

## An Ecochemical Study on Soil Sickness

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### Abstract

*The phenomenon of soil sickness in the continuous cropping of ginseng is a serious problem for the cultivation practices and is an unelucidated subject scientifically.*

*Present study is concerned mainly with ecochemical search on the cause of soil sickness in the continuous cropping of ginseng and the obtained results are summarized as follows:*

*The humic substances isolated from both cultivated and uncultivated soils with ginseng were compared with respect to its IR spectra but any difference which may be causative of soil sickness between them was not detected.*

*In contrast, some saponin-like substances extracted from the ginseng cultivated soil in root zone were detected but not from the uncultivated soil. Presumably, the saponin-like substances in the soils are originated from the ginseng radices and are accumulated in root zone year by year, while the interrelation between the root exudate of ginseng and soil sickness is still obscure.*

*According to a survey on the distributive pattern of microflora in rhizosphere of ginseng radices the number of fungi is relatively diminished with the cultivation years, while the number of actinomycetes is increased.*

*It is supposed that the soil sickness in the continuous cropping of ginseng has any correlation between the activities of microflora in rhizosphere and the root exudates.*

The phenomenon of soil sickness in the continuous cropping of ginseng is a serious problem for the cultivation practices and is an unelucidated subject scientifically.

Such soil sickness commonly occurs to continuous cropping of ginseng the exact cause is not known. (1) Many suggestions have been made on pathological disease, deficiency of soil nutrient, and certain growth inhibitors, for the explanation of soil sickness. (2) It has been reported that certain organisms have brought about such soil sickness of ginseng.

In this report, we attempted to investigate the cause of soil sickness in ginseng cultivation with respect to the effect of microorganisms and accumulation of toxic substances.

### Materials and Methods

Soil samples were collected from the places where ginseng are being cultivated for 6 years and from uncultivated lands mainly taken from Guacheon, Pochon and Kwangwha, Gyeong Gi Do.

The assay of soil followed the methods shown in references<sup>4,5)</sup>, and the extracts of soil were placed in the agar and Rose-bengal/ streptomycin agar medium in order to count and investigate the microorganisms<sup>3)</sup>.

Organic substances including some decayed material in soil sample were fractionated into two parts, alkali extracts and ethanol-water soluble extracts.

### Results and Conclusion

The assay of soil samples were shown in Table I.

Table I. Properties of soils tested

Region	pH (:2.5 H <sub>2</sub> O)	CEC (m.e./Org)	Org. matter (%)	Texture
Gua-Chun* 1	5.6	11.6	2.13	*CL
2	5.7	9.6	2.04	CL
Po-Chun 1	5.5	16.0	2.08	CL~SiL
2	5.4	13.3	1.83	CL~SiL
Kim-Po 1	5.6	11.0	0.97	SiL
2	5.6	9.5	0.93	SiL
Gang-Hua 1	5.4	10.6	1.33	CL
2	5.8	10.2	1.39	CL

\* 1 : Cultivated soil of ginseng.

2 : Uncultivated soil of ginseng

CL : Clay loam, SiL : Siity loam

CEC : Cation Exchange Capacity

The acidity, CEC and the contents of organic substances appeared to be almost same as those of other soils in Korea. And the texture of soil appeared to be fine.

The soil in which ginseng was cultivated had slight more organic substances than that of non-ginseng growing soils. This may be due to the organic fertilizer supplied to the ginseng growing soil. But the acidity of both soils appeared to be almost same.

### Microorganisms

The results of the examinations of soil microflora were shown in Table II.

**Table II.** Pattern of soil microflora.

	Fungi (No/g 10 <sup>4</sup> )	Actinomyces (No/g 10 <sup>6</sup> )
Guacheon (6th year soil)	74	28
2nd year	228	15
Guacheon 3rd year	93	19.6
Guacheon 5th year	77	26.4
Kimpo 1st year	32	33
2nd year	106	10.3
Pochon 1st year	87	—
2nd year	275	—

As Table II shows, there appeared to be some differences in numbers of fungi and actinomyces in both soils.

The fungi in ginseng soil showed less countings than that of nonginseng growing soils. This may be due to the differences of organic substances contents of various soil samples collected. In addition, the influences of pesticides and insecticides for ginseng should be considered but its exact effects were not known.

### Alkali Soluble Extracts

Both soils were extracted with alkali, and then both extracts were treated with acid. The precipitates were obtained and their IR spectra were taken. (6) There were no significant differences of IR spectra in decayed substances of both soils.

As the IR spectra show, the contents of  $-\text{COOH}$ ,  $-\text{OH}$  and  $>\text{C}=\text{O}$  showed some differences, though their exact quantitative measurements were not possible.

