CACTUS ALKALOIDS. LI. LACK OF MESCALINE TRANSLOCATION IN GRAFTED *TRICHOCEREUS*

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Grafting of cacti is commonly employed to accelerate growth; the possible translocation of physiologically active alkaloids from alkaloidiferous root stocks into grafted non-alkaloidiferous scions and edible fruits is an expressed concern of cactologists (1). Because little is known about the site of synthesis of cactus alkaloids, a simple experiment was conducted with reciprocal grafts between root stocks (roots plus 10–15 cm of stalk) and scions of *Trichocereus pachanoi* Br. and R. and *T. spachianus* (Lem.) Ricc. The former species ("San Pedro") contains appreciable mescaline (2), while the latter species is lacking in mescaline content (3). Thin-layer chromatography (tlc) and gas-liquid chromatography (glc) were then used to assay mescaline in the grafted vs. control plants. Tlc with fluorescamine as a spray reagent (4) is sensitive for qualitation of mescaline, and glc (5) is useful for quantitation of mescaline and for its separation from any co-occurring 3,4-dimethoxy-β-phenethylamine.

Ten months after grafting, mescaline was detectable only in *T. pachanoi* (control plants, scions, and stalks) while *T. spachianus* (control plants, scions, and stalks) contained no translocated mescaline. Also, the roots of both species contained no detectable mescaline. The results are summarized in table 1.

Similar grafting experiments have shown that in the Solanaceae, e.g., with *Nicotiana* and *Datura*, alkaloids are predominantly synthesized in the roots and translocated through the stalk into the scions; on the other hand, in the Leguminosae, e.g., with *Lupinus*, the opposite seems to be true, with alkaloids being both synthesized and accumulated in the aerial parts (6).

Such grafting experiments are subject to obvious criticisms. For example, the possibility exists that mescaline was translocated but was completely degraded or modified to undetected products in *T. spachianus*. Also, the lack of a specific active transport system for mescaline may have precluded its translocation in tissues of *T. spachianus*. However, the fact that mescaline was only detected in the aerial parts of *T. pachanoi* and not detected in the roots, supports an argument for its biosynthesis and containment in the aerial parts.

TABLE 1. Quantitation of mescaline in samples of grafted plants.

Sample No.[a]	Average peak area in $mm^2 \times 10^1$	Concentration in mole/1 $\times 10^3$ (as hydrochloride)	Percentage yield (as free base)
1	15.7	7.36	0.155
3	15.4	7.15	0.151
6	15.3	7.10	0.150
2,4,5,7,8	—	—	0.0

[a]For sample identifications, see Plant Material.

In the Cactaceae there may be very little, if any, vertical alkaloid translocation; alkaloids are apparently made and stored *in situ* in the aerial parts, likely near the epidermis. From this limited evidence, we suggest that the production of toxic or hallucinogenic scions or fruits, by grafting harmless cacti on alkaloidiferous root stocks is unlikely.

EXPERIMENTAL

PLANT MATERIAL.—Small plants of *Trichocereus pachanoi* Br. and R. and *T. spachianus* (Lem.) Ricc., ca. 5 x 30 cm and conforming to published descriptions (7), were obtained commercially. Successful reciprocal grafts, at heights of ca. 10–15 cm, were made (four plants, two of each species) in August 1979; the plants were maintained, along with non-grafted controls of each species, under usual greenhouse conditions until June 1980 (10 months). The grafted plants had grown firmly together, with joining of their vascular systems; there was no evidence of root primordia at the grafted sites.

The plants were then separated into eight parts as follows: 1) the whole plant of *T. pachanoi* (control); 2) the whole plant of *T. spachianus* (control); 3) the *T. pachanoi* scion; 4) the *T. spachianus* stalk; 5) the *T. spachianus* scion; 6) the *T. pachanoi* stalk; 7) the roots from the *T. pachanoi* grafted plants; and 8) the roots from the *T. spachianus* grafted plants. All of the separated parts were sliced into small pieces, frozen, and freeze-dried. Each sample was pulverized in a Wiley Mill and assigned a number, 1–8, as indicated above.

ALKALOID EXTRACTION.—Exactly 5.00 g of samples 1–6 extracted with basic chloroform and acid-base partitioning (8) yielded fraction A (alkaloids). Smaller amounts of samples 7 and 8, 2.45 and 3.46 g respectively, were extracted similarly. Each extract for samples 1–6 was dissolved in 0.8 ml of methanol; the extracts of 7 and 8 were dissolved in 0.3 ml and 0.5 ml, respectively.

THIN-LAYER AND GAS-LIQUID CHROMATOGRAPHY.—All of the alkaloid extracts were analyzed by tlc on silica gel plates with solvent systems A, C, and E (9). Fluorescamine (Fluram, Roche) spray and uv light located mescaline (4). Mescaline was detected only in samples 1, 3, and 6; the identification was substantiated by co-chromatography with reference mescaline hydrochloride (Sigma Chemicals) in the same solvent systems.

A Varian Aerograph series 1400, with a 6 ft. x ⅛ in., 5% SE-30 on Chromosorb P glass column (5), was used for the glc analysis of the extracts. Optimal conditions for the separation of 10 μg samples of reference mescaline hydrochloride (retention time, 365 sec) and reference 3,4-dimethoxy-β-phenethylamine hydrochloride (Calbiochem) (retention time, 210 sec) were: column temp 150°, detector temp 218°, injector temp 226°, and flow rate 30 ml/min. As in previous work (10), mescaline hydrochloride and free base gave identical retention times. Mescaline was detected by glc only in extracts 1, 3, and 6, in agreement with the tlc analyses.

QUANTITATION OF MESCALINE BY GLC.—Standard dilutions of mescaline hydrochloride were prepared in methanol at concentrations of 4.65×10^{-3}, 6.14×10^{-3}, 8.28×10^{-3}, 10.42×10^{-3}, and 12.16×10^{-3} moles/liter. To prepare a calibration curve, 5 μl of each dilution was subjected to glc analysis; an average of three peak area determinations at each concentration (in mm^2) was plotted vs. the mescaline concentrations (in moles/liter) to produce a straight line; the least squares equation gave correlation (r) 0.98, slope 1.57, and y intercept 4.27×10^1. Triplicate glc analyses of 5 μl samples of extracts 1, 3, and 6 were averaged, and the peak areas were used to estimate mescaline concentrations from the calibration curve. The results are summarized in table 1.

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