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STEROIDAL SAPOGENINS FROM LEAVES OF SOME SPECIES OF *AGAVE* AND *FURCRAEA*

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Key Word Index—*Agave*; *Furcraea*; Agavaceae; steroidal sapogenins; hecogenin; tigogenin; gitogenin; manogenin; 9-dehydromanogenin; chlorogenin.

Abstract—The steroidal sapogenins yielded by the leaves of *Agave aurea*, *A. avellanidens*, *A. cerulata*, *A. cerulata* ssp. *subcerulata*, *A. cocui*, *A. goldmaniana*, *A. shawii* and *Furcraea macrophylla* are recorded. In all these species, hecogenin and tigogenin were the major sapogenins isolated. Gitogenin was found in the extracts of all the leaf samples, except that of *A. shawii*, and manogenin and 9-dehydromanogenin in all but that of *A. cocui*. Chlorogenin was isolated from *A. cocui*, but was not detected in any of the other species examined. Qualitative and quantitative variations were found in the sapogenin contents of extracts of different regions of the same leaves of *A. cocui* and *F. macrophylla*. In particular, hecogenin predominated in the basal regions and tigogenin in the apical.

INTRODUCTION

Recently we reported the steroidal sapogenins present in the leaves of some species of *Agave*, *Beschorneria*, *Doryanthes* and *Furcraea* grown at the Royal Botanic Gardens, Kew, U.K. [1]. In this paper, the results are given of a further study of the leaves of some *Agave* and *Furcraea* species collected in Mexico and Venezuela.

RESULTS AND DISCUSSION

The steroidal saponins present in the dried leaves of the powdered samples of *Agave* and *Furcraea* species were acid-hydrolysed and the sapogenins liberated were extracted and examined by TLC against suitable reference compounds before isolation by preparative TLC. The monohydroxy, non-keto sapogenins were isolated together before the individual components were separated by preparative TLC using silver nitrate–Si gel. The monohydroxy keto sapogenins were isolated together, subjected to Wolff–Kischner reduction and their products were examined by TLC to enable characterization of the original keto-sapogenin mixture. The dihydroxy keto sapogenins were treated similarly. The mps, IR, NMR and MS of the sapogenins isolated in sufficient quantities from each species were compared with those of reference compounds. For the detection of 9-dehydrohecogenin and 9-dehydromanogenin, the UV spectra of the appropriate fractions were also recorded.

The steroidal sapogenins detected in the leaf extracts of the species examined are listed in Table 1, along with their hecogenin and tigogenin content. These two sapogenins were the major ones obtained from each species. Of the species investigated, only *A. cocui* has been studied previously for sapogenin content and hecogenin and tigogenin were reported [2].

Unlike our previous study [1], in which dihydroxy sapogenins were detected usually only as trace constituents, significant quantities of these compounds were found in most of the species investigated in the current work. In particular, gitogenin was detected in extracts of all the species, with the exception of *A. shawii*. Manogenin and 9-dehydromanogenin were found in all the species investigated, except *A. cocui*. However, from this species chlorogenin was isolated, whereas this compound was not detected in any of the other leaves examined. The presence of rockogenin was indicated also in *A. cocui*, but was not detected in any of the other species.

A. cocui leaves were divided into basal, middle and apical regions. The sapogenins recorded for this species in Table 1 are those found in the extract of the basal regions of the leaves. However, neither chlorogenin nor 9-dehydrohecogenin were detected in the extracts of the middle and apical regions. Although gitogenin was present in all three extracts, it was only a trace component of that of the apical regions. *F. macrophylla* leaves were similarly divided into three pieces. Gentrogenin and 9-dehydrohecogenin were not found in the extract of the apical leaf parts. Moreover, as reported earlier for *A. sisalana* Perrine [1], the hecogenin to tigogenin ratio varied considerably in different parts of the same leaf; in both *A. cocui* and *F. macrophylla*, hecogenin was the predominant sapogenin in the basal region, but tigogenin in the apical. It was not possible to similarly divide the leaf samples received of the other species.

EXPERIMENTAL

Plant materials. From Baja California, Mexico, 6 samples of dry *Agave* leaves were received from Dr. Howard Scott Gentry. These were *A. aurea* Brdg. (Gentry No. 23182), *A. avellanidens* Trel. (Gentry No. 23184), *A. cerulata* Trel. (Gentry No. 23185), *A. cerulata* ssp. *subcerulata* Gentry (Gentry No. 23170), *A. goldmaniana* Trel. (Gentry No. 23189) and *A. shawii* Engelm. (Gentry No. 23190). Dry leaf samples of *A. cocui* Trel. and *Furcraea macrophylla* Baker were supplied by Dr. Luis Ruiz Terán. The leaves of these 2 species were collected from wild plants

Table 1. Distribution of steroidal sapogenins in leaves of *Agave* and *Furcraea* species

Species	Steroidal sapogenin													Yield of major sapogenins (% dry wt)	
	Diosgenin	Yamogenin	Tigogenin	Neo-tigogenin	Gentrogenin	Hecogenin	Sisalagenin	9-Dehydrohecogenin	Gitogenin	Rockogenin	Chlorogenin	Manogenin	9-Dehydromanogenin	Tigogenin	Hecogenin
Agave aurea	±	−	++	±	+	++	−	+	±	−	−	±	±	0.04	0.52
A. avellanidens	+	−	++	±	+	++	−	±	+	−	−	+	+*	0.29	0.63
A. cerulata	±	−	++	−	+	++	−	+*	++	−	−	+	+*	0.10	0.60
A. cerulata ssp. *subcerulata*	±	−	++	−	+	++	−	+	++	−	−	+	+*	0.36	1.16
A. cocui	+	−	++	+	+	++	+	+*	++	+	++	−	−	0.62	1.04
A. goldmaniana	−	−	++	−	−	++	−	+*	±	−	−	±	±	0.16	0.11
A. shawii	+	+	++	+	+	++	−	++	−	−	−	++	++	0.66	1.11
Furcraea macrophylla	+	−	++	−	+	++	−	+*	++	−	−	+	+*	0.21	0.90

++ = compound fully characterized;
+* = TLC and UV spectral data only;
+ = TLC data only;
± = identity uncertain (trace amount only);
− = negative.

growing near Mérida, Venezuela. Voucher specimens have been lodged in the Herbarium of the Universidad de Los Andes, Mérida.

Estimation, examination and isolation of sapogenins. Each leaf sample was powdered prior to extraction of the steroidal sapogenins. The methods of extraction, chromatographic examination and isolation of the steroidal sapogenins have been described previously [3]. However, unlike the previous study [1], the monohydroxy, non-keto sapogenins were examined by TLC and the individual compounds isolated by prep. TLC using Si gel G layers containing 2% $AgNO_3$ [4]. The keto sapogenins were examined both before and after reduction by the Huang-Minlon modification of the Wolff–Kischner procedure [5]. The chlorogenin isolated from *A. cocui* was examined both before and after acetylation.

IR spectra were measured as KBr discs. ^1H NMR spectra were determined in $CDCl_3$ using a Bruker 270 MHz spectrometer. MS were recorded at an ionizing potential of 70 eV.

Estimation of sapogenin content. Hecogenin and tigogenin yields were determined using the GLC method of ref. [6].

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