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Nutritive value and safety of greater club rush as livestock feed

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ABSTRACT

The present study was undertaken to assess the nutritive value of greater club rush (*Scirpus grossus* L. f) and safety of the weed biomass as a livestock feed. The results showed that the nutrient composition of the weed biomass was comparable to some of the popular cultivated fodder crops like guinea grass. Heavy metal content of the sedge plant was mostly within the permissible limits as recommended by World Health Organisation (WHO). However, the cadmium concentration was found to be more than the safe limit, indicating possible risk in allowing free grazing in contaminated soils. The data on the transfer and accumulation of heavy metals from soils to plant shoots/roots as estimated through biological concentration factor (BCF), translocation factor (TF) and bio accumulation coefficient (BAC) also indicated that there is a need for caution when animals are allowed to graze freely on the luxuriant growth of greater club rush in wetland ecosystem.

Keywords: Greater club rush, Heavy metals, Nutrient value, Proximate analysis, *Scirpus grossus*

Greater club rush or giant bulrush (*Scirpus grossus* L. f) is an emergent hydrophyte which is a native of South-East Asia, found naturalized throughout India, Malaysia, and tropical Australia (Naskar 1990). It belongs to a small, worldwide group of the family Cyperaceae, often called the "tuberous bulrushes" and is one of the major sedge weed infesting rice growing tracts around the world (Hakim *et al.* 2010). The plant with its erect, robust stature grows to a height of about 1.5 to 2.5 m and produces large quantities of lush green biomass. In Kerala (India), greater club rush locally known as "*Korapullu*" has already infested vast tracts of wetland paddy fields. Once infested, the aggressive weed spreads fast and the cost involved in removing it and recovering the field becomes prohibitively high, forcing many farmers even to abandon rice cultivation. Farmers' practice of destroying the weed either through tillage or burning has been found to have only short effect, as the weed is propagated through underground rhizome fragments. However, it has been observed that farmers utilise greater club rush as a livestock feed especially to free grazing. This plant at its active growth stage is also cut and fed to cattle. These plants regenerate very fast from the underground propagules and the perennial growth habit of the large robust plant provides the farmers with a luxuriant and cheap source of forage year round. According to Sreethu (2011), greater club rush is capable of producing a plant dry weight of more than 20 t/ha.

It is true that the highly productive wetland ecosystems support a wide variety of flora and fauna, but the abandoned condition of the fields in many cases also encourage the disposal of industrial waste, sewage water, electronic wastes, *etc*. into the ecosystem. This is a matter of concern as there are chances of heavy metal contamination in such wetlands. Pollutants from contaminated soil later enter into livestock production systems and then into the food chain (Rajaganapathy *et al.* 2011). Earlier studies have indicated that greater club rush is a phytoaccumulator and has the potential to be used for phytoremediation of heavy metal contaminated environment (Tangahu *et al.* 2013). Food chain contamination is one of the major routes for entry of metals into the animal system and therefore, monitoring metals in contaminated soil, food stuff and water are of a paramount concern (Udiba *et al.* 2013). Hence, present study was undertaken to assess the nutritive value and safety of greater club rush biomass as a livestock feed.

MATERIALS AND METHODS

Study was conducted during January-August 2016, by collecting soil and plant samples from wetlands of approximately 10 ha, heavily infested with greater club rush (*Scirpus grossus* L. f). The selected field was lying close to an industrial area,

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located at 8^{o} 28’ 14.03" N latitude and 76^{o} 59’ 38.36" E longitude in Thiruvananthapuram district, Kerala. The rice field remained uncultivated for the past 8–10 years and the weed was reported to be spreading fast. Many farmers reported their helplessness in containing the weed. Waste water from the industrial area, sewage water, electronic wastes *etc*. were being discharged/dumped into the abandoned field and hence it was hypothesized to be contaminated with heavy metals. Local farmers have been using the land for cattle grazing for the past few years.

Approximately one kilogram each of soil samples were collected randomly from ten different points at 0-15 cm plough depth, air dried at room temperature for two weeks, crushed and pulverized to pass through 2 mm sieve and composite samples were drawn after homogenous mixing. The plant samples were also collected from the same location from where soil was collected. In order to analyse the proximate principles and heavy metal content in the plant samples, the uprooted plants were thoroughly washed to clean the mud and dirt especially from the entangled root mass, dried in shade for 2 weeks and then oven dried at 65 ^{o}C till they attained constant weights. The oven dried shoot and root samples were ground to fine powder and homogenized samples were drawn for further analysis.

