STUDIES ON THE CHEMICAL PROPERTIES OF NURSERY SOIL IN CULTIVATION OF *PANAX GINSENG*

C. Y. Lee, S. U. Lim
Department of Agricultural Chemistry,
Agricultural College of Seoul National University
Suwon, Korea

The wild ginseng plants naturally grow in shady place such as that underneath broad leaved trees. This medicinal herb has long been cultivated in Korea, but the farming practice is still adhering to the traditional techniques, very much sophisticated way of cultivation. However, the cropping system and the cultural practice are yet to be improved and developed by scientific researches and studies.

In the present study one of the basic aspects of soil concerned was pursued among other environmental elements such as meteorology and topography related to ginseng culture.

For the growth of ginseng the most noticeable is the requirement of nutrients. In the traditional and present method of growing ginseng the nutrients are supplied in orgaic form through "Yakto" beginning from the seed-bed stage until the harvest in field without chemical fertilizers which were said to harm the roots sooner or later.

The characteristics of soil recommendable for ginseng cropping, although it is difficult to define clearly, are considered in general to be as the following. For the seed-bed the sandy or gravelly sandy soil formed and developed through weathering of granite, gneiss and calcite. For the field the soils composed of texture of sandy clay loam, sandy loam, and loamy sand are suitable. When the soil taken from sveral locations of ginseng farming area is compared with that of upland field in terms of their nature the former was generally low in its fertility. (1) Especially the nursery soil, as it is mainly comprised of immatured raw soil, is much poor in the amount of general nutrients and chemical properties and low in the content of colloidal matter such as clay and humic substances.
Consequently its adsorption and exchange capacities are very small.

Table 1. Chemical properties of soils in Korea

	pH H_2O 1:5	Org. matter %	Avail. P. ppm	C.E.C. m.e/ 100g	Total N· %
Ginseng 1	5.8–6.3	0.6–1.0	35–50	5–7	0.06
cultiv soil 2	5.3–5.7	0.8–1.6	70–100	7–10	0.06–0.1
General upland soil in Korea	5.6	1.5	114	10.3	0.16

soil 1: Nursery soil
soil 2: Field soil

The nursery is classified into three grades according to its composition. The first grade (Yangjik) nursery is provided with sufficient amount of "Yakto" and chimney soot. The third grade (Tojik) is poorest and the second grade (Ban-Yangjik) is just inbetween. However, the third one is now nearly excluded in cultivation. If the bed soil is observed from the nutritional aspect its dependence on Yakto

Table 2. Raw materials of nursery soil for Ginseng seedlings (kg. per 100 m^2)

Raw mat.	Type: Yang – Jik	Semi – Yangjik
Raw soil	7000 – 8500	Upland soil
Yakto	3200 – 3700	800 – 1500
River sand	800 – 1000	800 – 1000
Chimney soot	100 – 130	70 – 100

is very great. (2)

Yakto is actually a decayed organic matter and composed of alive leaves or fallen leaves of broad leaved trees as the main part and some green grass, cotton seed cake, soybean cake and defatted rice bran as the additional part which are altogether heaped and reheaped twice or thrice during one to two year period, then rendering decayed. Yakto is necessary not only for the nursery but for the field as both basic application and top-dressing. In the basic application the powdery Yakto is broadcast on the entire surface of soil and thoroughly mixed with the top soil. In top-dressing it is applied between the rows at 15 cm depth and covered with soil.

The nature and effect of Yakto are still not clear and only partly explained. The process of humification through decomposition of plant remains is very complicated and the nature of humic substance is also not clear. In Yakto the component materials are decomposed or transformed by soil microbes and new intermediates may be formed. During the process easily decomposable substances may disappear but hardly decomposable ones such as lignin and plant wax may remain for a long period or be very slow to disintegrate.

