MULTIELEMENT ANALYSIS IN GINSENG AND ITS SOIL

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ABSTRACT

The multielement analysis and investigation on ginseng and soil samples have been conducted by X-ray fluorescence (XRF) with a nation approved standard matter for the quality control in measurements. The absorptivity of trace elements are different for various parts of ginseng. Concentrated elements and their degrees of concentration are also different. Ca and Sr are concentrated in the main root and their degrees of concentrations increased with growing ages. The absorptivities of element are higher in rhizome and fibrous root than in main root. In addition, the dried weight of ginseng's root increases exponentially with growing ages.
Keywords: Ginseng Ginsenoside Multielement analysis

1 INTRODUCTION

Since 1890, many chemists and pharmacologists have paid attention to ginseng's chemical compositions. It was affirmed that the ginsenosides are the ginseng's pharmacologically active components. The scientists have already identified twenty nine types of ginsenosides[1]. There are many papers[2-5] devoted to the investigation on chemical composition and properties of ginseng but few related to the histochemical multielement analysis and the element absorptivity.

2 EXPERIMENTAL

2.1 Preparation of samples

For getting rid of all the interference factors for analysis. Including: variation of planting place, sampling season, handling, soak, transportation, storage of ginseng and so on, the ginseng samples were chosen in 1–6 years of growth and gathered directly from the same planting site in the Tonghua County, Jilin Province. Soil samples were from the root side. Sampling was five times a year.

The ginseng samples were ultrasonically washed by running deionized water, then cut into six sections: fibrous root, main root, rhizome, stem, leaf and seed. Ginseng grown in 1, 2, or 3 years are cut into three sections only: root, stem and leaf. For the wild ginseng, fibrous root was only used. The sections were baked in an infrared oven at 60–80°C and ground in an agate mortar. Each 100 mg of samples were placed in a quartz crucible, then ashed in a muffle at 600°C. Finally, the target was prepared by dissolving in acid and adding yttrium as an internal standard.

The soil samples were prepared as follows: the soil dried was ground in an agate mortar. In order to extract the soluble elements from ginseng–planting soil samples, 5ml of 0.1 mol/l HCl were added to 200 mg of prepared soil sample in an Erlenmeyer flask. The mixture shaked for 5 minutes was filtered, and the filtrate was evaporated. The residue ashed out at 600°C was dissolved, meanwhile, yttrium was added to it. Targets prepared in this way are ready for bombardment.

2.2 Measuring

The analysis was carried out by XRF with effective area of ^{238}Pu in φ 7mm and source strength of 1.11×10^9Bq. The effective area of Si(Li) detector is 80mm^2 with a resolution of FWHM = 180 eV for Mn K X–ray. The concentration of element in sample is given by: $C_x = (N_x/N_y)\cdot(K_{xy}/R_{xy})\cdot C_y$ where C_x is the concentration of element to be measured, C_y the concentration of yttrium as internal standard, N_x and N_y the counts of characteristic peak of elements to be measured and yttrium, respectively, K_{xy} the correction factor of absorption under thick target, R_{xy} the factor of relative sensitivity.

3 RESULTS AND DISCUSSION

The analysis have been carried out for elements K, Ca, Ti, Cr, Mn, Fe, Co,

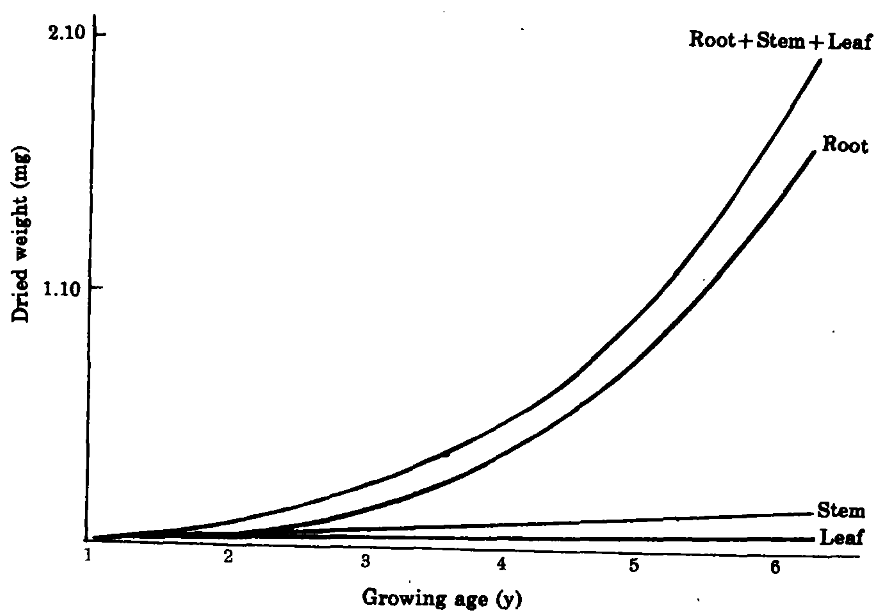

Fig.1 The relation between dried weights of ginseng sections and growing age

Ni, Cu, Zn, Pb, Se, and Sr, of which the contents found of Ti, Cr, Co, Ni, Pb and Se were too low to be discussed.

It was found that the dried weights of ginseng's root or the mixed increase exponentially with growing ages as shown in Fig. 1.