Several important IR absorption bands appeared at  $3400\text{cm}^{-1}$  (hydrogen bond of  $\text{OH}$ ), at  $2900\text{cm}^{-1}$  (aliphatic C-H stretch), at  $1450\text{cm}^{-1}$  (aliphatic C-H) and at  $1050\text{cm}^{-1}$  (Si-O). These data suggested that there seemed to be no relations between soil sickness and alkali soluble extracts.

### Ethanol-Water Soluble Extracts

There is a possibility that the substances secreted from ginseng radices were absorbed into soil around of radices, and it was assumed that this substance may cause the soil sickness.

Therefore, we extracted the soils with ethanol-water solution which was often used for extraction of ginseng roots, as follows.

The soil samples were first extracted with 10 volumes of ethanol at 60~70° for 10 hours, and water was added to it. The solution was extracted with n-butanol, dried under a reduced pressure, and the residue was dissolved in methanol.

The chromatography of methanol solution is shown in Figure 1.<sup>7)</sup>

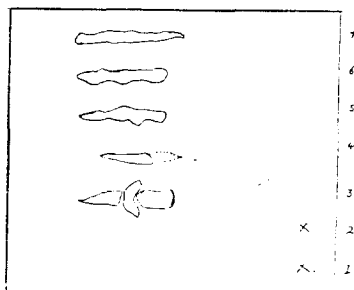


Fig. 1. Thin layer chromatograms extracts of Ginseng moot and rootzone soils, dsect. with ceric sulfate or chloro-sulfonic acid spraying reagents.

← n-BuOH-H<sub>2</sub>O (4 : 1 : 5, upper)

1. Extracts of uncultivated soil, Gua-Chun
2. Extracts of uncultivated soil, Kimpo
3. Extracts of Ginseng root, 6 year old
4. Extracts of rootzone soil of Ginseng cultivation, Gua-Chun (3 year old)
5. Extracts of rootzone soil of Ginseng cultivation, Gua-Chun (5 year old)
6. Extracts of rootzone soil of Ginseng cultivation, Gua-Chun (6 year old)
7. Extracts of rootzone soil of Ginseng cultivation, Gua-Chun, Kimpo, (6 year old)

They showed the saponin spots and the  $R_f$  values similar to the saponin spots of ginseng roots.

Thus, it is suggested that such saponins and other substances might be originated from roots of ginseng.

Contrary to this, the control (non-ginseng growing soil) did not show any such spots, and the saponin spots from 6th year soil appeared more vivid than those of third year one. But it is uncertain whether such accumulation of secreted substances caused soil sickness or not.

### Conclusion

Present study is concerned mainly with ecochemical search on the cause of soil sickness in the continuous cropping of ginseng and the obtained results are summarized as follows:

The humic substances isolated from both cultivated and uncultivated soils with

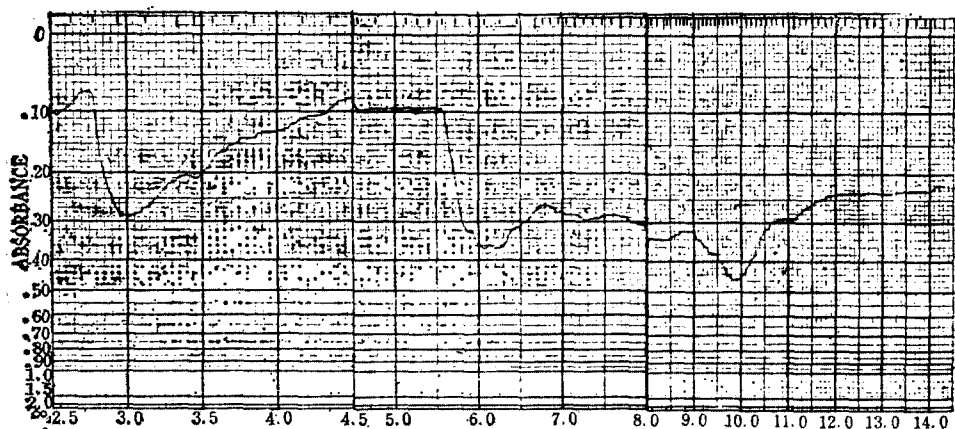
ginseng were compared with respect to its IR spectra but any differences which may be causative of soil sickness between them were not detected.

In contrast, some saponin-like substances extracted from the ginseng cultivated soil in root-zone were detected but not from the uncultivated soil. Presumably, the saponin-like substances in the soils are originated from the ginseng radices and are accumulated in root zone year by year, while the interrelation between the root exudate of ginseng and soil sickness is still obscure.

