Role of macrophytes in aquatic ecosystem: A case study on Dal Lake, Kashmir

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Abstract - Macrophytes play vital role in maintaining the structure and functioning of the lake ecosystems. They act as bio indicators of pollution of water body, provide suitable habitat for different life forms. Macrophytes have a great efficiency and potential of absorbing nutrients from the sediments by their roots, thus improving the lake water quality. In the present study, the higher accumulation of biochemical constituents-carbohydrates, proteins and lipids suggested that macrophytes belonging to different life-form classes can be utilized as a potential source of food and fodder for humans and bovine animals as well as fertilizers for agriculture fields and flowering gardens. The concentration of total carbohydrates was found to be higher during the peak growth season of macrophytes in case of rooted –floating like *Nelumbo nucifera* and *Potamogeton natans* (19.11 ± 0.67 % and 18.4 ± 1.36 % of fresh weight) and Maximum concentration of total lipids accumulated in case of Emergents like *Typha angustata* and *Nelumbo nucifera* rooted – floating (6.78 ± 1.98 % and 5.39 ± 1.89 % fresh weight) where as the The higest concentration of total proteins was registered for rooted floating-leaf type macrophytes such as *Nelumbo nucifera and Potamogeton natans* (3.40 ± 0.15 % and 2.10 ± 0.30 % of fresh weight) respectively.The analysis of carbohydrates, proteins and lipids indicated the presence of species specificity as well as spatial and temporal variations. The finding of the present study revealed that macrophytes play important role in determining the functioning and structure of the fresh water ecosystem.

Keywords: **Aquatic plants; Biochemical composition; life-form classes.**

I. INTRODUCTION

Macrophytes are the aquatic plants that need regular supply of water. Macrophytes are also known as hydrophytes and are the photosynthetic organisms of fresh water habitat. Macrophytes are the important component for shaping the physical environment and also determine the structure of biotic communities and form the base of aquatic ecosystems (Penfound, 1956; Cook *et al.*, 1974; Mitchell, 1974; Wetzel 2001). Aquatic weeds play an important role in nutrient cycling in water bodies like lakes, ponds and other waterways. A growth of aquatic weeds in water bodies shows the presence of nutrients in water bodies and also determines physico-chemical properties (Pompeo and Moschini-Carlos, 2003).

Macrophytes act as a source and sink of nutrients, thereby modifying the nutrient chemistry within the water body (Carnigan and Kalff, 1980; Pandit, 1984; Cronk and Fennessy, 2001). Macrophytes have a great role in development of wetlands by removing contaminants from the water bodies (Maine *et al.*, 2006).The high growth rate of macrophytes in lakes, ponds and other waterways causes eutrophication by covering the surface of water bodies which block water ways, block canals and increase water borne diseases (S. Gupta, *et al.*, 2008). The limited growth of macrophytes are very useful to water bodies because macrophytes maintains water quality, and have a good medicinal value after harvesting, they provide food and shelter for aquatic organisms but their uncontrolled growth damage the water bodies by covering the surface. It has been found that the macrophytes are being used as a good source of food for livestock and humans (Deepa, *et al.*, 2009; Shah *et al.*, 2010; Naghma and Sarwat, 2005). After harvesting macrophytes can be used in different ways as a good source of food and f odder for aquatic herbivores, humans and farm animals. They are also utilized as fertilizer like mulch, green manure, ash, and compost manure etc. for use in crop production like in paddy fields, home gardens for vegetables, flowering beds, apple gardens etc and also serves as a base for aquatic food chain (Hasan

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and Chakrabarti, 2009; Tardio *et al.,* 2005; Rahman *et al.,* 2007; Swapna, *et al.,* 2011). In order to determine the food potential and nutritional value it is necessary to determine the biochemical composition of different macrophytes (Chapman 1950; Hawkins and Hartnoll, 1983). It has been found that the abiotic factors such as light, temperature, sediment composition and water chemistry have a great impact on level of proximate nutrient constituents, photosynthesis and growth rates (Koskimies and Nyberg 1987; Rajasulochana *et al.,* 2002; Roslin, 2001). Light, temperature and Growth rate, influences photosynthesis, reproduction, chlorophyll composition, lipids and protein composition and morphology (Barko *et al*., 1986; Chambers, 1982; Nekrasova *et al.,* 2003; Ronzhina *et al.,* 2004; Robledo and Freile-pelegrin, 2005). So after harvesting these macrophytes they can be used as food for humans, animals and aquaculture purposes is based on their high nutritive value arising from the richness of biochemical constituents such as proteins, fibre, lipids, carbohydrates etc. proteins, fibre, carbohydrates and lipids are the major energy-yielding nutrients that are necessary for the human and animal body to enable the body in order to generate a good amount of energy to perform the body functions (Rather and Nazir, 2015). The aim of the present study is to highlight the significance of macrophytes in fresh water ecosystem by assessing their biochemical constituents.

