorporated as a good source of protein and other nutrients in animal feed.

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