Table 3. Composition analysis of "Yakto" (% dry matter basis)

	Holo-cellulose	Lignin	Hemi-cellulose	Total N	Alkali extract
Yakto	5.0–8.0	15–20	2.0–3.0	1.2–2.0	18–25
Plant leaves	28– 40	20–30	15– 25	0.7–1.3	

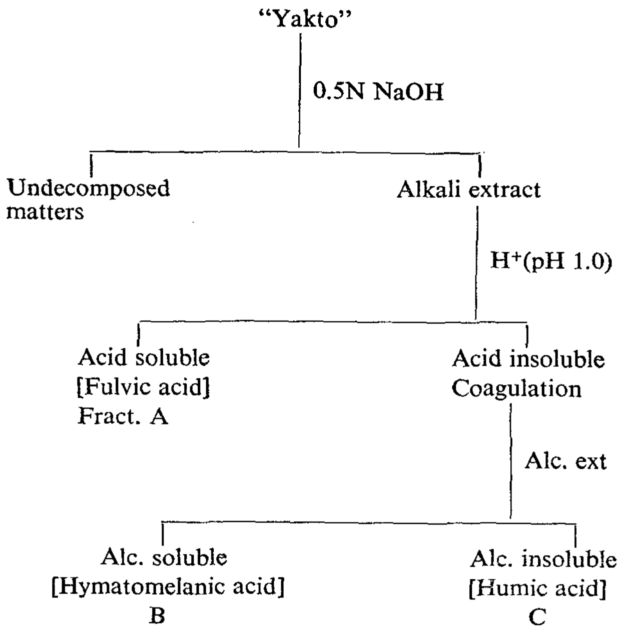
The rate of decomposition may depend on the supply of oxygen, the amount of nitrogen and so on. All of these environmental factors are closely related to the activity of microbes. Various reactions that proceed in the process may be grossly devided into the complete decomposition and recombination of intermediates. In the former we can see mineralizations of various organic components and in the latter we may find the formation of colloidal polymers through polycondensation and polymerization which will lead to humus formation contributory to physical and chemical properties of soils.

Decomposed substances in Yakto are a sort of the collection of wide range compounds in terms of molecular weight that we fractionated according to solubility. In this, the distribution of the fractions was not quantitative but the alkali extracts increased in amount as fermentative process proceeded.

The fractionation of Yakto is carried out according to the fractionation method of soil humus. (3) The acid treated Yakto is extracted with alkali (0.5 N NaOH) and is acidified to pH 1.0 and then the coagulation is purified, dialyzed, lyophilized and further fractionated with ethanol.

Fig. 1.

Fractionation of "Yakto"
acc. to the fract. method of soil humus



The nitrogen content of each fraction (Fraction A,B, and C) show difference and the amount of decomposed substances of each fraction also indicated difference. The distribution of total nitrogen

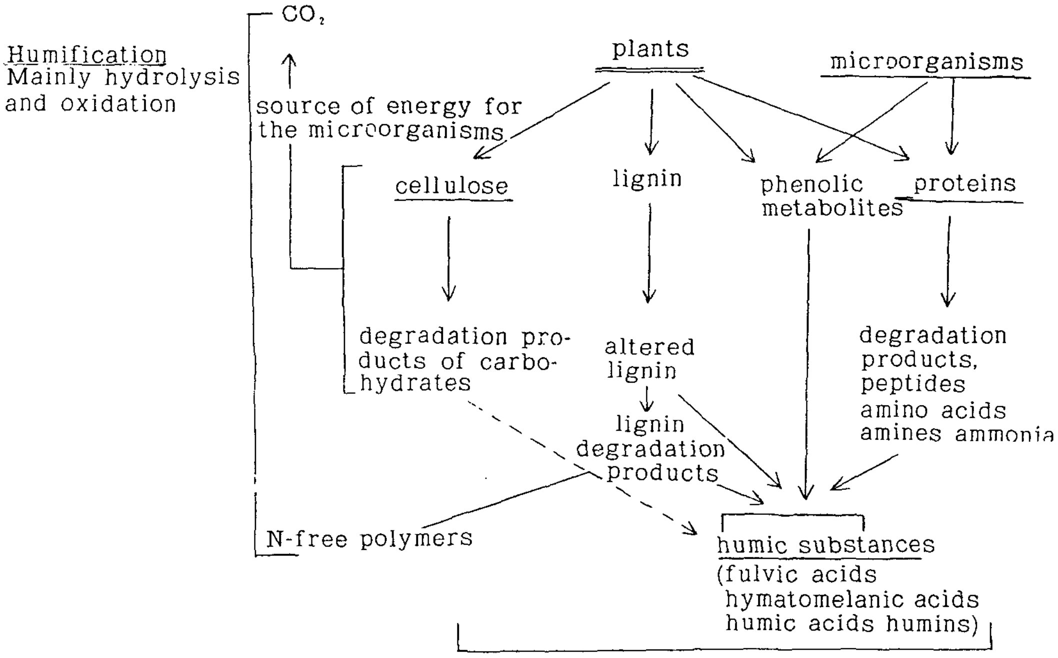


Fig. 2. Scheme of humification Processes

and form of nitrogen compound in each fraction shows in table 4. On the other hand, the distribution pattern of nitrogen in Yakto is compared to the podzolic humic acid. (4)