II. STUDY AREA

The valley of Kashmir is exists between the lesser and Greater Himalayas characterized by numerous aquatic ecosystems of great ecological and economic importance. The fresh water bodies of Kashmir Himalayas are the big sources of drinking water, irrigation, navigation, fishery, agriculture, socioeconomic development and recreation.

Dal lake is located in the heart of Kashmir valley in Srinagar city at an altitude of 1586 m above sea level between 34°5'– 34°9" N latitude and 74°49'–74°52' E longitude. Dal lake having been formed from the ox-bows of the River Jhelum and is probably of fluvial origin and originated from the River Jhelum. Due to increasing anthropogenic pressures of population living in vicinity, formation of floating gardens, land masses and marshes the present area of Dal Lake has been reduced to 10.4 km^2 only. The lake is not only shrinking in its surface area, but its water quality is also deteriorating, posing health hazards to the people living in its catchment.

Dal Lake, a multi-basined urban valley lake is divided into four basins like Hazratbal, Boddal, Gagribal and Nagin Lake. A large number of researchers studying the limnological features provide extensive data that shows that in recent decades, the ecosystem of these water bodies changed drastically due to the heavy anthropogenic pressures, discharge of large quantities of waste from human settlement which results shrinking of lake surface area and deterioration of water quality, thereby resulting in the enormous growth of macrophytes and eutrophication of Dal Lake.

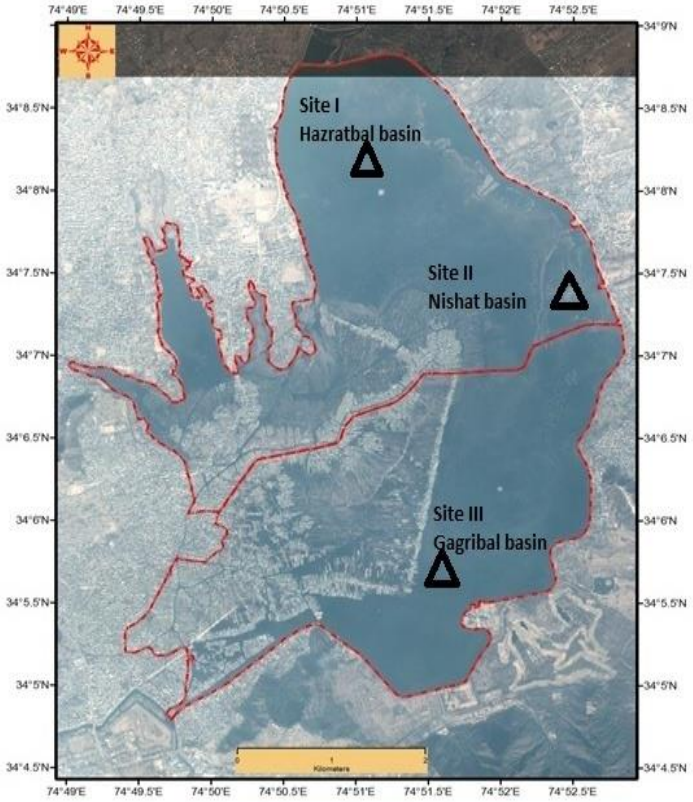

Figure: 1. Study Area and Sampling sites

Table: 1: Showing general geographical features of three sampling sites.

