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Comparative Nutritional Evaluation of Wetland Plants Available in Old Alluvial Zone of West Bengal

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Abstract—*The present study was carried out to evaluate the chemical composition of different wetland plants available in Old Alluvial Zone of West Bengal. The study was conducted taking three districts under old alluvial zone. The dominant wetland species were identified and screened based on crude protein content. Fifteen aquatic plants having crude protein content more than 8 per cent were collected and analysed for their chemical composition in terms of proximate composition, fiber fractions, protein fractions and mineral profile. Most of the selected wetland plants were having more than 12 percent CP. The results of present study showed that these wetland plants available in old alluvial zone were good sources of most of the minerals specially calcium, zinc, manganese and iron. Some of the plants though poor in protein but rich in mineral profile. Some plants like Eichhorniathough good source of CP and minerals but having high content of ADL and PC which reduce its value as feed supplement. Finally, critically analysing different parameters analysed here, five wetland plants namely, Jussearepen,Enhydrafluctans, SpirodelaPolyrhyza, Lemna minor and Marsileaminuta were found to be better sources of essential nutrients and can also serve as potential alternative feed resource in ruminant ration in old alluvial zone of West Bengal.*

Keywords: *Wetland plants, Aquatic plants, Nutritional Evaluation, Old Alluvial zone*

Introduction

Livestock sector plays a crucial role in rural economy and livelihood. Though India is a leading producer of milk, meat, eggs and other livestock products but the individual production capacity of the animals is 20-60% below the world average. This is only because of the improper nutrition which is contributed by the inadequate supply of feeds and fodders. This shortage of feeds and fodders is mainly due to continuously increasing livestock population, continuously decreasing fodder cultivation area and competition of animals with human food resources. Increase in human population also creates problems as many fodder cultivation areas are covered with human settlements which results in less available area for fodder cultivation. So, there is a huge deficit in green forage as well as concentrate ingredients for the livestock. In order to fulfil this gap, and to ensure optimum production of livestock throughout the year, use of non-conventional feed resources as supplemental feed without compromising on the quality is the area of focus in recent years. The cost related to the animal feeds account for 70% of the total cost of production [1]. The use of nonconventional local feed in the diet of animals reasonably seems to be an alternative to costly conventional commercial feed. Non-conventional feed resources include various agro industrial by-products, tree leaves, crop residues and wetland/aquatic plants. West Bengal is a place having large no. of water bodies and having many varieties of aquatic plants. In India, 7 million Ha. area is covered by inland water bodies excluding rivers and canals. Out of which tanks and ponds have maximum area (2.9million hectare). West Bengal is having an extensive varieties of wetland plants as compared to other states in India. According to a survey report [2] this wide diversity includes 370 species belonging to 170 genera and 81 families. Wetlands of West Bengal covering around 8.5% of the wetland zones (considering water bodies > 100 ha) of India. Southern states of India like Andhra Pradesh, Karnataka and Tamil Nadu along with West Bengal, Rajasthan and Uttar Pradesh, account for 62 percent of total area under tanks and ponds in the country.

Wetland vegetation/ aquatic plants are widely available in water bodies and nearby areas throughout India mainly in the eastern part of India. These are considered as weeds and sometimes destroyed by people. Some of these plants are expected to have good nutritional value, they can be used as animal feed, which will be helpful to fulfil the gap between demand and supply of fodder/ nutrients to large extent.In West Bengal, various wetland plants like Water lettuce, Nymphaea, Azolla, Water hyacinth, Salvinia etc. species are found in various lakes and water bodies [3]. The proximate composition of azolla is comparable with other conventionally used commercial feed supplements [4]. Fresh azolla supplementation can improve the growth rate of crossbreed heifers with a economized ration without having any adverse

effect on blood metabolites [5]. Naturally occurring aquatic plant *Spirodela* has been reported to act as a unconventional feed supplement for growing cattle without any adverse effects on growth rate, blood parameters, feed conversion efficiency and nutrient digestibility [6]. There is very little or no information is available on chemical composition of wetland vegetation or aquatic plants available in old alluvial zone of West Bengal. So, in the present study the samples of commonly available wetland plants from old alluvial zone of West Bengal have been collected to analyze the comparative nutritional composition of these plants

Materials and Methods:

Collection of Plant Samples

For the present study, various ponds, water logged areas and other water bodies were selected fromold alluvial zone under three districts (Burdwan, Murshidabad and Hoogley) of West Bengal. After the investigation different water bodies were selected which

were infested with different aquatic weeds. Based on the availability and crude protein (CP) content (>8 %) the wetland plants were screened. Fifteen wet land plants having CP more than 8 % were thus selected for comparative chemical evaluation. The detailed information on the selected aquatic macrophytes have been presented in Table 1.

