Carbohydrate Research, 26 (1973) 99–104

THE GUM EXUDATES FROM *Acacia dealbata* AND *Acacia sieberana*: CORRECTIONS TO PREVIOUS ANALYTICAL DATA*

D. M. W. ANDERSON, P. C. BELL, G. H. CONANT, AND C. G. A. MCNAB
Department of Chemistry, The University, Edinburgh EH9 3JJ (Great Britain)
(Received May 31st, 1972; accepted for publication, June 19th, 1972)

ABSTRACT

In the light of the analytical data acquired for the gum exudates from a greatly increased number of *Acacia* species in recent years, the data published for *A. sieberana* gum in 1939, and for *A. dealbata* gum in 1966, differ considerably, in several respects, from the range of values established for some closely related species. Seven specimens of gum from *A. dealbata* and four specimens from *A. sieberana* have therefore been studied; from the analytical results, it must be concluded that much of the data published earlier for *A. dealbata* and *A. sieberana* cannot be regarded as typical of these species.

INTRODUCTION

In a botanical genus as large and complex as *Acacia*, now known[2] to comprise at least 625 species native to Australia alone, taxonomic classification must be used wherever possible to guide systematic, chemical investigation. Since the chemotaxonomic situation with respect to *Acacia* was summarised[3], additional analytical data have been published for 8 species[4] in Series II (*Botryocephalae*) and for 6 species[1] in Series I (*Phyllodineae*) of Bentham's classification[5] of the genus. Within the *Phyllodineae*, it is now of interest that the gums from *A. pycnantha* and *A. cyanophylla* have widely differing, analytical parameters, since they had been regarded by Bentham[5] as closely related species. A re-investigation[1] of the composition and properties of these two species of gum showed, however, that the analytical data reported previously were substantially correct; a chemotaxonomic anomaly therefore remains, and the botanical classification of these species is now under scrutiny[2].

When the analytical parameters for *A. dealbata* gum published in 1966 by Anderson and Karamalla[6] are compared with the data now available for 10 other species[1,3] of the *Botryocephalae*, some of the parameters ascribed to *A. dealbata* gum are seen to differ greatly from the range of values representative of other species in that group. We now report the results for seven new specimens of *A. dealbata* gum

*Part 42 of the Series "Studies of Uronic Acid Materials". Part 41: ref. 1.

from Australian and South African sources, obtained with the object of establishing whether any taxonomic anomaly is involved.

The only data available to date for the gum from *A. sieberana* (a form of spelling now preferred to that formerly used, *i.e. A. sieberiana*) was published[7] by Adriaens in 1939. *A. sieberana* was therefore one of the first *Acacia* gums to be studied apart from the source of commercial gum acacia (*A. senegal*). Although Adriaens' study was superficial, some of his results for *A. sieberana* gum, *e.g.* his report of the presence of xylose and 12% of fucose, appear to be highly anomalous in the light of present day knowledge of the genus *Acacia*. Furthermore, Adriaens reported that *A. sieberana* gum contained 26% of arabinose, that it was rich in galactose, and that it was slightly dextrorotatory; these features do not correspond with the analytical data now established for species in the *Gummiferae* series. Further investigation therefore appeared to be required, and we now report the results of an analytical study of four specimens of *A. sieberana* gum.

EXPERIMENTAL

Origins of gum samples from Acacia dealbata *Link.* (*Bentham No. 284*). — Samples I–IV were collected by officers of the Wattle Research Institute, University of Natal, Pietermaritzburg (by the courtesy of Dr. H. Shaw, Director) as follows. Sample I (4 g) was collected on Feb. 14th, 1963, from a tree 40 ft high, probably over 25 years old, close to the road from Platberg Colliery to Collings Pass, ~2.5 miles west of Elandslaagte in the Ladysmith district of Natal; sample II (3.5 g) on the same date from a tree of similar size and age, growing 30 yards from the tree that gave sample I; sample III (3.5 g) on Feb. 16th, 1963, from a tree 50ft high, probably over 30 years old, at a camp site on the main road from Lidgetton to Balgowan, Natal; sample IV (3.5 g) on the same date from a tree 45 ft high, probably over 40 years old, growing close to the tree that gave specimen III. Sample V was collected by Dr. C. C. J. Culvenor (C.S.I.R.O. Melbourne) at Yandoit, Victoria, Australia, on April 15th, 1971. Sample VI was collected on March 11th, 1969, by Mr. R. Coveny and Mr. J. Pickard from a tree 6–7 m high, with silvery foliage, 15 miles SSW of Rylstone, New South Wales, Australia (Reference voucher no. N.S.W. 103114). From this sample, two large nodules were selected and treated separately as specimens VIA and VIB.