Sample preparation and basic chemical analysis of soil were conducted according to routine analytical methods. Soil organic matter was determined by Walkley and Black method, pH was determined by pH meter and EC was measured using conductivity meter. Available nitrogen was estimated by alkaline potassium permanganate method, phosphorus by Bray colourimetric method, potassium by ammonium acetate method and organic carbon by chromic acid wet digestion method. As the soil organic matter contains approximately 58% carbon, a factor of 1.72 was used to convert organic carbon to soil organic matter.

The nutritive value of the plant samples was assessed by the analysis of proximate principles based on the Official Methods of analysis (AOAC, 2012). Total ash, acid insoluble ash, crude protein (CP), crude fibre (CF), ether extract/crude ash (EE) and nitrogen free extract (NFE) were determined on dry weight basis.

NFE (%) = 100 - (CF% + CP% + EE% + Ash %)

Total nitrogen content of the plant samples was determined by modified micro Kjeldahl method. One g each of the plant samples were digested in diacid digestion mixture containing concentrated nitric and perchloric acid (9:4), till a clear extract was obtained and made up to 100 ml using distilled water. This extract solution was used to determine P, K, Ca, Mg and the heavy metals. Phosphorus was determined by vanadomolybdophosphoric yellow colour method and total potassium content was determined by EEL flame photometer. Calcium and magnesium were determined by EDTA titration method. The heavy metals, *viz*. lead (Pb), nickel (Ni), chromium (Cr) and cadmium (Cd) in both the soil and plant samples were determined by the Atomic Absorption Spectrophoto meter (AAS) method.

The efficiency of different plants in absorbing metals is evaluated by either plant uptake or soil-to plant transfer factors of the metals (Chandran *et al*. 2012). In the present study, the transfer and accumulation of heavy metals from soil to roots and shoots were estimated in terms of biological concentration factor (BCF), translocation factor (TF) and bioaccumulation coefficient (BAC) in line with the reports of Rezvani and Zaefarian (2011).

BCF = Heavy metal content in root/heavy metal content in soil

TF = Heavy metal content in shoot/heavy metal content in root

BAC = Heavy metal content in shoot/heavy metal content in soil

RESULTS AND DISCUSSION

Soil properties

The soil was strongly acidic (4.97), nonsaline (0.25 ds/m) and very high in organic matter content (5.14%). The nutrient status of the soil was medium (**Table 1**).

As per the regulatory standards for agricultural soils in USA as reported by He *et al*. (2015), the contents of chromium, nickel and lead in the selected sites were within safe limits (**Table 2**). High organic matter has been shown to decrease heavy metal availability through immobilization (Yi *et al.* 2007) and that was probably the reason for the low content of these metals in the soil. However, in case of cadmium, the content was above the permissible limit indicating contamination. According to Elinder (1992), concentration of available cadmium in soil

Table 1. Chemical properties of the wetland soil under greater club rush

Parameter	Composition	Rating
pH	4.97	Strongly acidic
EC (ds/m)	0.25	Non saline
Organic carbon (%)	2.99	High
Organic matter (%)	5.14	High
Available N (kg/ha)	339.00	Medium
Available P(kg/ha)	22.51	Medium
Available K(kg/ha)	278.10	Medium

Table 2. Heavy metal composition of the soil

Heavy metal	Composition (ppm)	Max. Permissible limit (ppm) #
Lead (Pb)	13.43	200
Nickel (Ni)	2.94	72
Chromium (Cr)	0.92	11
Cadmium (Cd)	0.67	0.48

increased with increase in soil acidity and strongly acidic nature of the selected site explained the high cadmium content.

Nutritive value of greater club rush

The nutritive value of greater club rush was found comparable with that of cultivated fodder crops like guinea grass, justifying its use as a livestock feed (**Table 3**). The crude protein and crude fibre content of the weed biomass were 7.5% and 26.75% respectively.