Table 1: List of the selected wetland plants

SN	Botanical Name	Common Name	Family
1	Jussiaearepens	Creeping water primerose	Onagraceae
2	Enhydrafluctans	Helencha	Asteraceae
3	Eichhorniacrassipes	Water hyacinth	Pontederiaceae
4	Marsileaminuta	Dwarf water clover	Marsileaceae
5	Trapanatans	Water chestnut	Trapaceae
6	Ipomoea reptans	Water spinach	Convolvulaceae
7	Trapabicornis	Horn nut	Trapaceae
8	Persicariabarbata	Water milkwort	Polygonaceae
9	Monochoriahastata	Nukha	Pontederiaceae
10	Typhadomingensis	Southern cattail	Typhaceae
11	Najasflexilis	Nodding water nymph	Hydrocharitaceae
12.	Spirodelapolyrhiza	Greater duckweed	Araceae
13.	Pistiastratiotes	Water lettuce	Araceae
14.	Salviniaauriculata	Eared water moss	Salviniaceae
15.	Lemna minor	Common duckweed	Lemnaceae

Sample Preparation

Aquatic plants contain more moisture and less dry matter. Collected plant material was first washed thoroughly with water and then dried in partial sunlight. Most of the contaminable things like other plants and other external materials were removed manually. After completion of sun drying, feed material was incubated at 50^0C for avoiding future spoilage by mould and other factors and thereafter it was stored in a clean dry airtight container for further analysis.

Chemical Analysis

The proximate compositions, such as; Crude Protein (CP), Ether Extract (EE), Total Ash (TA) and moisture content were estimated as per standard procedure [7].The fraction of cell wall constituents such as NDF, ADF, cellulose, hemicellulose and lignin were also estimated [8]. Acid detergent insoluble protein (ADICP), neutral detergent insoluble protein (NDCP), non-protein nitrogen (NPN) and soluble protein (SP) were estimated [9] and the protein fractions were estimated as per the following equations [10] :

Fraction P_A (% CP) = NPN (% SP) x 0.01 x SP (% CP)
Fraction P_{B1} (% CP) = SP (% CP) – P_A (% CP)
Fraction P_C (% CP) = ADICP (% CP)
Fraction P_{B3} (% CP) = NDICP (% CP) – ADICP (% CP)
Fraction P_{B2} (% CP) = 100 - P_A (% CP) – P_{B1} (% CP) - P_{B3} (% CP) - P_C (% CP)

Estimation of Macro and Micro Minerals

Minerals such as Ca, Mg, Cu, Zn, Mn, Fe, and Co in the feed were analyzed using atomic absorption spectrophotometer (Agilent 240 AA model) and Phosphorus was analyzed by volumetric method. 0.5-1g of feed sample was digested using tri acid mixture (HNO3: HClO4: H2SO4 in ratio 3:2:1) in Gerhardt-TT turbotherm till it become clear, properly digested samples were diluted with distilled water and passed through Whatman filter paper No. 1 and the final volume was made to 100 ml by adding double distilled water.

Results and Discussion:

Comparative Proximate Composition

The DM content of the thirteen wetland plants ranged from 5.9% (*Najasflexilis*) to 14.8% (*Persicariabarbata*). The reason for such a big variation of DM content of different samples are due to the fact that the samples contain both fully aquatic (submerged, floating, floating leaved) as well as semi aquaticplants (emergent, marshy land plants) and the marshyland plants

Table 2: Proximate composition (% DM) of collected wetland plants

lants	Crude protein	Ether extract	Total ash
Jussiaearepens	18.10±0.62 (16.7-19.8)	4.03±0.06 (3.7-4.41)	20.51±1.52 (17.2-25.2)
Enhydrafluctans	17.74±0.63 (16.4-19.7)	3.61±0.08 (3.24-3.9)	15.09±0.41 (13.7-16.8)
Eichhorniacrassipes	17.29±0.31 (16.1-18.3)	4.72±0.05 (4.5-5.02)	17.19±0.34 (16.1-18.5)
Marsileaminuta	16.31±0.56 (13.8-18.8)	2.83±0.03 (2.7-2.96)	19.62±0.11 (19.1-19.9)
Trapanatans	14.55±0.48 (12.2-16.3)	3.31±0.11 (2.7-3.74)	15.53±0.12 (14.7-16.2)
Ipomoea reptans	14.48±0.07 (13.9-14.6)	3.29±0.07 (2.9-3.63)	16.49±0.33 (15.5-18.2)

