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THE GUM EXUDATES FROM *CHLOROXYLON SWIETENIA*, *SCLEROCARYA CAFFRA*, *AZADIRACHTA INDICA* AND *MORINGA OLEIFERA**

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Key Word Index—*Chloroxylon Swietenia*; Rutaceae; *Sclerocarya caffra*; Anacardiaceae; *Azadirachta indica*; Meliaceae; *Moringa oleifera*; Moringaceae; gum exudates; polysaccharides; proteins.

Abstract—Analytical data are presented for the polysaccharide and proteinaceous components of the gum exudates from *Chloroxylon swietenia* and *Sclerocarya caffra*, and for the amino acid compositions of the exudates from *Azadirachta indica* (two specimens) and *Moringa oleifera*. The gums from *C. swietenia* and *S. caffra* contain 4-*O*-methylglucuronic acid, glucuronic acid, galactose and arabinose; rhamnose is absent. Amino acid analysis shows that proteinaceous material is present in the gums from *C. swietenia*, *S. caffra* and *M. oleifera* despite their low nitrogen content. Hydroxyproline accounts for 28% of the amino acid content of *S. caffra* gum. In contrast, *A. indica* gum has a high nitrogen content but contains very little hydroxyproline.

INTRODUCTION

Recent publications have shown that very high proportions of hydroxyproline are present in gum exudates from the genera *Acacia* [1, 2], *Astragalus* [3] and *Prosopis* [4] (all Leguminosae) but that exudates from the genus *Sterculia* [5] (Sterculiaceae) contain very little hydroxyproline. Gum exudates from genera within other families have therefore been studied to obtain more information on the extent of the variability in hydroxyproline content shown by various gum exudates.

Data for the carbohydrate and amino acid compositions of the gums from *Chloroxylon swietenia* (Rutaceae) and *Sclerocarya caffra* (Anacardinaceae) are reported, together with data for the amino acid compositions of the gums from *Moringa oleifera* [6] (Moringaceae) and *Azadirachta indica* [7] (Meliaceae), the carbohydrate components of which have been examined previously.

RESULTS AND DISCUSSION

Sclerocarya caffra ('Mu'gongo, Mongo or Mungango') was reported [8] not to yield gum although its relative, *S. birrea*, was noted as giving a clear, colourless, friable gum. Table 1 shows that *S. caffra* nevertheless gives an acidic gum of low intrinsic viscosity and low M_r, with an appreciable methoxyl content. It contains relatively little arabinose. Table 2 shows that its relatively low N content is proteinaceous and that hydroxyproline and serine account for *ca* 40% of its amino acid content. In this respect *S. caffra* gum shows similarities to the exudates from some *Acacia*, [1, 2] *Astragalus* [3] and *Prosopis* [4] species. Genera within the Leguminosae are therefore not unique in having high proportions of hydroxyproline.

The polysaccharide component of the gum from *C. swietenia* ('Bhirra') was stated to contain [9, 10] major amounts of galacturonic acid, to have a ratio of 2:3 for galactose:arabinose in the parent gum, a negative optical rotation and no N content. A specimen of the gum submitted to this laboratory for analysis was found not to conform to the published analytical parameters [9, 10]. Steps were therefore taken to secure a fresh sample of the gum, backed by botanical voucher specimens taken from the trees involved. Such a specimen was received in 1974; the botanical vouchers were submitted to the Herbarium, Kew, for confirmation of identity and for retention. The data in Tables 1 and 2 refer to the second, authenticated, gum sample received; in effect, the analytical parameters were little different from the first sample of gum received. The analytical parameters for *C. swietenia* shown in Table 1 differ considerably from those published previously [9, 10]; presumably an error in the botanical identification may have occurred. It has been necessary on previous occasions to publish corrections to data from earlier studies, e.g. for *Lannea* [11], *Azadirachta* [7] and *Acacia* [12] species. *Chloroxylon swietenia* gum has a highly positive specific rotation and is characterized by a very high arabinose content. The absence of rhamnose, as in *S. caffra* gum, is of interest. Although some *Acacia* exudates contain only traces (0.4–1%) of rhamnose [13, 14], rhamnose is absent in the gums from some *Grevillea* [15] and *Parkia* [16] species. In contrast, other gums, e.g. from *Acacia implexa* [17] and *Julbernardia globiflora* [18], have high rhamnose contents. The major

* Part 83 of the series "Studies of Uronic Acid Materials". For Part 82 see *Plants for Arid Lands* (Wickens, G. A., Goodwin, J. R. and Field, D. V., eds) p. 343. Allen & Unwin, London (1985).

