Phytochemistry, Vol. 24, No. 1, pp. 77–79, 1985.
Printed in Great Britain.

0031–9422/85 $3.00 + 0.00

GUM POLYSACCHARIDES FROM THREE *PARKIA* SPECIES*

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(*Received* 31 *May* 1984)

Key Word Index—*Parkia*; Leguminosae; gum exudates; seed-pod gum; seed dispersal; plant–animal interactions.

Abstract—Nigerian gum exudates from *Parkia bicolor* and *P. biglobosa*, and gum from the seed pods of *P. pendula* growing in Costa Rica have been analysed. The two gum exudates are proteinaceous and have closely similar physicochemical properties and compositions, with galactose, arabinose, glucuronic acid and 4-*O*-methylglucuronic acid as their constituent sugars; rhamnose is absent, and they are dextrorotatory. The gum from the seed pods of *P. pendula* contains the same constituent sugars in different proportions, and is laevorotatory. These data may be of interest in the continuing studies of plant–animal interactions and mechanisms of seed dispersal associated with the genus *Parkia*.

INTRODUCTION

Parkia (Leguminosae: Mimosoideae) is a pantropical genus of evolutionary interest with centres of distribution in South America, Africa and South-east Asia [2], comprising some 30 [3] to 40 [4] species which are pollinated by different groups of bats in different areas; by the Pteropoideae in the Old World; and by the Phyllostomidae in the New World [3].

Parkia is a natural taxon, most species being immediately distinguishable by their remarkable pendant, double inflorescences and imbricate calyx-lobes. The three closely allied species from mainland Africa [*P. biglobosa* (syn. *P. africana*), *P. bicolor* and *P. filicoidea*] can be distinguished by combinations of characters of the leaves, capitula, flowers, pods and seeds [3, 4]. Sectional arrangements in *Parkia* have been proposed by Bentham [5], Ducke [6, 7] and Hopkins [8]. Bentham and Ducke both placed *P. biglobosa* and *P. bicolor* in section *Euparkia* but Hopkins places them in section *Parkia* [8]. In contrast, Bentham [5] placed *P. pendula* in section *Euparkia* but Ducke [7] and Hopkins [8] place this species in section *Platyparkia*.

Parkia biglobosa, sometimes called the African locust-bean tree, is one of the grain legumes and has other food and non-food applications. The economic uses and potential of *Parkia* spp. have been discussed recently [8]. Extensive data exist for the chemical compositions and nutritive values of the fruits and seeds; for their content of vitamins, amino acids and oils; and for the presence of toxic alkaloids and other substances possessing powerful physiological effects [8]. Thus the genus *Parkia* has offered great scope for both chemical and botanical investigations yet there have been no studies of the *Parkia* gums and mucilages. This paper presents the results of analytical studies of the gum exudates from *P. bicolor* and *P. biglobosa*, and of the gum extracted from the seed pods of *P. pendula*.

RESULTS AND DISCUSSION

The analytical data obtained, shown in Table 1, provide an interesting range of parameters. All three gum polysaccharides are of high weight-average molecular weight and intrinsic viscosities, comparable with the highest values reported so far for any of the gums from *Acacia* species [9, 10], but not as high as those reported for some *Combretum* [11] and *Grevillea* [12] gums.

The methoxyl and nitrogen contents of the *Parkia* gum exudates are higher than that of the *Parkia* seed-pod gum. The values observed (0.72–1.25%) for the methoxyl contents are intermediate in the range now known for the gum exudates from many plant genera. The nitrogen values are also intermediate; some *Acacia* gums [13] contain up to 8% of nitrogen (i.e. indicating a 50:50 carbohydrate–protein complex, glycoprotein, or proteoglycan). The presence of 0.92–0.95% N in the *Parkia* gum exudates nevertheless indicates the presence of 6% of protein (which may be nutritionally attractive to the birds and arboreal animals known [2] to feed on *Parkia* gums) and this provides fresh evidence that the proteinaceous content of a plant gum exudate is important in terms of gum structure and properties.

