

Studies of the Constituents of Crassulaceous Plants

II. Paper Chromatographic Investigation of the Free Sugars of some *Rochea*, *Kalanchoë*, *Cotyledon*, *Aeonium*, *Monanthes*, *Rosularia*, *Altamiranoa*, and *Echeveria* Species

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In a previous communication¹ we reported the results of our paper chromatographic investigations of the free sugars of some *Sedum*, *Sempervivum*, *Echeveria*, and *Crassula* species. Thanks to the assistance of Professor Nannfeldt of the University of Uppsala, we have been able to extend the investigations to cover some species of other genera of the *Crassulaceae*, and 2 further species of the genus *Echeveria*.

We have used the same procedure as before, namely, direct chromatography of the juice pressed out from the plants. Ketoses were detected by means of a special reagent² which our experience has indicated produces a bluish-green colour only with ketoheptoses, and is, therefore, especially suited for the detection of these sugars in plants. Aldoses were detected by other reagents.

The results are given in Table 1. Sedoheptulose was detected in all the species investigated, and on most chromatograms the spot produced by this sugar was the predominating one. One or more fermentable sugars (glucose, fructose, sucrose) were also detected in all the species.

According to Richtmyer³, sedoheptulose has been previously reported to be present in species of *Sedum*, *Bryophyllum*, and *Sempervivum*, and in a previous communication¹ we reported the presence of this sugar also in representatives of the genera *Echeveria* and *Crassula*. As we now have detected sedoheptulose in a further 7 genera, this sugar has been found to occur in species of 12 genera of the family *Crassulaceae*. According to Berger⁴, this family is divided into 33 genera, in 5 subfamilies. All the subfamilies are represented in the 12 genera studied. According to Engler and Diels⁵ 9 of these genera comprise

about 1 250 species of the family's total number of about 1 300. It may therefore be concluded that sedoheptulose occurs in species of the principal genera of the family *Crassulaceae* and is distributed throughout the family.

EXPERIMENTAL

Juices pressed from fresh plants were used for the experiments. If the juices were not to be used immediately, they were heated to boiling in order to destroy the enzymes. It was impossible to press out any juice from *Monanthes atlantica* because of its morphological structure. The plant was therefore extracted with ethanol, and this extract used after concentration and filtration. About 0.01–0.02 ml of the juice was placed on the paper (Whatman No. 1). The solvent used was ethyl acetate – acetic acid – water (3 : 1 : 3)⁶. The paper was equilibrated with the solvent atmosphere overnight, then the chromatogram was run for 36–48 hours, during which time the solvent ran off the lower edge of the paper. R/-values were therefore unobtainable, but sedoheptulose, fructose, glucose, and sucrose standards were run each time (0.005–0.01 ml of approximately 1 % solution).

As spraying reagents we used:

1. Orcinol and trichloroacetic acid in *n*-butanol², for the detection of ketoses.
2. Aniline hydrogen phthalate in *n*-butanol⁷, and
3. *m*-Phenylenediamine in aqueous ethanol⁸, the latter two for the detection of both aldoses and ketoses.

On some occasions when we attempted to demonstrate the presence of glucose, we obtained a long, white trail, which rendered this impossible. This is most likely due to the presence of too high a concentration of salts, as these juices had been concentrated to a rather large extent.

Table 1. Free sugars of some Crassulaceous plants, detected by means of paper partition chromatography. The sugars have not been determined quantitatively, but from the size of the spots and the intensity of the colours we have estimated the quantitative relationship. The predominating sugar is denoted by ++, very weak spots by (+). The genera are arranged in the order described by Berger⁴, and the nomenclature follows Berger⁴ and Praeger⁹.

Species	Sedoheptulose	Glucose	Fructose	Sucrose
<i>Rochea coccinia</i> (L.) DC.	++	+	+	(+)
<i>R. falcata</i> Wendl.	+	+	+	+
<i>Kalanchoë Hildebrandtii</i> Baill.	+	+	++	
<i>K. marmorata</i> Bak.	++		+	(+)
<i>Cotyledon coccinia</i> Cav.	++	(+)	(+)	(+)
<i>Aeonium cuneatum</i> Webb et Berth.	++	+	+	+
<i>A. Haworthii</i> Webb et Berth.	+		+	+
<i>Monanthes atlantica</i> Dall.	+	+	+	+
<i>Rosularia pallida</i> Stapf.	++			+
<i>Altamiranoa elongata</i> Rose	++		+	
<i>Echeveria Scheideckiri</i> X (L.) De Smet.	++		+	(+)
<i>E. scaphylla</i> X Deleuil	++		+	+

SUMMARY

The free sugars of the juice pressed out from some Crassulaceons plants have been studied by means of paper partition chromatography. All the extracts contained sedoheptulose and fermentable sugars. Sedoheptulose has now been shown to occur in all the 5 subfamilies of the family *Crassulaceae*.

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