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THE COMPOSITION AND PROPERTIES OF THE GUM EXUDATES FROM *TERMINALIA SERICEA* AND *T. SUPERBA**

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Key Word Index—*Terminalia sericea*; *T. superba*; Combretaceae; gum exudates; polysaccharides; 4-*O*-methyl-galacturonic acid.

Abstract—The gum polysaccharides from *Terminalia sericea* and *T. superba* have been analysed. They have a complex sugar composition, containing galacturonic, glucuronic, and 4-*O*-methylglucuronic acids as well as galactose, arabinose, rhamnose, mannose and xylose. The exudates from *T. sericea* and *T. superba* are remarkably similar in composition, particularly with respect to their proportions of neutral sugars and total uronic acid content, although *T. sericea* gum contains considerably more 4-*O*-methylglucuronic acid than *T. superba*. Both gums are very viscous and dissolve readily to give solutions of good colour.

INTRODUCTION

THE GENUS *Terminalia* L. is the largest[2] (approx 150 spp.) in the sub-tribe Terminaliinae of the tribe Combreteae which belongs to sub-family Combretoideae of the Combretaceae (order, Myrtales). Since this classification was proposed in a recent revision[2] of the Combretaceae and published in a rather remote journal, the relationships are given in full in Table 1, which shows that *Terminalia* is closely related to *Anogeissus* (of which the gum exudates from two species, *A. latifolia* Wall.[3–6] and *A. schimperi* Hochst. syn. *A. leiocarpus* (DC.) Guill. et Perr.[7–11] have been studied). Table 1 also shows that *Terminalia* is less closely related to the large genus *Combretum*, of which the gum exudates from only two species (*C. verticillatum*[12] and *C. leonense*[13,14]) have been investigated to date. Since *Anogeissus* spp. are the main source of gum ghatti (which is a gum of commercial importance that is, unfortunately, very variable because it is liable to contain poor quality gums of other genera in admixture) and also because *C. leonense* has an unusually viscous gum, it

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was decided to seek specimens of the exudates from other species of the Combretaceae for examination. This communication reports the results obtained for the gum exudates from *Terminalia sericea* Burch. and *T. superba* Engl. and Diels, syn. *T. altissima* A. Chev. To date, the gum from only one *Terminalia* sp. (*T. tomentosa*) has been studied[15] to any extent, although several *Terminalia* spp. are stated by Mantell[16] to be tapped and sold as "East Indian" gum.

TABLE 1. THE BOTANICAL RELATIONSHIPS IN COMBRETACEAE (EXELL AND STACE, 1966)[2]

Family: Combretaceae R.Br. (20 genera)
Subfamilies: (a) Strephonematoideae Engl. & Diels
(1 genus: *Strephonema* Hook.f. (7 spp.))
(b) Combretoideae (19 genera)
This is subdivided into 2 tribes:

(a) *Tribe* Laguncularieae Engl. & Diels
Genera: *Laguncularia* Gaertn.f. (1 or 2 spp.), *Lumnitzera* Willd. (2 spp.), *Macropteranthes* (F. Muell.) (4 spp.).

(b) *Tribe* Combreteae (16 genera). This is divided into 3 sub-tribes:

(i) *Sub-tribe* Combretinae
Genera; *Combretum* Loefl. (approx. 200 spp.). *Thiloa* Eichl. (3 spp.), *Quisqualis* L. (16 spp.). *Calopyxis* Tul. (22 spp.), *Meiostemon* Exell & Stace (2 spp.), *Guiera* Juss. (1 sp.). *Calycopteris* Lam. (1 sp.)

(ii) *Sub-tribe* Pteleopsidinae
Genera: *Pteleopsis* Engl. (10 spp.)

(iii) *Sub-tribe* Terminaliinae
Genera: *Terminalia* L. (approx. 150 spp.). *Ramatuella* Kunth (6 spp.). *Terminaliopsis* Danguy (1 sp.). *Bucida* L. (9 spp.), *Buchenavia* Eichl. (22 spp.), *Anogeissus* Wall. (14 spp.), *Finetia* Gagnep. (1 sp.), *Conocarpus* L. (2 spp.).

RESULTS AND DISCUSSION

The analytical data obtained are shown in Table 2. Both the specimens studied are exceptionally viscous water-soluble plant gums. Intrinsic viscosity values of 11–20 ml g^{-1} are typical[17] of good quality examples of gum from *Acacia senegal* (gum arabic), and this viscosity range is usually associated with molecular weights in the $1–20 \times 10^5$ range[18] in *Acacia* species. It therefore appears reasonable to predict that studies will reveal these *Terminalia* exudates to be more linear and less highly branched than those studied so far in the *Acacia* group. Although *T. sericea* and *T. superba* gums contain determinable amounts of acetyl groups, their gum solutions do not have a perceptible odour of acetic acid, and their good solubility and pale colour in solution indicate that they have considerable potential commercial interest.