Origin of gum specimens from Acacia sieberana *DC.* (*Bentham No. 307*). — The specimens were collected by Mr. A. G. Seif-el-Din, M.Sc., Gum Research Officer to the Republic of the Sudan, at El Obeid in June 1969. Specimens I, II, and III were large, single nodules (~20 g) each obtained from a different tree: specimen IV was a mixture of small pieces obtained from several trees.

Preparation of specimens for analysis. — All the specimens from *A. dealbata* were soluble in cold water. Specimens I–IV gave pale-brown solutions; specimen V gave a pale, slightly cloudy solution; specimens VIA and B gave clear, yellow solutions.

All the specimens from *A. sieberana* gave clear, colourless or very pale-yellow solutions. Specimen I was completely soluble, but specimens II–IV contained ~10% of gum that imbibed water to give a gel but did not dissolve. These gels were not investigated.

After dialysis against tap-water for 24 h and then against distilled water for 24 h, all the gum solutions were filtered in turn through Whatman Nos. 42, 1, and 41 papers, and then freeze-dried.

Analytical methods. — The standard, analytical methods have been described[1].

RESULTS AND DISCUSSION

Acacia dealbata. — The analytical data obtained for seven different specimens of *A. dealbata* gum are shown in Table I; for comparison, the data published[6] in 1966, for what was at that time believed to be a sample from *A. dealbata*, are shown in the final column. The analytical values obtained for the specimens studied in this investigation are remarkably self-consistent, and are in general in good agreement with the set of parameters typical of the *Botryocephalae* species[4], characterized by a high ratio of galactose–arabinose, low negative or low positive rotation, low intrinsic viscosity, and relatively low contents of nitrogen and uronic anhydride. There are large differences between the data found for the present specimens and the putative specimen studied in 1966; the differences in the galactose–arabinose ratio, specific rotation, intrinsic viscosity, and molecular weight are particularly significant. The collector of the specimen studied in 1966, Mr. R. L. Willans (who was government silviculturalist, Southern Highlands Province, Tanganyika, in 1960), cannot now be traced; unfortunately, a botanical, reference-voucher specimen was not supplied with the gum sample in question. The difficulties inherent in this type of situation have already been discussed[3].

The present sample VI is backed by an authenticated, botanical reference-voucher lodged in the Sydney National Herbarium, and the other specimens studied here are all closely similar analytically. It appears, therefore, that the data published previously under the name *A. dealbata* can no longer be regarded as typical of that species. According to a botanical authority[8] on *Acacia* spp., *A. dealbata* is not reputed to be particularly variable; this is confirmed by the fact that the present specimens originated from two different locations in Natal and from two locations in Australia. There has, however, already been one report of the composition of a gum sample differing markedly from other samples from the same species[9]. Attempts to obtain new specimens of *A. dealbata* gum from Tanzania are therefore being made, but co-operation from that locality is difficult to secure at the present time.

Acacia sieberana. — The analytical data obtained for the specimens of gum from *A. sieberana* are shown in Table II. From these parameters, *A. sieberana* can be regarded as a typical member of Bentham's Series 4 (*Gummiferae*) in having a highly positive rotation, high molecular weight, and a high ratio of arabinose to galactose. Indeed, the specific rotations given by two of the present specimens equal the highest

