The Uptake of Lower Aliphatic Amines by Pea Plants

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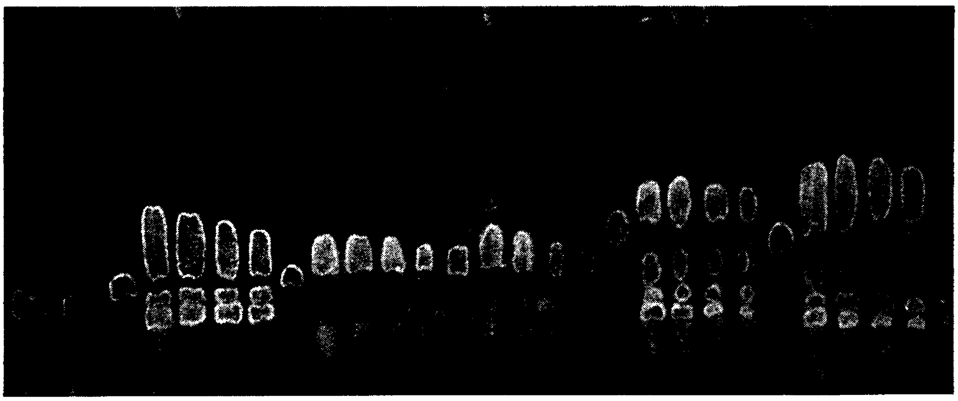
To what extent the plants are able to take up organic compounds from the soil by their roots is still an open question. By means of the sterile culture method it has been possible to demonstrate that plants can grow on certain amino acids as their sole N-source but even then there is the possibility that the amino group splits off as ammonia already on the surface of the root. Virtanen [1] has advanced the opinion that aspartic and glutamic acids, which are good nitrogen sources for pea — surprisingly enough wheat and barley are entirely unable to utilize them — are taken up as such by the root although the deamination and transamination reactions may occur already in the root cells. The decarboxylation product of phenylalanine, phenylethylamine, which does not act as nitrogen nutrition for plants, causes even in small concentrations, according to Virtanen and Linkola [2], a curious branching on pea. α-Alanine, too, causes changes in the shape of pea. These observations strongly suggest that the plants really take up organic nitrogen compounds as such and also those which are not used up for N-nutrition. Steinberg [3] has later noted a transforming effect of isoleucine on the tobacco plant.

The question of the uptake of organic substances from the soil is not only of theoretical value but has a great practical bearing since some of these substances may even in small amounts affect injuriously both the animal and human nutrition.



No amines	Trimethylamine	Dimethylamine	Ethylamine	n-Propylamine	i-Propylamine
40 15 μl	5γ 11.5 10 7.5 5 μl	5γ 10 7.5 5 2.5 μl	5γ 7.5 5 2.5 1.2 μl	5γ 12 10 7.5 5 μl	5γ 15 10 7.5 5 μl
2	1 2	1 2	1 2	1 2	1 2

1) Known concentration in water solution. 2) Plant extract.

Fig. 1. Uptake of amines by pea plants.

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Experimental. The chromatographic methods enable us to detect in plants even small amounts of foreign organic substances, which have been added to the root support. Therefore, we have taken this method into use in this laboratory for studying accumulation of different organic substances in plants and their possible participation in the metabolism. Using the paperchromatographic detection and semiquantitative determination of aliphatic amines described by one of us[4] we have been able to show that dimethylamine, trimethylamine, ethylamine, *n*-propylamine, and *i*-propylamine are taken up by pea plants growing in sterile culture in a nutrient solution containing these amines as their HCl-salts.

A nutrient solution was prepared containing no other source of nitrogen except the amine under study in a quantity representing 25 mg of organic nitrogen per litre of nutrient solution. 6 day old pea plants were grown for three weeks in sterile culture on these nutrients. The plants growing with trimethylamine began to excrete this substance through the leaves after a few days, as could be noticed by their odour.

After three weeks the plants were dried for two days at 40° C and pulverized. Aliquots of 100 mg were thoroughly mixed with 0.50 ml of absolute alcohol containing 2 per cent glacial acetic acid. Series of volumes of 1 to 15 μl of the extracts were placed on filter paper (Munktell OB), and chromatographed in the usual manner. These dilution series were compared with known amounts of the amines run on the same chromatogram. As an average of 4 plants, the following amounts of amine were taken up: (On drying some loss of amines occurs).

	Dry weight per plant g	Amine per plant mg	Total N per plant mg
Control	0.213	0.0	5.5
Dimethylamine	0.258	2.9	7.8
Trimethylamine	0.232	1.1	6.2
Ethylamine	0.286	3.1	9.9
Propylamine (*n*-)	0.261	1.6	6.7
Propylamine (*iso*-)	0.213	1.4	7.3

A photograph of the obtained chromatograms is given in Fig. 1.

A basic compound ($R_f = 0.20$) present in the controls and in plants grown on trimethylamine and propylamines was missing in the plants grown on ethylamine and dimethylamine. The probable metabolic function of amines in the plant organism is under further investigation in this institute.

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Reduktionsversuche mit Hämoglobin an Benzhydroxamsäure und Brenztraubensäureoxim

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Wegen des Auftretens organischer Derivate im lebenden Organismus wurde dem Hydroxylamin die Rolle eines Zwischenproduktes der Stickstoffassimilation zugesprochen.[1] So entstehen aus Hydroxylamin und Derivaten organischer Säuren auf enzymatischem Wege Hydroxamsäuren [2-8]. Es wäre auch denkbar, dass Oxime von Ketosäuren als Zwischenprodukte bei der Verwendung des Hydroxylamins durch den Organismus auftreten, obwohl bisher keine Enzymsysteme aufgefunden worden sind, welche einen solchen Prozess katalysieren [1].

Ausgehend von Beobachtungen von Colter und Quastel [9] über die Reduktion von Hydroxylamin durch Hämoglobin und Ascorbinsäure, versuchten wir, ob unter ähnlichen Versuchsbedingungen auch Benzhydroxamsäure und Brenztraubensäureoxim zu Benzamid resp. Alanin reduziert werden. Diese Versuche wurden spe-