involved in bonding, there is naturally a decrease in intensity. In the lanthanide complexes now investigated, both the 1273 and 1248 cm^{-1} bands of the ligand have been affected in position and there is considerable decrease in intensity.

There is broad band between 3500–3600 cm^{-1} in all the lanthanide complexes and this band is due to the presence of water molecules in the complexes. However, there is no band in the free ligand in this region.

From an examination of the above data, it can be concluded that orthophenylenediamine acted as a bidentate ligand in the lanthanide complexes.

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STUDIES ON *COSTUS SPECIOSUS* SIMS.

Part I. Variability in Diosgenin Content

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ABSTRACT

A wide range of variation in the diosgenin content has been observed in the rhizomes of *Costus speciosus*. The distribution in different portions of the same rhizome is uneven. There is a definite clone to clone variation while the diosgenin content is highest during the full bloom period in the months of July and August.

INTRODUCTION

COSTUS SPECIOSUS SIMS. has recently gained importance as a source of diosgenin, a precursor in the synthesis of steroidal hormones[1]. Analysis of a large number of rhizome samples collected from various localities during different months revealed a lot of variation in diosgenin content from plant to plant as well as at different periods of harvest. Detailed studies were, therefore, undertaken to find out the range of variability in the diosgenin content and the factors affecting it.

MATERIALS AND METHOLS

Four plants from one year old crop in the nursery were harvested during December, 1975 for determining the distribution of diosgenin in different portions of the same rhizome. Each rhizome was divided into tips, nodes and internodes and each set analysed separately for diosgenin content. For determining the range of diosgenin content in the natural population, two hundred plants growning side by side in the Suhari Village were harvested during November, 1975 and each of the rhizome analysed separately. Determination of the diosgenin content during different months of the year was done by sampling three plants from a two year crop in the nursery. A uniform portion of the rhizome of each plant was taken for analysis at 50 days interval between January, 1975, the period when the dormancy sets into April, 1976 when buds on the nodes start swelling. The procedure adopted for chemical analysis is according to Sarin *et al.* (*loc. cit.*). The diosgenin content has been calculated on dry weight basis.

RESULTS AND DISCUSSIONS

(i) The diosgenin content in tips, nodes and internodal portions of the rhizome are given in Table I. The diosgenin content in the nodal regions is greater than the tips and internodes, the latter having the least amount. The lesser concentration of diosgenin in tip and internodal regions, however, does not affect much the overall yield from the rhizome as the bulk of its biomass (about 75%) is formed by close set nodes.

(ii) *Range of diosgenin content in natural population*:

The analysis of 200 rhizome samples indicate that the diosgenin calculated on crude basis range from 0·39% to 3·65% (d.w.b.). Of the seven categories of clones containing between 0·5% and 4·0% of diosgenin, those having upto 1% constitute only 2% of the total, while those containing 1·0% to 1·5% 1·5% to 2%, 2·5% to 3·0%, 3·0% to 3·5% and 3·5%

TABLE I

Distribution of diosgenin in one year old rhizome of Costus speciosus

Tuber portion	Diosgenin percentage (Pure: dry wt. basis)					
	Sample No. 1		Sample No. 2		Sample No. 3	
	diosgenin %	Increase or decrease over average	diosgenin %	Increase or decrease over average	diosgenin %	Increase or decrease over average
Nodes with sprouted stem	0·88	+0·27	0·57	+0·14	0·72	+0·15
Internodes	0·41	−0·20	0·36	−0·07	0·42	−0·15
Tips	0·60	−0·01	0·37	−0·06	0·56	−0·01
Average	0·61	..	0·43	..	0·57	..

TABLE II

Seasonal variation in diosgenin content of Costus speciosus *rhizome*

Date of sampling	Vegetative stage	% Diosgenin (Pure: dry wt. basis)		
		Clone (1)	Clone (2)	Clone (3)
1st January, 1975	Aerial portions dried up	0·63	0·52	0·61
20th February, 1975	Dormant	0·91	0·75	0·86
10th April, 1975	Dormant	0·80	0·81	0·81
30th May, 1975	Aerial shoots 10–15 cm tall with few leaves	0·65	0·69	0·65
21st July, 1975	Aerial shoots with flower buds	2·61	2·02	2·64
10th September, 1975	Fruit formation on lower flowers of the inflorescence	1·02	0·98	0·88
30th October, 1975	Flower heads with mature fruits lower leaves yellowing	1·21	0·86	0·34
20th December, 1975	Aerial portions dried up	0·72	0·38	0·44
8th February, 1975	Dormant	1·03	0·45	0·50
30th March, 1976	Dormant	1·10	0·69	0·61

to 4% of diosgenin constitute 14%, 30%, 39%, 12%, 2·5% and 0·5% of the total respectively. It can be noticed that more than half of the total number of clones sampled (54%) contain more than 2% of crude diosgenin. Somewhat similar observations have been made in certain other localities in Jammu, Kangra and Dehradun. The fact that some of the clones are exceptionaliy rich in diosgenin, promises great possibilities of evolving a high yielding strain through selection and multiplication.

(iii) *Seasonal variation in diosgenin content* : The analysis of rhizome portions obtained from three plants have revealed interesting results (Table II). The diosgenin content increases steadily from early January when complete dormancy sets in till the month of May when young shoots sprout. There is a very sharp increase in the months of July and August when the plants achieve optimum height and are in full bloom. Diosgenin content again declines sharply during September and October, the period of intensive fruit formation. This decline continues till the last week of December when the aerial shoots dry up completely. The average diosgenin content of bulk material during August was 3·86% (Crude) as against 2·11% (Crude) for the material collected in November. Similarly a large number of samples harvested from Jammu plantations in July gave a diosgenin content (pure) above 2·0% (d.w.b.). There appears to be a close

relationship between the flowering and fruiting of the plant and diosgenin content.

The foregoing observations indicate a wide range of variability in the diosgenin content of the rhizomes of *Costus speciosus*. There is a definite clonal variation with a very wide range of diosgenin content. The variation appears to be genetic rather than physiologic as no relationship with the size and correspondingly the age of the rhizome could be established. A large percentage of plants growing wild in the sub-Himalayan localities of Jammu, Kangra and Dehradun contain appreciably high content of diosgenin. This makes the task of evolving a high yielding strain more easy.

The abrupt and sharp rise of diosgenin during the months of July and August, an equally sharp decline in September and October and reduction of diosgenin content to less than half of July concentration during the period of dormancy suggests that the crop should be harvested during the peak diosgenin months.

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