TABLE I

ANALYTICAL DATA FOR DIFFERENT SPECIMENS OF PURIFIED *Acacia dealbata* GUM

	Specimen							*Data from ref. 6*
	I	*II*	*III*	*IV*	*V*	*VIA*	*VIB*	
Moisture, %	8.2	9.3	9.1	9.6	9.1	11.3	7.7	—
Ash, %	1.9	1.3	1.4	1.0	1.7	0.9	1.0	2.9
Nitrogen[a], %	0.28	0.26	0.19	0.22	0.21	0.31	0.26	0.61
Hence protein[a], % (N×6.25)	1.8	1.6	1.2	1.4	1.3	1.9	1.6	3.8
Methoxyl[b], %	0.81	0.74	0.74	0.66	0.74	0.63	0.70	0.35
$[\alpha]_D$ in water, degrees[b]	+3.0	+1.5	+7.5	+4.0	+4.0	−1.0	−2.5	−25
$[\alpha]_D$ in 7M urea, degrees[b]	+4.0	+2.0	+9.0	+4.0	+5.0	n.d.	−2.5	−30
Intrinsic viscosity $[\eta]$[a], ml.g^{-1}	7.6	6.0	6.5	5.9	5.8	7.6	7.2	21.5
Molecular weight[a], $\overline{M}_W \times 10^3$	320	200	140	200	71	130	190	1200[e]
Equivalent weight[b]	2310	2730	2680	2890	2450	3140	3080	1840
Hence, uronic anhydride[b,c], %	7.6	6.4	6.6	6.1	7.2	5.6	5.7	9.5
Sugar composition[b] after hydrolysis								
4-*O*-Methylglucuronic acid[d]	5.5	4.4	4.4	4.0	4.4	3.8	4.2	2.1
Glucuronic acid	2.1	2.0	2.2	2.1	2.8	1.8	1.5	7.4
Galactose	62	63	64	61	65	62	64	41
Arabinose	21	20	21	22	19	23	22	41
Rhamnose	9	10	8	10	9	9	8	6

[a]Corrected for moisture content shown. [b]Corrected for moisture and protein content. [c]If all acidity arises from uronic acids. [d]If all methoxyl groups are located in this acid. [e]From ref. 9.

TABLE II

ANALYTICAL DATA FOR DIFFERENT SPECIMENS OF PURIFIED *Acacia sieberana* GUM

	Specimen			
	I	*II*	*III*	*IV*
Moisture, %	6.1	5.3	6.8	10.4
Ash, %	1.7	1.5	1.6	2.7
Nitrogen[a], %	0.34	0.33	0.30	0.43
Hence protein[a], %(N × 6.25)	2.1	2.1	1.9	2.7
Methoxyl[b], %	0.76	0.78	0.84	0.60
$[\alpha]_D$ in water, degrees[b]	+108	+106	+108	+104
$[\alpha]_D$ in 7M urea, degrees[b]	+113	+115	+112	n.d.
Intrinsic viscosity $[\eta]$[a], $ml.g^{-1}$	10.0	12.7	14.5	11.8
Molecular weight[a], $\overline{M}_W \times 10^3$	900	1200	1500	1500
Equivalent weight[b]	2070	2780	2420	1930
Hence, uronic anhydride[b,c], %	8.5	6.3	7.3	9.1
Sugar composition[b] after hydrolysis				
4-*O*-methylglucuronic acid	4.6	4.7	5.0	3.6
Glucuronic acid	3.9	1.6	2.3	5.5
Galactose	30	27	26	29
Arabinose	57	63	61	58
Rhamnose	5	3	6	4

[a]Corrected for moisture content shown. [b]Corrected for moisture and protein content. [c]If all acidity arises from uronic acids. [d]If all methoxyl groups are located in this acid. [e]From ref. 9.

value (108°) previously reported for any *Acacia* species, *i.e.* for *A. nilotica*[9], and the average for the arabinose–galactose ratio for the present four specimens (60/28) is almost as high as has been recorded[10] to date, *i.e.* for *A. nubica* (64/28). There can be no doubt that Adriaens' statement[7] that the specific rotation of this species is "slightly dextrorotatory" (he did not quote any specific value) is erroneous. His report of the presence of both xylose and fucose is also incorrect; no trace of either of these sugars could be found in careful chromatographic analyses of several hydrolysates of each of the present specimens. It is clear from Adriaens' report[7] that his analyses were conducted in difficult circumstances prior to the introduction of chromatographic techniques.

ACKNOWLEDGMENTS

We thank Rowntree–Mackintosh Ltd. (York) and Laing-National Ltd. (Manchester) for financial support, and Dr. C. C. J. Culvenor, Mr. A. G. Seif-el-Din, Dr. H. Shaw, and Dr. Mary Tindale for arranging the collection of specimens.

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