Trapabicornis	12.05±0.29 (10.9-13.4)	2.65±0.05 (2.4-2.75)	16.15±0.07 (15.6-16.7)
Persicariabarbata	12.11±0.18 (11.6-12.7)	1.42±0.03 (1.3-1.53)	13.85±0.29 (13.0-14.7)
Monochoriahastata	11.05±0.49 (9.45-12.9)	2.72±0.05 (2.4-2.87)	16.79±0.23 (15.5-17.7)
Typhadomingensis	9.18±0.17 (8.48-9.92)	2.19±0.11 (1.7-2.65)	12.59±0.22 (11.2-13.7)
Najasflexilis	9.05±0.69 (6.72-11.9)	3.15±0.04 (2.9-3.27)	20.04±0.07 (19.6-20.5)
Spirodelapolyrhiza	16.96±0.21 (15.9-17.8)	4.01±0.06 (3.74-4.36)	20.1±1.15 (19.1-22.2)
Pistiastratiotes	9.49±0.41 (8.89-10.2)	1.28±0.08 (1.09-1.4)	16.8±0.52 (15.9-17.8)
Salviniaauriculata	9.62±0.56 (8.55-10.1)	1.61±0.09 (1.43-1.78)	13.3 (12.5-14.1)
Lemna minor	17.98±0.41 (17.1-18.3)	4.09±0.11 (3.45-4.68)	20.3 (18.9-21.1)
Overall Mean	13.74 ±1.02	2.97 ±0.30	17.18±0.76

[1]Figures in parenthesis are range. Each data for each parameter for individual plants is a mean value of 3 observations.

Contained more amount of DM. Out of fifteen wetland plants eleven plants (around 73 %) had more than 10% crude protein content and out of those, six plants (around 40 %) had more than 15% crude protein content. According to an earlier report [3], the crude protein content of thirty different aquatic plants in the Kolkata region ranges between 8.7 to 25.8%. The CP content of most of the collected samples of old alluvial zone of West Bengal in the present study was within this range. The crude protein content of water hyacinth was found to be similar to the value (17.23%) reported earlier [11]. The overall mean crude protein content (% of DM) of fifteen wetland plants was 13.74±1.02, which showed that these aquatic plants have potential to replace some portion of concentrate mixture in the diet of goats or other ruminants.

Ether Extract content (% of DM) of these wetland plants ranged between 1.28 (*Pistia*) to 4.72% (*Eichhornia*). Eight plants (around 53%) out of fifteen contained more than 3% of EE (on DM basis). Similar values of ether extract content of different aquatic plants (1.18% to 5.42%) were reported earlier [3]. The overall mean of Ether Extract (% of DM) of all thirteen plants was 2.97±0.30, which means these aquatic plants were fair sources of Ether extract. The overall mean of Total Ash (% of DM) of all thirteen plants was 17.18±0.76. Total ash content of most of the samples were found to be similar to the values reported earlier[3]. The overall mean AIA content (% of DM) was 2.41±0.14. High Total Ash content and low AIA content in most of the wetland vegetation analysed here indicates these plants to be very good source of mineral elements. The overall mean of TCHO (% of DM) was 65.88±1.57. From above analysis it was evident that most of the wetland plants (around 53 %) had TCHO content within 60 to 70% of DM. Lower value of TCHO content of different plants was due to higher content of CP, EE and Total Ash.

Comparative Fiber Fractions

The overall mean of NDF content (% of DM) was 46.02±1.97%. Only 5 samples (around 33%) were having NDF content more than 50 percent. The average ADF content was 34.92±2.44% of DM. The overall mean of ADL content (% of DM) of fifteen wetland plants was 3.87±0.56% of DM. There were sevenwetl and plants namely, *Jussea, Enhydra, Spirodela, Lemna, Eichhornia, Trapanatans* and *Ipomoea* had less than 30% of ADF. Lower ADF with low ADL content is generally desirable for better digestibility. *Eichhornia*though was having comparatively lower ADF content was having highest ADL content (9.06±0.27%) and thus makes it less suitable for feeding. There was a wide variation in hemicellulose content among these wetland plants. According to the present analysis the hemicellulose content (% of DM)of these plants ranged between 5.14 to 15.7% with the overall mean value of 11.09±0.98%. Cellulose content also varied a lot among different wetland plants collected from old alluvial zone of West Bengal. The average content (% of DM) of cellulose in the collected samples was 30.23±2.06%.