The major features to emerge from the data in Table 1 are the close similarity of the exudate gums from *P. bicolor* and *P. biglobosa*, and the extent of their differences from *P. pendula* seed-pod gum. These differences, particularly the specific rotations and the ratios of galactose to arabinose, are not surprising in view of the different forms of exudation and the considerable geographical and morphological differences involved. There is, however, strong support for a very close taxonomic relationship between *P. bicolor* and *P. biglobosa*.

The gum polysaccharide from the seed pods of *P. pendula* must be regarded as a typical plant gum. Its possible mode of biosynthesis and the nature of the gum precursors pose intriguing questions at a time when their answers are being sought for the more typical tree

*Part 71 in the series "Studies of Uronic acid Materials". For Part 70 see ref. 16 [1].

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Table 1. Analytical data for gum polysaccharides from *Parkia* species

	Seed-pod gum	Exudate gums from	
	P. pendula	*P. bicolor*	*P. biglobosa*
Loss on drying, 105°, %	5.6	8.3	9.9
Total ash, 550°, %*	1.5	3.0	3.2
Nitrogen, %*	0.35	0.92	0.95
Hence protein (N × 6.25), %*	2.2	5.8	5.9
Methoxyl, %†	0.72	1 25	1.06
Sp. rotation, $[\alpha]_D$, °†	−74	+13	+33
Intrinsic viscosity, ml/g†	34	44	32
MW × 10^6†	5.6	2 0	3.0
Neutralization equivalent (electrodialysis)†	2280	1030	960
Hence uronic anhydride, %†‡	8	17	18
Sugar composition after hydrolysis, %			
4-*O*-Methylglucuronic acid§	4.5	7.5	6.5
Glucuronic acid	3.5	9.5	11.5
Galactose	30	74	73
Arabinose	62	9	9
Rhamnose	—	—	—

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

exudates. There has been a great deal of speculation ([12]; Janzen, D. H., personal communication) regarding the biological function of seed-pod gums in terms of their role in the different natural seed-dispersion processes observed in *Parkia* spp. Moreover, in *P. pendula* the gum is produced from the pod sutures when the pod dehisces; in all other *Parkia* spp. gum is produced inside the pod around the seeds and the pods do not dehisce (Hopkins, H. C., personal communication). In *Parkia* it is suggested [8] that attacks by beetles and wood-borers may be prevented or reduced by gum exuded in response to wounding, and there is widespread evidence [8] of the utilization of *Parkia* spp. as sources of foodstuffs for a wide range of types of tree-climbing animals. Comparisons with earlier studies of such tree–animal interactions involving *Acacia* spp. [15] show that *Parkia* gum exudates are more nitrogenous than *Acacia karroo*; the gums are therefore possible sources of foodstuff protein, carbohydrate and, in addition, of dietary calcium and magnesium, which are customarily the major components of the natural inorganic content of gum exudates revealed by ash determinations.

EXPERIMENTAL

Origin of gums. Seed pods from *Parkia pendula* (Willd.) Benth. were collected by Professor D H. Janzen, Botany Department, University of Philadelphia, in Corcovado Natural Park, Puntarenas Province, Costa Rica, on 20 March 1977. The pods and seeds had a thick coating of gum which was isolated by dissolution of the gum in H_2O, removal of the seeds and pods by simple filtration, and recovery of the gum by freeze-drying.

Gum exudates from *Parkia bicolor* A. Chev. and from *P. biglobosa* (Jacq.) R. Br. *ex* G. Don fil. were collected by Dr. H. C. Hopkins at the Forest Research Institute, Ibadan, on 10 February 1978. The gum exudates were dissolved in distilled H_2O to give a 1% soln (w/w), filtered (muslin, then Whatman No. 1 and No. 42 papers), dialysed (vs. tap H_2O for 2 days, vs. distilled H_2O for 1 day) and recovered by freeze-drying.

Analytical methods. The standard methods of analysis used have been described [16].

Acknowledgements—We thank the University of Zulia, Venezuela, for financial support (to G. de P.); and Dr. H. C. Hopkins and Professor D. J. Janzen for collection of gum samples and invaluable information on the genus *Parkia*, its seed-dispersal processes, and plant–animal interactions.

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