The total nitrogen is contained more in Fraction C than in fraction B and A, while the content of hydrolysable nitrogen in total nitrogen is highest in fraction A and the other both fractions have nearly same value. The content of alpha-amino nitrogen form in hydrolysable nitrogen is increased in fraction A, B, and C successively. The nitrogen of humin type in Yakto is contained lower than in podzolic humic acid remarkably.

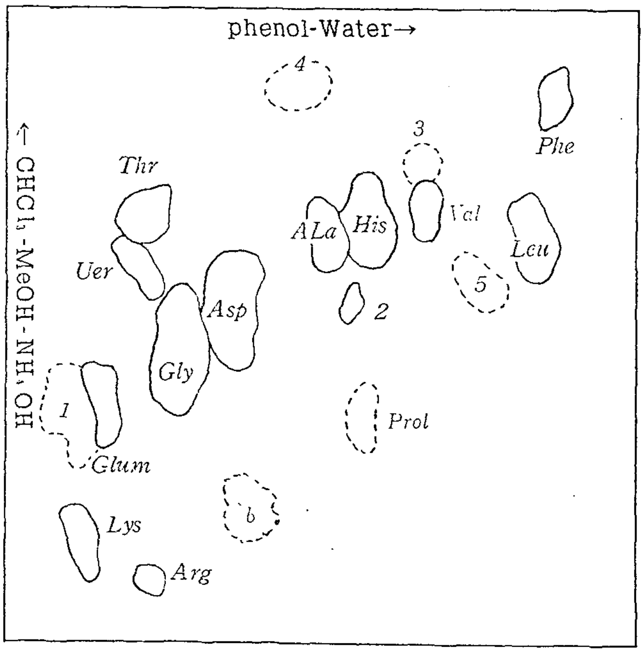
These results point out a close relation between the

Table 4. Fractional distribution of nitrogen in "Yakto"

	Average % of total N					
	Total-N	Hydro-ly.-N	α-Ami-no-N	Hexo-sam.-N	Humin N	NH_3-N
Fraction A	0.5–0.8	87	7	4	8	
B	1.6–2.0	62	28	6	20	
C	3.2–3.7	65	35	8	23	
Hymic acid from Podzol (Schnitzer)	2.3	45	30	—	50	17

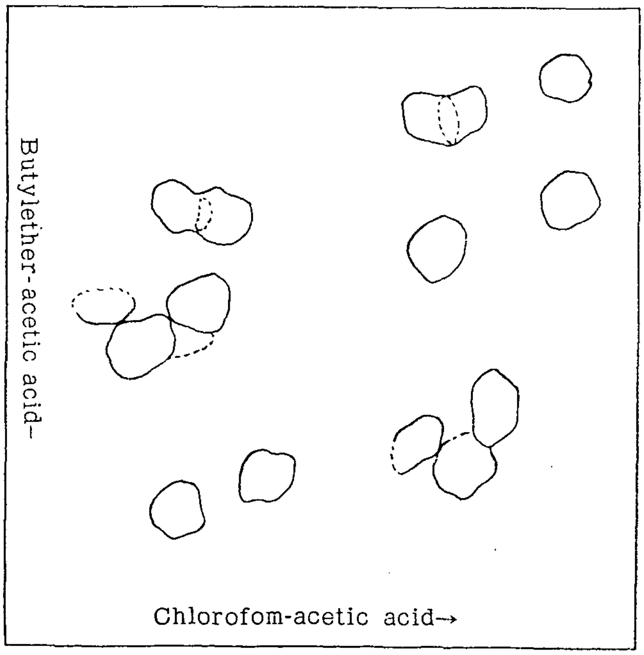
(Fraction A: Fulvic B: Hymatomelanic C: Humic)

Fig. 3. Thin layer chromatogram of hydrolysate (6NHCl) of Yakto-Fract. C



on silica gel G Colored with ninhydrin reagent identified amino acids, Spots 1-6 unidentified

Fig. 4. Thin layer chromatogram of cleavage product of Yakto-Fract. C with Na-amalgam.



on silica gel GF
The spots are detected by diazotized sulfanilic acid or by UV light.
Unidentified phenols and phenolic acids

distribution of nitrogen form and humification grade.