Table 3: Fibre Fractions of collected wetland plants

Aquatic Plants	NDF	ADF	ADL
Jussiaearepens	42.51±0.98 (38.7-46.9)	27.60±0.59 (25.1-30.5)	1.91±0.13 (1.52-2.31)
Enhydrafluctans	37.02±0.67 (34.3-39.5)	23.84±0.52 (21.4-26.0)	2.01±0.15 (0.92-3.07)
Eichhorniacrassipes	42.72±1.09 (38.9-47.0)	29.42±0.71 (27.5-31.7)	9.06±0.27 (7.84-10.1)
Marsileaminuta	45.25±1.11 (40.7-50.1)	31.79±1.25 (27.1-35.7)	4.78±0.33 (3.62-6.27)
Trapanatans	43.05±1.43 (36.3-47.2)	28.92±0.71 (25.9-31.7)	2.95±0.32 (1.06-4.13)
Ipomoea reptans	34.71±0.85 (29.7-38.0)	25.95±0.59 (23.1-28.8)	3.98±0.29 (2.77-4.98)
Trapabicornis	46.12±1.09 (42.2-51.4)	40.98±0.52 (39.0-42.9)	3.02±0.08 (2.29-3.69)
Persicariabarbata	50.11±1.43 (44.9-56.1)	40.14±1.32 (35.6-44.1)	2.93±0.16 (1.91-3.73)
Monochoriahastata	53.92±0.65 (51.2-55.3)	46.14±0.23 (45.1-47.5)	7.02±0.39 (5.65-8.73)
Typhadomingensis	54.98±1.29 (50.5-60.8)	48.29±0.22 (47.3-49.8)	6.52±0.09 (5.62-6.95)
Najasflexilis	42.05±0.91 (37.9-45.9)	36.85±0.33 (34.9-38.1)	3.16±0.05 (2.93-3.38)
Spirodelapolyrhiza	40.2±1.14 (37.1-43.2)	24.6±0.78 (22.1-26.5)	1.85±0.06 (1.62-2.11)
Pistiastratiotes	57.6±1.62 (52.1-60.3)	48.1±1.39 (45.1-51.3)	2.85±0.09 (2.45-3.01)
Salviniaauriculata	59.2±1.91 (55.2-63.1)	46.1±1.23 (43.1-48.8)	3.98±0.11 (3.65-4.25)
Lemna minor	40.8±1.69 (37.1-43.2)	25.1±1.65 (22.1-28.7)	2.01±0.12 ((1.69-2.23)
Overall Mean	46.02±1.9	34.92±2.44	3.87±0.56

[1]Figures in parenthesis are range. Each data for each parameter for individual plants is a mean value of 3 observations.

Comparative Protein fractions

Crude protein is the heterogeneous mixture of true protein, NPN, amino acids etc. The protein fractions in feed affect both ruminal degradability and digestibility of undegradable protein in the small intestine. The CNCP system of partitioning proteins has been developed [10] by subjecting feeds in different buffer and detergent solutions. The data on solubility in different buffers or detergents have been used to estimate the different protein fractions namely, P_A, P_{B1}, P_{B2}, P_{B3} and P_C. Out of fifteen wetland plants collected, eight plants were selected for comparative protein fractionation as these plants had more than 14% of crude protein. Fraction P_A include NPN compounds like NH_3, AA, peptides, which are instantaneously degradable in rumen. Fraction A (% of CP) was highest in *Jussea (*29.2±1.6%) and lowest in *Marsilea (*8.2±0.3%)

Table 4: Comparative Protein Fractions

Protein Fractions (% of CP)	Range	Overall Mean
PA	11.1-29.2	17.7±1.3
PB1	10.4-30.6	17.5±1.2
PB2	23.6-67.4	51.0±3.0
PB3	2.61-13.5	8.09±0.5
PC	3.12-8.89	6.22±0.4

whereas, B1 fraction (% of CP) was highest in case of *Ipomoea* (30.6±0.2%) and lowest in case of *Marsilea* (10.4±0.2%). The (P_A+P_{B1}) fraction represents soluble portion (SP), which are highly degradable in rumen. The (P_A+P_{B1}) fraction was much highest in *Ipomoea* (56.8%) followed by *Jussea (*46.7%), *Trapanatans (*42.9%) and *Eichhornia (*40.3%) indicating higher RDP content than the other plants. Average content of P_A and B1 fraction (% of CP) of eight selected samples were 17.7±1.3 and 17.5±1.2, respectively.