Table 3. Nutritive value of greater club rush (*Scirpus grossus* L. f)

Parametre	Composition (%)
Moisture	66.66
Dry matter	33.34
Total ash	7.96
Acid insoluble ash	2.30
Crude protein	7.50
Crude fibre	26.79
Ether extract (crude fat)	1.21
Nitrogen free ether	56.40
[(*K*/(*Ca*+*Mg*)]	1.39

The proximate analysis is a quantitative analysis technique of the different macronutrients in feed developed by Henneberg and Stohmann in 1865 (Lloyd *et al.* 1978). According to KAU (2011), the crude protein and crude fibre content of guinea grass (*Panicum maximum*) vary from 8 to 14% and 28 to 36 %, respectively, while gamba grass (*Andropogon gayanus*) has 5.5 % crude protein and 32.6% crude fibre. As per the standards set for silage quality, a crude protein range of 7 to 8% is considered good and moisture content of less than 70% is considered excellent (Rivera and Parish, 2010). Evidently, greater club rush with a crude protein content of 7.5% and moisture content of 66% could also be considered for silage making. In forage grasses, K/(Ca+Mg) ratio above 2.20 may cause grass tetany, which is a metabolic disease caused due to magnesium deficiency, especially in the cool season (Kumar and Soni, 2014). In greater club rush, the tetany ratio was 1.39, which is definitely within safe limits as a livestock feed.

Heavy metal accumulation in greater club rush

The results showed that the order of concentration of the heavy metals in the plant tissue was Ni > Cr > Pb > Cd (Table 4). Presence of heavy metals in feed can cause several health hazards directly to animals and indirectly to human beings who consume these animal products. Toxic heavy metals like cadmium affect biological functions, affecting hormone systems and growth (Rajaganapathy *et al.* 2011). Among the elements, lead, nickel and chromium contents were well within the permissible limit recommended by WHO (Nazir *et al.* 2015). However, the cadmium content was substantially higher than the regulatory standards for feed materials for cattle. Evidently, greater club rush being a phytoaccumulator had bioaccumulated higher level of cadmium from the cadmium contaminated soil. According to Blaylock and Huang (2000), the heavy metals that are available for plant uptake are those that are present as soluble components in the soil solution or those that are easily solubilized by root exudates. Even though the presence of high organic matter is likely to bind more of cadmium, the metal was available to plants in organically bound form as observed by Nigam *et al.* (2000). Further, the acidic soil pH must have also favoured cadmium uptake (Elinder 1992).

The values of biological concentration factor (BCF), translocation factor (TF) and bioaccumulation factor (BAC) of the heavy metals in greater club rush are shown in (**Table 4)**. Biological concentration factor (BCF) is an index of the ability of the plant to accumulate a particular metal in its roots with respect to its concentration in the soil (Ghosh and Singh 2005). The value was the highest for chromium followed by nickel, cadmium and lead. The BCF value more than 1, as in the case of chromium (1.67) indicated the plants' ability to act as a biostabiliser for chromium. On the other hand, the translocation factor (TF) was highest for cadmium (1.01)

Table 4. Heavy metal composition and transfer by greater club rush

Heavy Metal	Composition (ppm)	Max. Permissible limit (ppm)##	BCF	TF	BAC
Lead	0.10	2.0	0.02	0.43	0.01
Nickel	0.40	10.0	0.19	0.71	0.14
Chromium	0.39	1.3	1.67	0.25	0.42
Cadmium	0.03	0.02	0.05	1.01	0.05

##Nazir *et al.* 2015

BCF= Biological concentration factor; TF= Translocation factor; BAC= Bioaccumulation coefficient indicating that greater club rush was highly efficient in transfer of the heavy metal from the root to the shoot. The result is in line with the reports of Smolders (2001) who observed that cadmium is a metal which is easily absorbed by plant roots and transferred to the above-ground parts. The higher TF value also explained the higher concentration of cadmium in the plant tissues in the present study. This information is a matter of concern, since in many cases the weed may be growing in abandoned and consequently contaminated soils. Since metal concentrations consistently biomagnify from one trophic level to the next (Monteiro 1996), it is probable that animals higher in the food chain may accumulate toxic concentration of cadmium, especially when they are allowed free grazing on a luxuriant weed growth, as in the present case.

It can be concluded that the use of greater club rush as a livestock feed as practiced by local farmers is allowable in terms of its nutritional value. However, considering its potential as a phytoaccumulator, free grazing need to be curbed if the plants are growing in localities likely to be contaminated with heavy metals.

REFERENCES

AOAC. 2012. *Official Methods of Analysis* (19th Ed.). Association of official analytical chemists, Washington D.C. 587 p.

Blaylock MJ and Huang JW. 2000. *Phytoextraction of metals.* pp. 53–70. In: *Phytoremediation of Toxic Metals: Using Plants to Clean up the Environment*. (Eds. Raskin I and Ensley BD) Wiley, New York, USA.