Site	Code	Latitude	Longitude
Hazratbal basin	I	34° 08′ 03.8″ N	74° 50′ 40.1″ E
Nishat basin	II	34° 06′ 33.1″ N	74° 51′ 05.5″ E
Gagribal basin	III	34° 05′ 12.5″N	74°52′ 40.0″ E

III. MATERIALS AND METHOD

The present study was carried out in the dal lake during five months in three basins namely as (I Hazratbal basin, II Nishat basin, III Gagribal basin) and the material was collected from the 3 basins for a period of five months during June to October (Fig). The sampling site selection was made on the basis of the abundance of macrophytes, where there is easy collection recognition. The choice of macrophytes for analysis was done on the basis of forms. Nine species of macrophytes belonging to three different systematic forms emergents, rooted-floating leaf type and submerged (03 each) were chosen for the present study (Table 2).

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Table: 2 Macrophytes with scientific name, common name and flowering season that were collected from Dal Lake for the proximate nutrient analysis.

S. No.	Plants	Scientific name	Common name	Flowering period
1	Emergents	*Typha Angustata*	*Cattalis*	June-July
2		*Phragmites Australis*	*Common reed*	July-August
3		*Azolla sp.*	*Mosquito fern*	July-August
4	Rooted Floating	*Nelumbo nucifera*	*Lotus*	July-September
5		*Potamogetan natans*	*Pondweed*	July-September
6		*Trapa Natans*	*Water chestnut*	July-September
7	Submerged	*Potamogetan lucens*	*Shining pondweed*	May-September
8		*Ceratophyllum demersum*	*Horn wort*	May-September
9		*Myriophyllum verticillatum*	*Whorled water milfoil*	September-November

IV. WEEDANALYSIS

The biochemical analysis of macrophytes like total carbohydrates, total lipids and total proteins for macrophytes were worked out on monthly basis for a period of five months. The identified macrophytes were picked with the help of tools from their natural habitat, washed and clean thoroughly with water with proper care so that there is no damage to the sample then put in ecofriendly polybags. For further treatment the samples were transported to the laboratory, where macrophytes were sorted and then incised with the help of scissor into include leaves and shoots and sorted out. In order to make macrophytes free from mud, periphytic growth, encrustaceans, etc. the plant material was again washed thoroughly and then washed macrophytic materials was kept in plastic containers at room temperatures, air dried for some days up to analysis or moisture was drained before being analysed for various biochemical parameters. The analysis was done as per standard methods given by Lowry *et al*. (1951), Dubious *et al*. (1956), Knight *et al*. (1972), Bames and Blackstock (1973).

Total protein content of macrophytes was determined colourimetrically by the method of Lowry *et al.* (1951).Total carbohydrate content of macrophytes was determined colourimetrically by phenol - H_2S0_4 method after extraction into buffer solution of pH-7 (Dubois *et al.*, 1956). Total lipid content of macrophytes was determined colourimetrically by Sulphophosphovanillin method after extraction in buffer solution of pH-7 (Knight *et al*., 1972; Bames and Blackstock, 1973).

V. RESULTS AND DISCUSSIONS

The results of the present study showed profound variations in the biochemical constituent's viz. carbohydrates, total lipids and protein content among different macrophyte species. The results are expressed as mg/gm on fresh weight basis. It has been found that the maximum concentration of total carbohydrates was found to be higher during the peak growth season of macrophytes in case of rooted –floating like *Nelumbo nucifera* (19.11 ± 0.67 % of fresh weight) and the minimum concentration of total carbohydrate in case of *Ceratophyllum demersum* (10.7 ± 0.93 % of fresh weight). As shown in fig 2. Similar results have also been reported by (Pandit and Qadri, 1986; Gatenby *et al.*, 2003). The variations in carbohydrate concentration among the macrophytes may be attributed to the factors like growth medium, nutrient level, climatic factors, hydrological conditions and sediment characteristics which alters the vegetative growth metabolism and causes variations in soluble carbohydrate concentration in plant tissues. (Prasannakumari and Ganga, 2012).

Table .3: Biochemical analysis analysis on mean value basis of selected Macrophytes of Dal Lake.