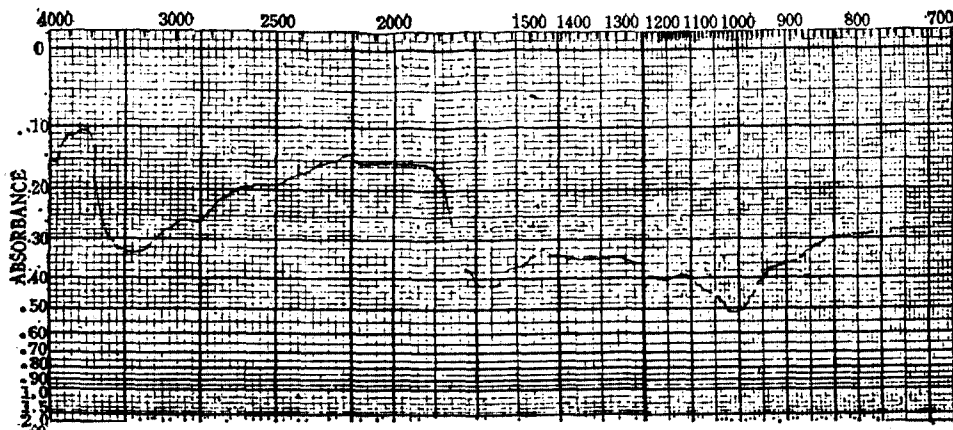
According to survey on the distributive pattern of microflora in rhizosphere of ginseng radices the number of fungi is relatively diminished with the cultivation years, while the number of actinomycetes is increased.

It is supposed that the soil sickness in the continuous cropping of ginseng has any correlation between the activities of microflora in rhizosphere and the root exudates.

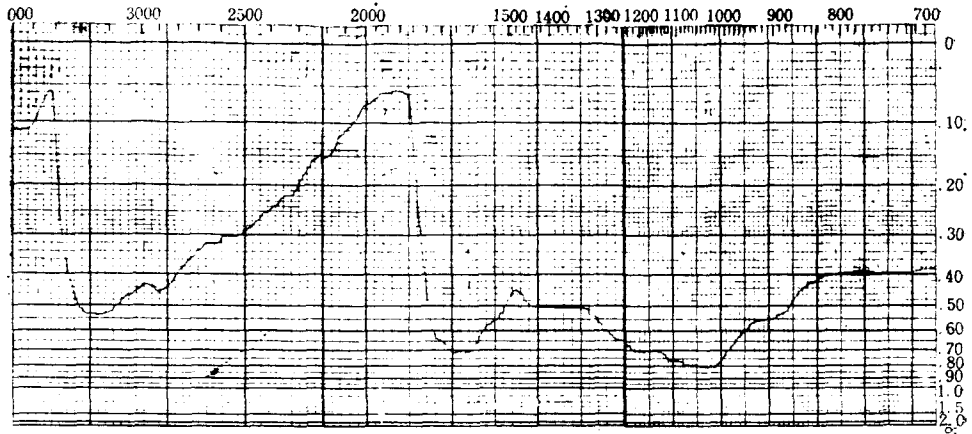
Fig. 2. Infrared spectra of humic substances from cultivated and uncultivated soils of ginseng.