The chemical composition and structure of

Tabl. 5 Cleavage of Humic Substances

Reactions	Agents	Main products
Hydrolysis	Acid, Alkali	Amino acids, Phenols, Sugars
Fusion	Alkali	Phenolic compounds
Oxidation	HNO_3, $KMnO_4$/OH	Polycyclic hydrocarbon
Reduction	Zn, Na-amalgam	Phenolic compounds
Hydrogenat.	H_2/Raney-Ni	Alkanes
	Enzymes	Amino acids, Sugars

"Yakto" fractionates appear to be as complex as

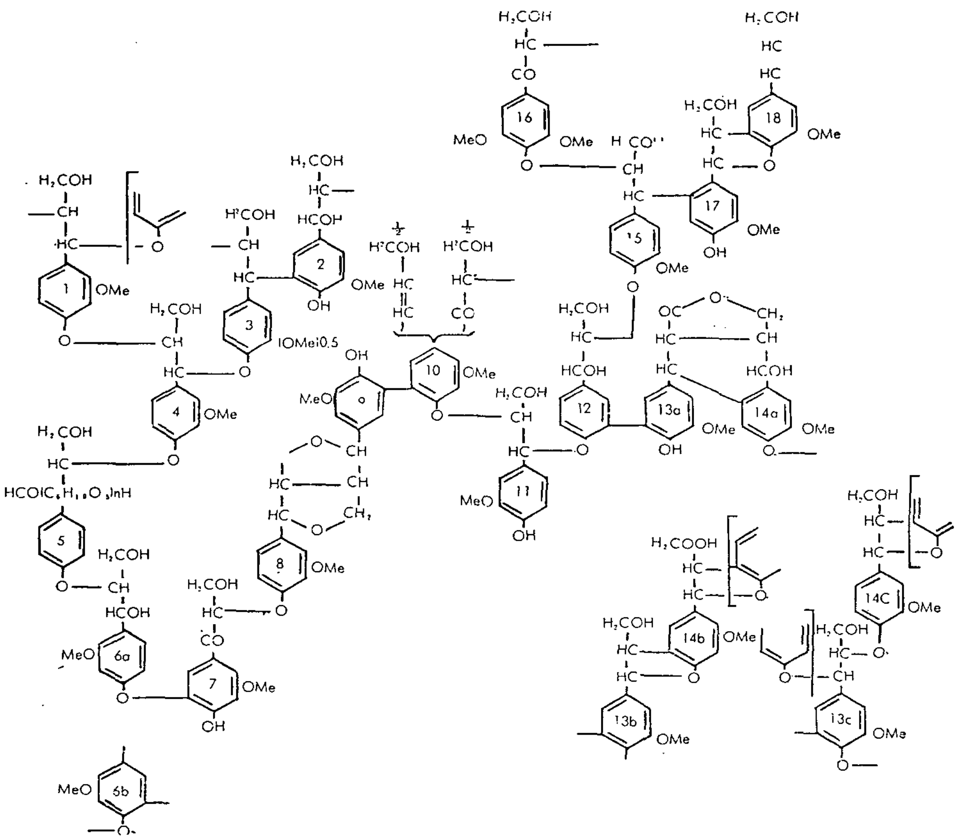


Fig. 5 Structure scheme and the monomers

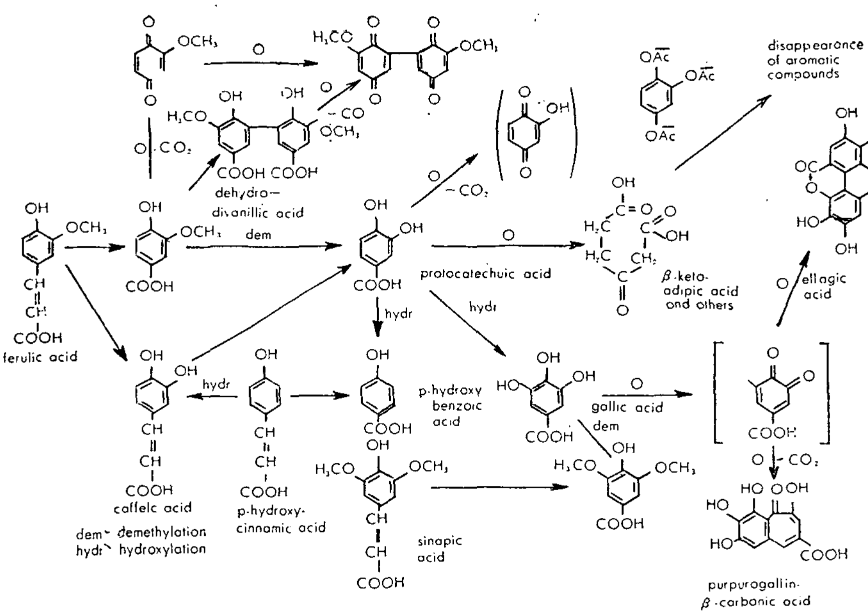


Fig.6. Transformations of lignin degradation products by the action of microorganisms. (Haider, Lim and Flaig)

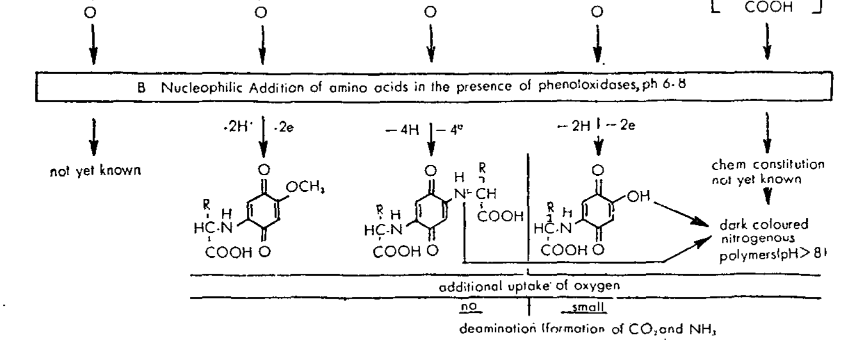


Fig.7 (A) Oxidation of phenol carboxylic acids to quinones; oxidative carboxylation; (B) nucleophilic addition of amino acids in the presence of phenoloxidases, pH =6−8. [(Ref. 9. 10)

those of soil humic substances. The prevailing methods and decomposing agents for understanding the composition of himic subtstance may be summerized as follows.

The groups of products to be obtained from various procedures are mainly amino acids, phenolic compounds, sugars, and aromatic alkanes derived either directly from the materials of Yakto or indirectly from enzymatic processes related to microbial activity, or nonenzymatic reactions. The humification processes may be schematized as the following.

The amino acids yielded through hydrolysis of Yakto with 6N HCL are varied in kinds and the thinlayer chromatogram is shown below,

C fraction of Yakto was subject to reductive degradation with sodium amalgam and the etheral extract was purified to be developed on silica gel chromatography. The chromatogram shown in Fig 4. is comprised of unidentified phenolic compounds which appear to compose the prime part of colloidal substances of Yakto.