Table 1. Analytical data for the gum exudates from *Chloroxylon swietenia* and *Sclerocarya caffra*

	Chloroxylon swietenia	*Sclerocarya caffra*
Loss on drying, 105°, %	11.6	13.2
Total ash, 550°, %*	3.9	5.1
Nitrogen, %*	0.08	0.06
Hence protein (N × 6.25), %*	0.5	0.4
Methoxyl, %†	1.5	2.1
Specific rotation $[\alpha]_D$, degrees†	+91	+12
Intrinsic viscosity, ml/g†	10.1	4.3
$M_r \times 10^4$†	147	5.6
Neutralization equivalent (electrodialysis)	1800	750
Hence uronic anhydride, %†‡	9.8	23.5
Sugar composition after hydrolysis (% total sugars)		
4-*O*-Methylglucuronic acid§	9	12.5
Glucuronic acid	1	8
Galacturonic acid	trace	3
Galactose	21	63
Arabinose	69	14
Rhamnose	0	0

*Corrected for loss on drying.
†Corrected for * plus protein content.
‡If all acidity arises from uronic acids.
§If all methoxyl groups located in this acid.

Table 2. The amino acid compositions (residues per 1000 residues) of the proteinaceous components of the gum exudates from *Sclerocarya caffra*, *Chloroxylon swietenia*, *Moringa oleifera* and *Azadirachta indica*

	Sclerocarya caffra	*Chloroxylon swietenia*	*Moringa oleifera*	*Azadirachta indica* A	*Azadirachta indica* B
% N	0.06	0.08	0.15	5.0	5.6
Alanine	65	82	90	63	63
Arginine	4	14	31	24	14
Aspartic acid	69	118	76	155	154
Cystine	0	0	2	8	9
Glutamic acid	48	80	88	73	73
Glycine	39	62	68	66	65
Histidine	29	45	30	45	45
Hydroxyproline	282	104	68	10	17
Isoleucine	19	32	54	54	54
Leucine	66	60	71	83	83
Lysine	20	29	51	39	39
Methionine	0	1	7	0	0
Phenylalanine	17	25	30	50	53
Proline	61	62	84	63	63
Serine	126	111	80	82	83
Threonine	76	54	68	69	69
Tyrosine	18	20	18	27	28
Valine	61	99	84	89	90

amino acid in *C. swietenia* gum is aspartic acid; although it also contains a high proportion of serine, its hydroxyproline content is very much less than that in *S. caffra* gum. The amino acid profile of *C. swietenia* gum (Table 2) shows many similarities to that of *Acacia microbotrya* gum [14].

The gum ('Sahjan') from *M. oleifera* provides a third example of a gum having a very low N content that is, however, very largely accounted for by its amino acid content. Its hydroxyproline content is, however, lower than that of seven of the other amino acids present, a feature comparable with that reported [14] for *Acacia aestivalis* gum. Previous investigators have found [9, 10] *M. oleifera* gum to contain galacturonic acid, galactose, arabinose, and traces of rhamnose.

The polysaccharide component of *A. indica* gum has also been studied previously [7] and it was one of the first plant gums to be subjected to amino acid analysis [19]. At that time, a value for the hydroxyproline content was not reported; it was recorded that hydroxyproline partly obscured the peak due to aspartic acid. Because of the importance now attached [14] to the hydroxyproline content of the proteinaceous component of gum exudates, the opportunity has been taken to re-examine the Indian (Sample A) and Ceylonese (Sample B) specimens of *A. indica* gum available. The results shown in Table 2 are in good agreement with those published earlier [19]; aspartic acid is, by far, the major amino acid present. In contrast, the hydroxyproline content is extremely small. As attempts [7] to separate the nitrogenous material from carbohydrate in *A. indica* gum failed, an amino acid/carbohydrate linkage involving the aspartic acid, serine, proline or threonine may be involved [19], distinct from the linkage involving hydroxyproline postulated recently [20] for *Acacia senegal* (gum arabic). The very low hydroxyproline content of *A. indica* gum is comparable with that of the *Sterculia* exudates [5], which also have aspartic acid and valine as their major amino acids.

It can be concluded that the gum exudates from genera from families other than the Leguminosae may contain high contents of hydroxyproline, that the hydroxyproline content bears no relationship to the N content and that gum exudates from the genus *Sterculia* are not unique in having very low hydroxyproline contents.

EXPERIMENTAL

Gum specimens. Gum from *S. caffra* Sond. was sent by Mr. Th. Müller, Curator, Botanic Gardens, Salisbury, Rhodesia (reference voucher Kelly 482). Gum from *C. swietenia* DC was sent by Thiru P. Baskaradoss, I.F.S., in January 1970; a further supply, together with reference vouchers, from Thiru M. Thyagarajan, I.F.S., Forest Utilisation Officer, Tamil Nadu Forest Dept., Madras 28, India, was received in March 1974. Details for the two specimens of *A. indica* gum have been published [7, 19]. Gum from *M. oleifera* Lam. was sent by Dr. D. B. Deb, Regional Botanist, Botanical Survey of India, Southern Circle, Coimbatore-2, India.

Analytical methods. The standard analytical methods used in the study of carbohydrate [18] and amino acid [17] components have already been described. The data presented in Tables 1 and 2 are averages for at least two separate determinations of each parameter. N contents were determined with an autoanalyser. Amino acid analysis accounted for 68–80% of the N content of the gums examined; there were no unidentified amino acid peaks in the chromatograms of the acid hydrolysates.

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