Chandran S, Niranjana V and Joseph B. 2012. Accumulation of heavy metals in waste water irrigated crops in Madurai, India. *Journal of Environmental Research and Development* **6**(3): 432.

Elinder CG. 1992. Cadmium as an environmental hazard. *IARC Science Publications* **118**: 123-132.

Ghosh M and Singh SP. 2005. A review on phytoremediation of heavy metals and utilization of it's byproducts, biomass and waste management laboratory. *Asian Journal on Energy and Environment* **6**(4)**:** 214-231

Hakim MA, Juraimi AS, Ismail MR, Hanafi MM and Salemat A. 2010. Distribution of weed population in the coastal rice growing area of Kedah in peninsular Malaysia. *Journal of Agronomy* **9**: 9-16.

He Z, Shentu J, Yang X, Baligar VC, Zhang T and Stofella PJ. 2015. Heavy metal contamination of soils: sources, indicators, and assessment. *Journal of Environmental Indicators* **9**:17-18.

Kumar K and Soni A. 2014. Elemental ratio and their importance in feed and fodder. *Research Article. International Journal for Pure and Applied Biosciences* **2**(3): 154-160.

KAU. 2011. *Package of Practices Recommendations:Crops*. Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, India.

Lloyd LE, Mc Donald BE and Crampton EW. 1978. *Fundamentals of Nutrition* (2nd Ed.). W. H. Freeman and Company, San Francisco, CA.

Monteiro LR, Costa V, Furness RW and Santos RS. 1996. Mercury concentrations in prey fish indicate enhanced bioaccumulation in mesopelagic environments. *Marine Ecology Progress Series* **141:** 21-25.

Naskar K. 1990. *Aquatic and Semi-Aquatic Plants of Lower Ganga DeltaIts Taxonomy Ecology and Economic Importance. Daya Publishing House, New Delhi: Its Taxonomy Ecology and Economic Importance.* Daya Publishing House, India. 323p.

Nazir R, Khan M, Masab M, Rehman H, Rauf N, Shahab S, Ameer N, Sajed, M, Ullah M, Rafeeq M and Shaheen Z. 2015. Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of soil and water collected from tanda dam Kohat. *Journal of Pharmaceutical Science and Research* **7**(3): 89-97.

Nigam R, Srivastava S, Prakash S and Srivastava MM. 2000. Effect of organic acids on the availability of cadmium in wheat. *Chemical Speciation and Bioavailability* **12**(4): 125-132.

Rajaganapathy V, Xavier F, Sreekumar D, Mandal PK. 2011. Heavy metal contamination of soil, water and fodder and their presence in livestock and products: A review. *Journal of environmental Science and Technology* **4**(3): 234 - 249

Ranjhan SK. 1977. *Animal Nutrition and Feeding Practices in India*. Vikas Publishing House Pvt. Ltd., Ghaziabad, UP, India. 350p.

Rezvani, M and Zaefarian, F. 2011.Bioaccumulation and translocation factors of cadmium and lead in *Aeluropus littoralis*. *Asian Journal of Agricultural Engineering* **2** (4): 114-119.

Rivera D and Parish J. 2010. Interpreting forage and feed analysis reports. Publication 2620. Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Available: https://extension.msstate.edu/sites/default/files/publications/publications/p2620.pdf

Smolders E. 2001. Cadmium uptake by plants. *International Journal of Occupational Medicine and Environmental Health* **14** (2): 177-183.

Sreethu GS. 2011. *Management of Greater Club Rush (Scirpus grossus L. f) in Wetland Rice Ecosystem,* M.Sc. (Ag.) Thesis, Kerala Agricultural University, Thrissur.

Tangahu BV, Abdullah SRS, Barsi S, Idris M, Anuar N and Mukhlisin M. 2011. Isolation and screening of rhizobacteria from *Scirpus grossus* plant after lead (Pb) exposure. *Journal of Civil Engineering and Architecture* **5**(6): 484-493

Udiba UU, Diya'uddeen BH, Michael OO, Inuwa B, Aisha L, Ade-Ajayi, Ade-Bola F, Nkechi NF and Shittu MU. 2013. Toxicological implications of grazing on forage grasses in Dareta Village, Zamfara, Nigeria. *Archives of Applied Science Research* **5** (3): 220-228

Yi LY, Hong D, Wang and Zhu Y. 2007. Determination of free heavy metal ion concentrations in soils around a cadmium rich zinc deposit. *Geochemical Journal* **41**(4): 235–240.