The formation of phenolic compounds may be attributable to lignin which slowly decomposes to intermediates or is transformed to microbial metabolites.

The proposed structure of lignin is shown in Fig. 5. (6)

Viewing from the above structure the formation of mono-, Di- and Triphenol is quite feasible and the composition of phenols is variable according to the kinds of plant. Foliages of broad leaved-trees contain much more syringyl units than conifers and accordingly is possible to form much more functional groups that are reactive.

An example of formation of phenolic compounds emerging from lignin through decomposition or transformation by soil microorganisms is shown in Fig. 6. (7, 8)

The major reactions that occur during the process are demethylation, decarboxylation, hydroxylation, and oxidation depending highly upon the structure. Aside from such decompositions the formation of phenolic polymers and addition compounds with amino acids that coexisted during the oxidative process may lead to unhydrolysable nitrogeneous complex. Fig. 7 shows the routes of these changes. (9. 10)

Since the process of humification occurring during the preparation of Yakto is very complicated and in dynamic state the clear understanding of reality is very difficult for the moment but it may be said that the products of humification are towards the state of high polymerization and higher stability while the products are continuously decomposed into lower molecular weight compounds or into inorganic compounds that are eventually absorbed by plants to accelerate or stimulate the growth and physiological actions. (11, 12)

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