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Amino Acids in Soil
II. Distribution of Water-soluble Amino Acids in a Pine Forest Soil Profile

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Water-soluble amino acids in the A-layer of a pine forest soil profile from Western Norway have been studied by the circular paper chromatographic technique. The amino acids found and their quantities are compared with those found in the layers above (F- and H-layer), and the distribution of free amino acids in the whole profile is discussed.

Investigations of podsol profiles from Western Norway [1] have shown that the nitrogen content of the humus increases with depth, in accordance with observations made on American podsol profiles by Waksman and Hutchings.[2]

The results [3,4] of estimations of water-soluble amino acids in H- and F-layer of the same profile are listed in Table 1.

In the present study an estimation of water-soluble amino acids in the third layer (A-layer) has been performed in order to get some informations about the distribution of the total amount and the individual variation of the free amino acids in the whole profile. Like the previous investigations,[3,4] circular paper chromatographic procedures were applied, and the techniques, including mixed chromatograms and multiple development, were performed essentially according to the specifications of Giri *et al.*[5,7]

EXPERIMENTAL

900 g samples of air-dry soil from the A-layer were first extracted with ether and then with water; both extractions were carried out at room temperature (20°C). The water extracts were filtered through membrane filters, and the filtrates were concentrated *in vacuo* and subjected to chromatographic analysis.

Circular filter papers (30, 32, and 33 cm in diameter) were made from Whatman No. 1 paper.

Micro-pipettes, cabinettes, solvent mixtures and colour reagents were the same as previously described.[3]

All amino acids observed were completely separated in the solvent mixtures: (*a*) BuOH:HAc:H_2O (4:1:1), (*b*) Water-saturated PhOH, and (*c*) EtCOMe:Py:H_2O (70:15:15).

Quantitative estimations were carried out according to Giri *et al.*[7], using a Hilger Photoelectric Absorptiometer with the green filter No. 604 (wavelength 5200 Å). The yellow colour of proline derived by treatment with ninhydrin was extracted with 50 % propanol and the intensity measured in a Beckman Spectrophotometer DU at 3500 Å.[8]

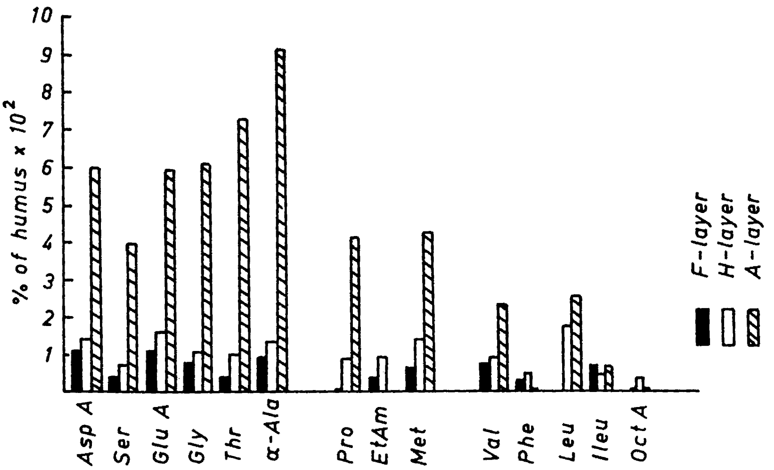

Fig. 1. The amount of individual amino acids (water-soluble) in the three profile layers expressed as percentage of dry organic matter (humus).

RESULTS AND DISCUSSION

The results are shown in Table 1. The values listed represent, in most cases, the average of four or more estimations. Air-dry A-layer soil contained 1.84 % moisture, and the content of ash was 88.70 % of dry (105°C) soil.[9]

It is seen from Table 1 that the individual and total amounts of free amino acids in the three different profile layers show a marked increase downwards with depth. The total amounts in the F to H to A layers were approximately as 1:2:8, respectively, expressed as percentage of humus. Individually, the contents of detected amino acids, with a few exceptions, increase with depth, but the increase is rather irregular.

Alvsaker[1] found the nitrogen percentage to be low and rather constant in F_1-, F_2-, and H-layers, but it increased abruptly in the A_2-layer.

Apparently, there exists a dependence between free amino acid fraction of soil and the nature of soil micro-flora. Interactions between microbial

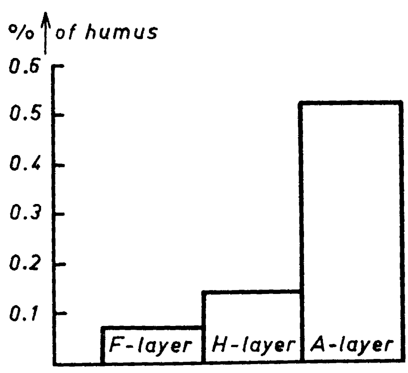

Fig. 2. The total quantities of free amino acids in the three profile layers expressed as percentage of organic matter (humus).

Table 1. Free amino acids in F-, H-, and A-layers expressed as percentage of dry (105°C) organic matter (humus).

Amino acids	*F-layer* % of humus × 10^3	*H-layer* % of humus × 10^3	*A-layer* % of humus × 10^3
Cys	—	trace	trace
Orn	trace	—	—
Lys	trace	—	—
Asp	—	trace	—
His	trace	—	—
Tau	—	trace	—
Hpro	2.30	—	—
Asp A	10.60	14.01	60.20
Ser	3.95	7.97	39.60
Glu A	11.05	15.35	59.50
Gly	7.64	10.83	61.10
Thr	3.56	10.43	72.60
α-Ala	8.90	13.35	91.46
β-Ala	trace	trace	—
Pro	trace	8.66	41.26
EtAm	3.25	9.19	trace
Met	6.07	13.84	42.67
But A	—	trace	—
Val	7.25	9.34	22.76
Phe	2.30	5.17	trace
Leu	—	17.69	25.03
Ileu	6.50	4.29	6.26
Oct A	trace	3.28	trace
Total	73.37	143.40	522.44

synthesis and microbial degradation of the compounds may be rather complex, and vary with climate and vegetation. These interactions are assumed to be most extended in the uppermost layer with its maximum of microbial activity.

Extremely wet climates, however, such as in Western Norway, effect the migration of water-soluble compounds downwards in the profile. It may therefore be assumed that the increase in the free amino acid fraction downwards in the profile investigated, is partly due to such a migration.

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