B2 fraction (% of CP) is the most important fraction of protein which is potentially degradable portion of crude protein and it is otherwise known as intermediately degradable protein. Overall mean B2 fraction of collected plants was 51.0±3.0%. The average B3 fraction, otherwise known as slowly degradable protein fraction, was 8.09±0.5%. C is the fraction that is neither degraded in rumen nor digested in lower tract, and this represents the Acid Detergent Insoluble Protein (ADIP) portion of the feed. This portion is completely undesirable from animal nutrition point of view. C fraction value was highest in case of Marsilea (8.89±0.1%) followed by Eichhornia (6.89±0.2%). Overall mean of C fraction of collected nine wetland plants was 6.22±0.4.

Comparative Mineral Profile

The average Ca content of these thirteen wetland plants was 1.11±0.17%. Out of these fifteen wetland plants, the highest Ca content was of *Lemna* (2.65%) followed by *Pistia* (2.04%). According to Banerjee and Matai (1990) out of thirty aquatic plants only five aquatic plants were having more than 1% calcium content. However in our study six wetlands plants out of fifteen were having more than 1% calcium content. The calcium content was more or less similar to the values reported by Khan *et al. (*2002). Overall mean Phosphorus (P) content (% of DM) of the wetland plants was 0.59±0.06%). Highest P content was of *Monochoria* (1.01%). Banerjee and Matai (1990) reported that P content of aquatic plants in Kolkata region varied from 0.13% to 0.85% which was more or less similar to the values obtained in the present study. The overall mean concentration of Magnesium (Mg) in fifteen wetland plants was 0.33±0.03%.

Concentration of Micro elements was calculated as mg/kg or ppm. Average Cu content of collected wetland plant samples was 1.01±0.06 ppm. There was not much variation in Cu content among different plant samples. The Cu content of these samples were within 0.59 to 1.49 ppm. These values were more or less similar to the values reported by Anderson *et al. (*2011). The present study showed that almost all wetland plants were good source of zinc (Zn). The average content of Zn in fifteen wetland plants were 326.17±22.6 ppm. The best source of Zn was *Salvinia* (505.3 ppm) followed by *Trapabicornis* (461.9 ppm). Concentration of Mn showed wide range of variation15.28 to 519.5 mg/kg). The average content of Mn of these thirteen collected wetland plants was 214.09±57.6 mg/kg. Out of these plant samples the best source of Mn was *Lemna* (665.9 ppm) whereas the poorest source was of *Marsilea* (17.1ppm). Cobalt (Co) concentration in wetland plants in the present study did not vary a lot. The average Co content was 1.52±0.09 ppm. Iron (Fe) content of all samples from old alluvial zone of West Bengal was more as compared to other micro minerals. The average Fe content of these fifteen wetland plants was 604.39±40.1 ppm. The results of present study showed that these wetland plants available in old alluvial zone were good sources of most of the minerals analyzed here.

Table 5: Comparative Mineral Profile

Mineral Elements	Range	Overall Mean
Calcium (%)	0.46-2.65	1.11± 0.17
Phosphorus (%)	0.22-1.01	0.59±0.06
Magnesium (%)	0.15-0.66	0.33±0.03
Copper (mg/kg)	0.59-1.49	1.01±0.06
Zinc (mg/kg)	221.3-505.3	326.17±22.62
Manganese (mg/kg)	17.1-665.9	214.09±57.55
Cobalt (mg/kg)	1.13-2.09	1.52±0.09
Iron (mg/kg)	269.4-1185.3	604.39±70.80

Conclusion

In the present study efforts have been made to identify and nutritionally evaluate the wetland plants available in old alluvial zone of West Bengal for their potential use as ruminant feed supplement. The plants have been evaluated for proximate composition, fiber fraction, protein fraction and mineral profile. Most of the selected wetland plants were having more than 12 percent CP. Some of the plants though poor in protein but rich in mineral profile. Some plants like *Eichhornia*though good source of CP and minerals but having high content of ADL and PC which reduce its value as feed supplement. Finally, critically analysing different parameters

analysed here, five wetland plants namely, *Jussearepen, Enhydrafluctans, Spirodela Polyrhyza, Lemna minor* and *Marsileaminuta* were found to be better sources of essential nutrients and can also serve as potential alternative feed resource in ruminant rationin old alluvial zone of West Bengal. However, further studies should be done on amino acid profile, anti nutritional factors and heavy metal concentration in these wetland plants. Present study was restricted to old alluvial zone of West Bengal only. So, comparative availability and chemical composition of wetland plants should be done in other agro climatic zones of West Bengal as well. Increased research attention should be given towards the utilization of different non-conventional feed resources like wetland plants as livestock feed to reduce the gap between demand and supply of feeds and fodders and also to economize the ration.

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