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ACACIA GUM EXUDATES FROM SPECIES OF THE SERIES GUMMIFERAE*

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Abstract—An analytical study of the gum exudates from the African species *Acacia ehrenbergiana* (three specimens), *A. xanthophloea* (two specimens), *A. hockii* and *A. sieberana* var. *villosa*, and of the Australian species *A. calcigera*, has been made. There are now 19 species within the series Gummiferae Benth. for which gum parameters are available; of these, only *A. ehrenbergiana* gum displays a slightly negative optical rotation. The data for the three gum specimens from *A. ehrenbergiana* give a further example of the extent to which the gum from different trees of one particular species can vary in composition. The data for *A. sieberana* var. *villosa* gum are compared with the values established previously for subsp. *sieberana*; the differences between varieties of one species are similar in extent to those established for some subspecies. Although *A. xanthophloea*, *A. hockii*, *A. ehrenbergiana*, *A. seyal* and *A. karroo* are regarded as being very closely related botanically, the values for some of their analytical parameters differ considerably and strongly support the view that it is correct to retain them as distinct species.

INTRODUCTION

The analytical data obtained for the gums from *Acacia calcigera*, *A. sieberana* var. *villosa*, *A. xanthophloea* (two specimens), *A. hockii* and *A. ehrenbergina* (three specimens) are shown in Table 1 and compared with the data obtained previously for the gums from *A. sieberana* var. *sieberana* [1], *A. seyal* [2–4] and *A. karroo* [5].

RESULTS AND DISCUSSION

The new data recorded here increase the number of species in Gummiferae Benth. for which analytical data for gum exudates are available [4] to 19. Of these, all except *A. ehrenbergiana* give gums having strongly positive optical rotations, ranging from +28° for *A. hebeclada* [6] to +108° for *A. nilotica* [7]. The data for gum specimens A, B and C from *A. ehrenbergiana* give further examples of the extent of the variations found in the gum nodules exuded by different trees of a particular species, e.g. *A. senegal* (gum arabic) [8], *A. karroo* [5], *A. nilotica* [7], *A. dealbata* [1], *A. laeta* [9], etc.

None of the gum samples studied in this work have high nitrogen contents. The highest nitrogen content recorded so far (9.4%) for an *Acacia* gum is for a Gummiferae species, *A. hebeclada* [6]; several species within the subseries Juliflorae are now known [10] to have nitrogen contents of greater than 7.5%.

It is unusual for species within the Gummiferae to occur in Australia. The gum from *A. calcigera*, a species discovered recently by Dr. Mary Tindale, has been shown (Table 1) to be a typical member of the Gummiferae; it is similar to the gums from *A. drepanolobium*, *A. nilotica* and *A. nubica* [4] in containing less than 1% of rhamnose, a feature also shown by some members of the Juliflorae [10].

The data for the gum from *A. sieberana* var. *villosa* are shown in Table 1 together with the data reported previously for *A. sieberana* var. *sieberana* [1]. Many of their gum parameters are closely similar, e.g. the optical rotations, intrinsic viscosities, molecular weights, and the nitrogen, methoxyl and rhamnose contents, but there are differences in their uronic acid contents and the ratios of galactose to arabinose. The differences between these two *varieties* of *A. sieberana* are comparable with those recorded recently for some subspecies, e.g. for *A. dealbata* [1] and its subspecies *subalpina* [11], *A. mellifera* and its subspecies *detinens* [6], and for three of the subspecies of *A. tortilis* [12, 13]. Although the analytical differences between varieties and between subspecies are not large, they are nevertheless adequate for analytical differentiation for chemotaxonomic purposes.

Acacia xanthophloea, found from Kenya southwards to Swaziland and Zululand, is unique [14] in having either deep yellow or white/purple flowers and these two forms are, in general, clearly differentiated geographically [15]. On this basis, specimens A and B almost surely had white/purple and yellow flowers, respectively (we are grateful to one of the referees for this suggestion). The yellow-flowered specimens have been stated [14] to resemble *A. seyal* and the white/purple flowered specimens to resemble *A. kirkii*. Comparison of the gum data for *A. xanthophloea* specimens A and B and *A. seyal* (Table 1) with that for *A. kirkii* [6] now indicate that although *A. xanthophloea* specimens A and B are closely similar, there does not appear to be any close similarity between the gums from *A. seyal* and yellow-flowered *A. xanthophloea* nor between the gums from *A. kirkii* and white/purple flowered *A. xanthophloea*. In contrast, the gum from *A. seyal* is clearly very similar to that from *A. kirkii*.

Acacia hockii is exceedingly variable and has long been confused with *A. seyal* [14]. Although the two are undoubtedly closely related, Ross [14] believes it to be

*Part 63 of the series "Studies of Uronic Acid Materials".