Plant Name	Carbohydrate	Lipid	Protein
Typha angustata	15.9 ± 0.77	6.78 ± 1.98	1.17 ± 0.8
Phragmites australis	16.35 ± 0.69	2.19 ± 1.09	1.19 ± 0.8
Azolla sp.	14.74 ± 0.38	3.97 ± 2.21	1.28 ± 1.17
Nelumbo nucifera	19.11 ± 0.67	5.39 ± 1.89	3.40 ± 0.15
Potamogetan natans	18.4 ± 1.36	2.57 ± 1.31	2.10 ± 0.30
Trapa natans	11.71 ± 0.54	3.68 ± 1.92	1.05 ± 0.7
Potamogetan lucens	13.5 ± 1.1	4.7 ± 1.21	1.15 ± 0.10
Ceratophyllum demersum	10.7 ± 0.93	4.77 ± 1.21	0.97± 0.4
Myriophyllum verticillatum	12.71 ± 0.54	3.38 ± 1.23	1.9 ± 0.32

The concentration of lipids recorded its highest value in case of emergents like *Typha angustata* (6.78 ± 1.98 % of fresh weight) and where as the lowest was recorded in case of *Phragmites australisa* (2.19 ± 1.09 % of fresh weight) during the peak growth season. As shown in fig 2. It shows that they have high efficiency of absorbing plant nutrients from the sediments, thus helping in pollution control and

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abatement (Pandit, 1984). The results of present study coincide with that of (Pandit 1984; Dar *et al.*, 2013; Boyd, 1968; Pandit and Qadri, 1986). Aquatic plants have been reported to contain 1.18 to 5.42% total lipid content (Boyd, 1968). Difference in the concentration of various biochemical constituents of macrophytes depends upon species, season and location (Annon; 1984). In different genera the fluctuations in lipid concentration may be due to the changes in different environmental factors that might have influenced the development and vegetative growth including availability of nutrients, allochthonous materials as well as variation in the efficiency of lipid accumulation among the plants (Dar *et al.*, 20130). As a result of frequent rains in early autumn shows the significant increases in lipid for *Ceratophyllum demersum*. This shows that during this period there is acceleration in productive metabolic activity and/or in dry period there is higher consumption of this organic compound (Esteves and Suzuki, 2010; Haroon *et al.*, 2000; Nelson *et al.*, 2002). The findings of the study revealed that during the utilization of more photosynthetic intermediates there will be more concentration of lipids and decreases level of proteins and carbohydrates. It has been found that during this period the submerged plants shows the higher accumulation of lipid content and suggests that this period is more suitable for the growth and development of these species macrophytes (Dar *et al*,. 2013; Daniel R, *et al.*, 2005)

During the peak growth season it has been found that total proteins concentration was registered highest value in case of rooted floating-leaf type macrophytes-*Nelumbo nucifera* (3.40 ± 0.15 % of fresh weight) and *Ceratophyllum demersum* recorded its lowest value as (0.97 ± 0.4 % of fresh weight). As shown in fig 2.Similar results have also been reported by (Prasannakumari and Ganga, 2012; Jayasankar and Kulandaivelu, 1999; Banerjee and Matai, 1990). As a result of species, season of the year, locality and water distribution influences spatio temporal variation in protein content of macrophytes. (Prasannakumari and Gang,2012). In general, physicochemical factors causes the variations in vegetative growth, metabolism and development of the plant and may cause the fluctuations of protein content in the same plant. Different plants show different accumulation at the one station. This may be due to variation in the accumulation efficiency in terms of their phenology. The environmental factors such as pH and high amount of nutrients created a congenial atmosphere for the luxuriant and healthy growth of the plant. High growth rate causes rapid formation of tissues and increases protein content and it is in agreement with the findings of [Prasannakumari and Ganga, 2012; Gangadevi 1997; Banerjee and Matai 1990;. Thus, specificity as well as spatial and temporal variations has been found during the analysis of carbohydrates, proteins and lipids.

VI. DISCUSSIONS

The results of the present study shows that macrophytes plays essential roles in maintaining the functioning of the lake ecosystems They act as the bio indicators of pollution of water body, provide suitable habitat for different life forms, have a great efficiency of absorbing nutrients from the sediments by their roots and improve the water quality. Macrophytes are important in releasing nutrient from water to surface by absorbing nutrients from deep layers and act as nutrient pump. Macrophytes decrease the eutrophication by absorbing nutrients and convert them into carbohydrates, proteins, lipids, chlorophyll etc. which are used by macrophytes for growth and development (Hynes, 1970; Pandit, *et al.*, 2010; Smith, *et al.*, 1999; Pandit and Qadri, 1986).

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