The gums from *T. sericea* and *T. superba* are slightly less acidic (uronic anhydride, 11%) than *Acacia senegal*[17] (uronic anhydride, 13–17%) but they are more complex structurally since they contain three uronic acids—galacturonic acid, glucuronic acid, and 4-*O*-methylglucuronic acid. Although it is not at all uncommon for a plant gum to contain three or more aldobiouronic acids, it is unusual for more than two of the three uronic acids named above to be involved.

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The gums from *T. sericea* and *T. superba* are also unusually complex in terms of their neutral sugar composition. The major sugars are the usual arabinose and galactose, but the presence in addition of rhamnose, mannose, and xylose, in amounts that cannot be dismissed as traces, is exceptional. Structural studies of *Terminalia* gums will therefore only be based meaningfully on specimens that have been previously subjected to careful tests to establish whether fractionation of components can be achieved, or whether there is contamination from other polysaccharide types.

TABLE 2. ANALYTICAL DATA FOR PURIFIED GUM POLYSACCHARIDES FROM TWO *Terminalia* SPECIES

	T. sericea	*T. superba*
Moisture (%)	9·2	12·2
Ash (%)*	2·4	0·6
Nitrogen (%)*	0·46	0·18
Hence protein (%) (N × 6·25)*	2·87	1·12
Methoxyl (%)†	1·20	0·39
Acetyl (%)	0·6	0·3
$[\alpha]_D$, in water (degrees)†	−13	+44
Intrinsic viscosity $[\eta]$ (Ml g^{-1})*	145	157
Molecular weight (MW × 10^5)	21	40
Equivalent weight†	1615	1659
Hence uronic anhydride (%)†‡	10·9	10·9
Sugar composition† after hydrolysis		
4-*O*-methylglucuronic acid§	7·2	2·3
Glucuronic acid	1·6	5·2
Galacturonic acid	2·1	3·1
Galactose	22	20
Arabinose	48	51
Rhamnose	6	5
Mannose	7	9
Xylose	6	4

* Corrected for moisture content.
† Corrected for moisture and protein content.
‡ If all acidity arises from uronic acids.
§ If all methoxyl groups located in this acid.

The only other *Terminalia* gum to have been studied previously (*T. tomentosa*) was reported[15] to contain 30% galactose, 21% arabinose, 14·5% xylose, 1·5% rhamnose and 33% glucuronic acid, with $[\alpha]_D = +35{\cdot}3°$. This therefore appears to be a much more acidic gum than those from *T. sericea* and *T. superba*, but the fact that only one uronic acid was detected suggests that further samples of this exudate should be examined; the yield of crude gum obtained was, moreover, only 50 g from 5 kg of fresh exudate and this represents a major difference from the freely water-soluble materials available for our studies. Unfortunately the amounts remaining from this analytical survey are insufficient for a full structural study; attempts to secure further specimens of gum from *T. sericea*, *T. superba*, and other *Terminalia* spp. are in progress.

EXPERIMENTAL

Origins of gum specimens. Gum from *Terminalia sericea* Burch. was collected by Mr. T. Gordon at Audley End Farm, Darwendale, Salisbury, Rhodesia in October 1970 (voucher ref. T. Gordon 161, in SRGH, and verified by Mr. Th. Müller, Curator, National Botanic Gardens, Salisbury). Gum from *T. superba* Engl. and Diels, syn. *T. altissima* A. Chev. was collected by Mr. W. Kriek from 1 tree at Marak Forest reserve, Cameroon on 22 April

1970, and sent by Mr. J. J. Lawrie, Project Manager, United Nations FAO Forest Industries Development Project, B.P. 369, Yaounde, Cameroon.

Preparation of samples for analysis. The gum from *T. sericea* dissolved readily overnight in cold water to give an approx 5% soln. The gum from *T. superba* was received as a soft plastic mass, packed in polythene; the gum dispersed quickly when stirred gently in cold H_2O. After dialysis against tap H_2O for 24 hr and then against distilled H_2O for 2 × 24 hr, the gum solns were filtered successively through Whatman No. 41, No. 1, and finally No. 42 papers, then freeze-dried.

Analytical methods. The standard analytical methods have been described[19,20] in earlier parts of this Series, with the following exceptions. Equivalent weights were found by potentiometric titration (to pH 7) of weighed amounts of gum (50–100 mg) that had been electrodialysed exhaustively. In the calculation of MW from light-scattering data, the value of $dn/dc = 0{\cdot}146$, established[18] for *Acacia* species, was used. Acetyl contents were determined by the Weisenberger method.[21]

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