Table 1. Analytical data for gum polysaccharides from *Acacia* species of the series Gummiferae Benth

	A. calcigera	*A. sieberana* var. *sieberana*	*A. sieberana* var. *villosa*	*A. xanthophloea* A	*A. xanthophloea* B	*A. hockii*	*A. ehrenbergiana* A	*A. ehrenbergiana* B	*A. ehrenbergiana* C	*A. seyal*	*A. karroo*
Moisture (%)	13.1	7.1	6.0	12.7	11.1	4.4	6.0	7.9	12.1	13.4	6.7
Ash (%)*	2.7	1.9	1.5	2.4	5.5	1.3	3.1	3.0	3.5	2.8	3.2
Nitrogen (%)*	0.15	0.35	0.19	0.14	0.39	0.23	0.09	0.12	0.11	0.14	0.15
Hence protein (%) (N × 6.25)*	0.9	2.2	1.2	0.87	2.4	1.4	0.6	0.8	0.7	0.9	0.9
Methoxyl (%)†	0.76	0.74	0.68	2.4	2.0	0.61	0.84	0.56	0.48	0.94	0.47
$[\alpha]_D$ in water (degrees)†	+97	+106	+103	+35	+44	+91	−7	−9	−3	+51	+53
Intrinsic viscosity (ml/g)*	15	12	12	15	24	13	7	8	8	12	17
Molecular weight, MW, $\times 10^5$	26	14	14	9.2	0.4	2.7	2.7	1.1	1.0	8.5	18
Equivalent weight†	1430	2300	1230	1050	1120	1460	1060	810	820	1470	1250
Hence uronic anhydride (%)‡	12	8	14	17	16	12	17	22	22	12	14
Sugar composition after hydrolysis											
4-O-Methylglucuronic acid§	4.5	4.5	4	14.5	12	3.5	5	3.5	3	5.5	2.5
Glucuronic acid	7.5	3.5	10	2.5	4	8.5	12	18.5	19	6.5	11.5
Galactose	34	28	35	54	61	50	56	55	51	38	50
Arabinose	54	60	47	23	16	30	17	13	16	46	28
Rhamnose	< 1	4	4	6	7	8	10	10	11	4	7

*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.

preferable to maintain them as separate species; *A. hockii* differs mainly in not having a powdery bark. As *A. seyal* is also closely related to *A. karroo* [14] and as the absence of a powdery bark suggests [14] that *A. ehrenbergiana* is more closely related to *A. hockii* than to *A. seyal*, comparisons are made of the gum parameters from all of these species in Table 1. The analytical data differ quite extensively, supporting the view [14] that they should all be maintained as separate species. To strengthen these deductions, analytical data for further specimens of the gums from these closely related, variable, species are desirable. Similar evidence from other series in *Acacia*, e.g. Juliflorae [10] and Botryocephalae [11] indicate that the analytical differences between closely related species can be extensive and of potential chemotaxonomic use, as suggested in 1969 [16].

In the past, gums from the series Gummiferae Benth. (e.g. *A. seyal*) have been of minor commercial interest in comparison with those from the series Vulgares Benth.; *A. seyal* gum has long been offered for sale commercially as a commodity distinct from true gum arabic (derived from *A. senegal*, series Vulgares). *Acacia seyal* gum (Talha) behaves differently in confectionery manufacture and in other technological applications and is regarded as being of inferior quality. As toxicological clearance for use in foodstuffs has been accorded by international regulatory committees to gum arabic when defined as "the gummy exudate from *A. senegal* Willd. and the related *Acacia* species" [17, 18], gums from *Acacias* within the series Gummiferae Benth. are excluded and therefore now largely of academic interest only. An implication of the definition adopted is that 'gum arabic', a special term for gum from specified *Acacias*, is no longer synonymous with the general term 'gum acacia'.

EXPERIMENTAL

Origin of gum specimens. Gum from *A. ehrenbergiana* Hayne; specimens A, B and C were collected by Dr. J. Vassal, University of Toulouse, France, near the airport at Nioro du Sahel, Mali, on 16/2/1977. *Acacia xanthophloea* Benth.: gum specimen A was collected in Kenya in August 1976 by Dr. J. O. Kokwaro, Botany Department, University of Nairobi; specimen B, sent by Professor K. D. Gordon-Gray on 19/1/1976, was obtained from a tree cultivated in Pietermaritzburg from seed collected from a tree growing indigenously in Zululand. Gums from *A. hockii* De Wild. and from *A. sieberana* DC. var. *villosa* A. Chev. were collected in April 1975 in Northern Ghana by Dr. M. Jefferies, University of Salford. The identifications of voucher specimens were confirmed by Dr. R. M. Polhill, Royal Botanic Gardens, Kew. Gum from *A. sieberana* DC. var. *sieberana* was collected by Mr. A. G. Seif-el-Din, Gum Research Officer to the Republic of the Sudan, at El Obeid in June 1969. Gum from *A. calcigera* Tindale MS (NSW 108559) was collected by Dr. Mary Tindale (M. Tindale 6075) on 9/7/79, 28.8 km South of Maranboy turn-off on Stuart highway, Northern Territory, Australia.

Preparation of samples for analysis. All the gum specimens dissolved in cold water to give clear solns, which were filtered (muslin, then paper), dialysed for 2 days vs tap water, and freeze-dried.

Analytical methods. The analytical methods used have been described [19].

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