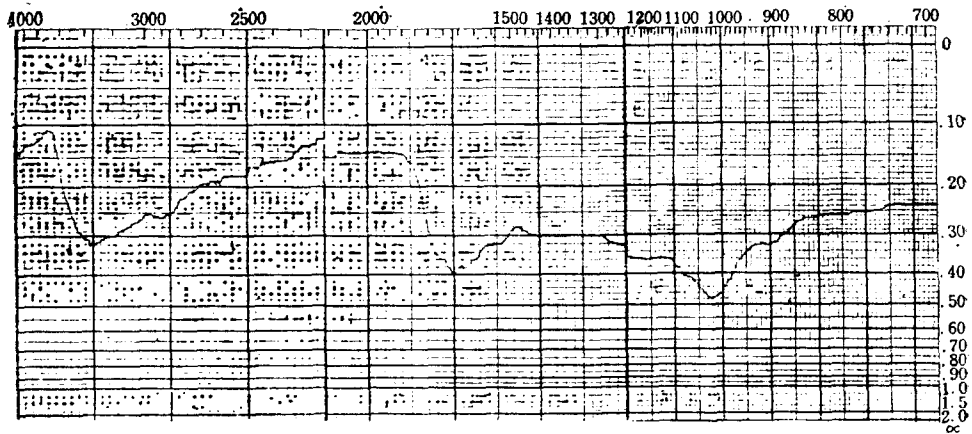
Spectrum 1. Uncultivated Soil, Gua-Chun



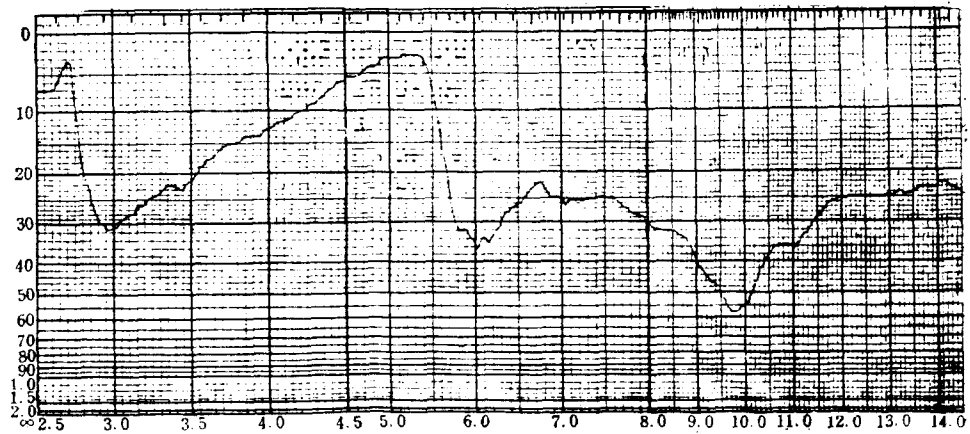
Spectrum 2. Cultivated Soil, Gua-Chun(1)



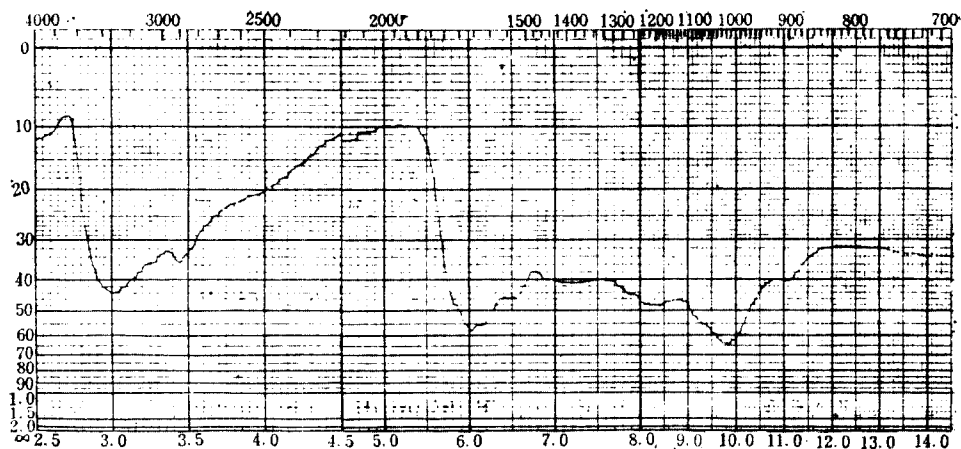
Spectrum 3. Cultivated Soil, Gua-Chun(2)



Spectrum 4. Uncultivated, Po-chun



Spectrum 5. Cultivated, Po-Chun



Spectrum 6. Cultivated, Kim-Po

### Acknowledgment

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## 인삼 연작 장애의 발생 원인 구명을 위한 생태화학적 연구

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### 초 록

본 연구는 현재로는 인삼의 조작이 불가능한 것으로 인식되어 있는 장애 현상을 생태화학적인 면에서 검사하여 그 원인을 추구하려 하였다. 현재 인삼의 조작장애 원인은 특정균의 침해로 해석하고 있으나, 그 병 유발의 원인에 대하여는 아직 불분명하며 여러가지 가능성이 추리된다. 삼재배지와 비재배지 토양의 일반적인 성질의 비교에서는 별차이를 볼 수 없었으며, 경작을 통한 유기물의 증가와 그에 따른 양이온 교환용량의 상승을 볼 수 있었다.

삼 재배지와 비 재배 토양에서 알칼리로 추출되는 부식물의 성상을 비교하였으나, 적외선부 흡광곡선으로는 양자간에 별차이점이 없이 공통 또는 유사성을 보이는 급광대를 가지며 재배지역에 따라 근소한 상이점을 보였다. 한편 삼근권 토양의 에탄올 추출물에는 삼생육 기간중 분비하였을 것으로 추정되는 물질들이 함유되어 있으며 정성적인 검색으로 삼근성분의 일부와 같거나 또는 유사한 것으로 보였다.

이러한 근권내 특수 유기물질과 연작장애와의 연관성은 삼근 부패인(특정 미생물)의 특성을 고려하여 상호 긴밀히 검토되어야 할 것이다.