Short Communication

Chemical Characterization of the Stem of *Cyperus tegetum* — A Semi-aquatic Plant of Economic Importance

Abstract

Cyperus tegetum *Roxb. is a perennial herb growing naturally in marshy land in the humid tropics including India. The stem of the plant is used for making mats for floor covering as well as decoration, and this is a remunerative occupation for people in the rural areas in India. Analyses of the stem of C. tegetum grown under different fertilizer doses for increasing yield showed no significant variations in compositions. The stem was lignocellulosic and similar in contents of major constituents to straws, bagasse, grasses, etc. The stem being acidic could have a strong affinity to basic dyes for attractive colour finishing of mats, though the high crude fat content might inhibit good colouration. The strength properties of upper, middle and lower portions of stem measured by breaking load indicated higher strength in the middle portion than other parts of the stem.*

Key words: Cyperus tegetum, semi-aquatic, economic importance, chemical composition, lignocellulosic, mat production.

INTRODUCTION

Cyperus tegetum Roxb. (Cyperaceae) synonymous with *C. corymbosus* Roxb. and *C. tegetoformis* Roxb. is a perennial herb grown widely in marshy lands in the humid tropics, including India and particularly in the eastern and southern parts of the country (Council of Scientific and Industrial Research, 1952). The crop is usually grown for two to three years in a field and three harvests are taken every year. Experimental plantings (Chatterjee, 1991) at Mohanpur, West Bengal have shown that the crop may be harvested 6–7 months after planting, with yield upto 140 t ha^{-1}, by fertilizer management and a ratoon crop will develop within 5 months after cutting. The stem of the plant is used for production of mats in the rural sector. The stem may be used as such or split into two or more strands for weaving fine mats.

The market value of mats depends mainly on quality and length of the stem harvested and the number of harvests made. Quality improvement of mats by chemical treatment and attractive dye finishes, to make them more remunerative to farmers, requires basic information on chemical composition and physical characteristics of *C. tegetum* stem. Although investigations have been made on chemical composition and uses of several *Cyperus* species (Buchala and Meier, 1972; Gupta *et al.*, 1972; Ueki *et al.*, 1974), no report is available on the chemical nature and physical characteristics of *C. tegetum*. The present study gives an account of the chemical nature and strength properties of the stem of *C. tegetum* used for making mats.

METHODS

The *C. tegetum* was grown at Mohanpur, West Bengal (Chatterjee, 1991) under four different fertilizer doses $N_{120}P_{50}K_{50}$, $N_{120}P_{50}$, $N_{120}K_{50}$ and $N_{70}P_{50}K_{50}$. The subscripts for N, P, K indicate kg ha^{-1} of the corresponding fertilizers applied in the form of urea for N, superphosphate for P (as P_2O_5) and muriate of potash for K (as K_2O). Plants were pooled at random for harvesting from each plot under specific fertilizer dose, the flower heads were cut off and the entire stems were dried in air, cut into small pieces, ground, mixed thoroughly and sampled for replicated chemical analyses. Ash value was determined by heating the sample at 550°C in a muffle furnace and nitrogen was estimated by a Kjeldahl method. Crude fat was estimated by extraction with ethanol–benzene (1:2, v/v) for 6 h in a Soxhlet apparatus. Lignin, holocellulose, pentosan, α-cellulose, and pectin were estimated using defatted samples following standard methods (TAPPI, 1971). The samples were hydrolysed with sulfuric acid (Jeffery *et al.*, 1960) and neutral sugars in the hydrolysate were analysed by g.l.c. as their alditol acetates (Sawardekar *et al.*, 1965). A Hewlett-Packard Gas Chromatograph (Model 5830A) equipped with f.i.d. and stainless steel column (1800 × 5 mm dia) containing 3% ECNSS-M on

Table 1. Proximate composition of *C. tegetum* stem grown under different fertilizer doses

Constituents	Stem composition (% of oven dry weight)			
	$N_{120}P_{50}K_{50}$	$N_{120}P_{50}$	$N_{120}K_{50}$	$N_{70}P_{50}K_{50}$
Ash	11.30±1.06	9.80±0.92	9.50±0.85	10.75±0.95
Fat and wax	5.00±0.45	5.40±0.48	5.00±0.42	5.14±0.36
Lignin	16.62±1.07	16.44±1.02	16.63±1.05	17.25±1.15
Holocellulose	64.95±6.35	66.00±7.50	68.70±8.55	66.26±7.36
α-Cellulose	36.30±2.96	36.30±2.88	37.13±3.00	36.24±3.08
Pentosan	25.32±1.88	24.95±1.75	24.42±2.72	25.63±1.78
Uronic anhydride	8.21±0.91	8.75±1.11	8.54±1.00	8.32±1.06
Pectin	0.92±0.03	0.90±0.05	0.86±0.06	1.22±0.08
Nitrogen	0.40±0.01	0.40±0.01	0.40±0.01	0.40±0.01

Values are the mean ± SD of five replicates.
Subscripts for N, P and K indicate kg ha^{-1} of corresponding fertilizer applied.

Table 2. Breaking load of *C. tegetum* stem

Stem portion	Breaking load (kN)	Standard deviation (δ)	CV%
Upper portion	0.1811	0.0198	10.90
Middle portion	0.2238	0.0214	9.61
Lower portion	0.1870	0.0218	11.62

Values are the mean of ten replicates.

Supelcoport (80–100 mesh) was used for g.l.c. analysis at 190°C with nitrogen as carrier gas. Molar proportions of sugars were determined conventionally from peak area. The breaking loads of the upper, middle and lower portions of the stem were determined for a test length of 85 mm using UTS TESTSYSTEME with the rate of traverse of 25 mm min^{-1}.

RESULTS AND DISCUSSION

The results of chemical analyses of the stem of four samples of *C. tegetum* grown under different fertilizer doses are reported in Table 1. Fertilizer variations had little influence on the chemical composition, though yield could be significantly increased by proper fertilizer doses. The data indicated α-cellulose, pentosan and lignin as major constituents of *C. tegetum*, similar to grasses in composition. The ash content and crude fat of *C. tegetum* were in the high range of 9.5–11.3% and 5.0–5.3%, respectively. Woody stalks and stems also had similar α-cellulose and pentosan contents but their lignin content was quite high. Analysis of neutral sugars in the acid hydrolysate of stem samples showed the presence of the following sugars (in mole percent): arabinose, 19.21; xylose, 33.33; mannose, 5.91; galactose, 2.96; and glucose, 38.59. The largest amount of glucose accounted for α-cellulose in the plant, while the two predominant sugars, xylose and arabinose, constituted the main hemicellulose fraction. Uronic acid was also found in the acid hydrolysate by paper chromatography indicating the acidic nature of the hemicellulose fraction. The acidic nature of the stem indicated that it could be dyed better with basic dyes with attractive colour finishes. The high percentage of crude fat (5%) in the stem, however, would be a deterrent to good colour finishes. The breaking load of upper, middle and lower portions of *C. tegetum* stem were measured to find the portion contributing maximum strength to the mat. The data reported in Table 2 indicated higher strength in the middle portion, as found in lignocellulosic bast fibres, than in the upper and lower portions of the stem which were almost the same.

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