Table 1 shows the concentrations of soluble in soil elements for 1–6 years of ginseng grown, soil for wild ginseng and soil in which ginseng can not be planted. The data indicate that, in the 3–3 planting system, concentration of soluble elements Ca, Mn, Zn and Sr in soil are basically decreased with planting ages. The concentrations of above elements are generally higher in soil for wild ginseng than in soil for ginseng. The concentrations of trace elements mentioned above in soil in which ginseng can not be planted and those in soil for ginseng growing on the same hillside do not differ evidently from each other so that the soil in which ginseng can not be planted seems to be not cognate with soil for ginseng growing in contents of measured element, but in the other physical factors.

Table 1

Soluble element concentrations in ginseng planting soil (dried weight)

A	*B*	Concentration of elements (ppm)						
		K	Ca (×10±)	Mn	Fe	Cu	Zn	Sr
1	1	333±127	362±87	170±7	129±6	6.43±1.16	11.7±1.3	11.6±3.6
2	2	411±100	338±76	147±6	115±5	7.56±1.05	9.36±1.11	12.5±3.5
3	3	370±100	242±67	83.4±5.1	125±5	7.52±1.15	4.36±1.03	6.30±2.60
1	4	278±130	532±112	190±8	159±7	9.83±1.50	6.54±1.39	20.1±4.2
2	5	333±143	534±106	173±7	160±6	8.07±1.07	13.9±1.3	20.1±4.2
3	6	259±112	247±66	121±5	181±6	7.84±0.93	4.29±0.95	8.90±2.90
20	Wild ginseng soil	518±259	555±150	180±11	163±9	8.53±2.19	12.3±2.3	30.4±5.8
0	Unplantable soil	611±177	370±101	166±8	262±9	7.55±1.27	8.60±1.40	16.1±4.8

A planting years (planted in same place) *B*—planting age (years)

Table 2

Element solubility in planting soil of various ginseng planting age (%)

A	*B*	Solubility of element						
		K	Ca	Mn	Fe	Cu	Zn	Sr
1	1	16	86	39	0.78	5.10	20	32
2	2	8	77	55	1.0	10.4	18	35
3	3	9	76	83	1.39	4.95	12	18
1	4	3	42	89	0.70	4.61	19	14
2	5	12	89	52	1.30	5.49	40	56
3	6	9	68	96	3.43	5.76	4	8
20	Wild ginseng soil	10	11.6	90	0.95	6.05	31	28
0	Unplantable soil	17	67	83	1.32	3.56	22	22

A—planting years *B*—planting age (years)

Table 2 shown the element solubility (%) in planting soil of various ginseng planting age. The solubility is not constant. It seems to be related to the state of whole system.

In table 3, listed is the absorptivity of the elements in different sections of ginseng with 1–6 ages. The data show that ginseng is able to concentrate the water soluble elements K, Cu and Sr from soil that are considered relevant to enzymes and their activators, and also show that the highest degree of concentration is referred to K with a factor of up to 135. It is worth to note that the content of K dissolved in water from soil is independent on the planting years while the degree of concentration for K

Table 3

The absorptivity of elements in different sections of ginseng

Section of ginseng	*B*	Absorptivity of element						
		K	Ca	Mn	Fe	Cu	Zn	Sr
Rhizome	4	52	3.91	0.17	0.85	2.68	1.07	3.68
	5	56	6.61	0.15	0.76	6.85	3.37	7.01
	6	58	12.5	0.47	0.57	6.24	5.55	9.79
Main root	1	45	0.33	0.094	0.67	2.55	0.93	0.64
	2	135	0.64	1.4	0.21	2.18	0.61	0.75
	3	22.3	1.10	0.14	0.33	1.50	1.31	1.71
	4	23.7	1.08	0.044	0.42	1.50	0.76	1.72
	5	27.4	1.52	0.030	0.24	2.30	0.55	1.90
	6	33.2	1.47	0.048	0.19	2.13	1.30	2.65
Fibrous root	4	68	0.79	0.22	3.66	2.96	4.28	1.91
	5	56	0.68	0.14	1.25	3.87	4.27	1.65
	6	55	2.58	0.15	0.98	2.92	2.86	3.92
Stem	1	33	7.91	—	1.41	14.3	3.09	11.2
	2	745	7.22	—	0.56	10.1	5.12	11.1
	3	45	4.02	—	0.47	3.38	4.90	5.10
	4	135	0.78	—	0.10	1.73	1.54	1.85
	5	92	0.20	—	0.33	3.33	1.54	1.21
	6	60	2.14	—	0.44	2.41	4.00	2.94
Leaf	1	35	4.12	0.26	3.06	9.32	4.51	4.79
	2	144	8.52	0.15	2.84	6.00	8.78	6.02
	3	70	8.81	0.62	1.36	2.94	53.9	0.58
	4	86	9.02	0.47	3.28	3.26	41.9	3.33
	5	82	5.69	—	2.37	4.82	14.2	2.85
	6	76	6.56	0.25	3.20	4.97	25.9	4.02
Seed	4	50	0.31	0.051	1.44	1.62	2.10	0.42
	5	45	0.28	0.019	0.21	1.56	1.22	0.37
	6	41.1	1.53	0.12	2.32	3.02	2.92	0.89

Absorptivity = Element concentration in a section of ginseng/Concentration of solution in soil element

in ginseng's root is higher in the first three years during which carbohydrate is mainly formed and is lower in the later three years during which ginsenosides are mainly formed[6]. This fact implicates that the production of ginseng may be increased if fertilizer K is applied properly to the soil in the first three years.

Trace elements Sr and Ca are concentrated by ginseng main root from soil in starting with the third year of its growing when the effective component ginsenoside in main root is formed obviously. Then the concentration degrees for Sr and Ca are getting increased with years (Fig.2) and so does.

For the content of ginsenosides in ginseng, it seems that there exists an interrelationship between the degrees of concentration for Sr and Ca and the content of ginsenoside[7].

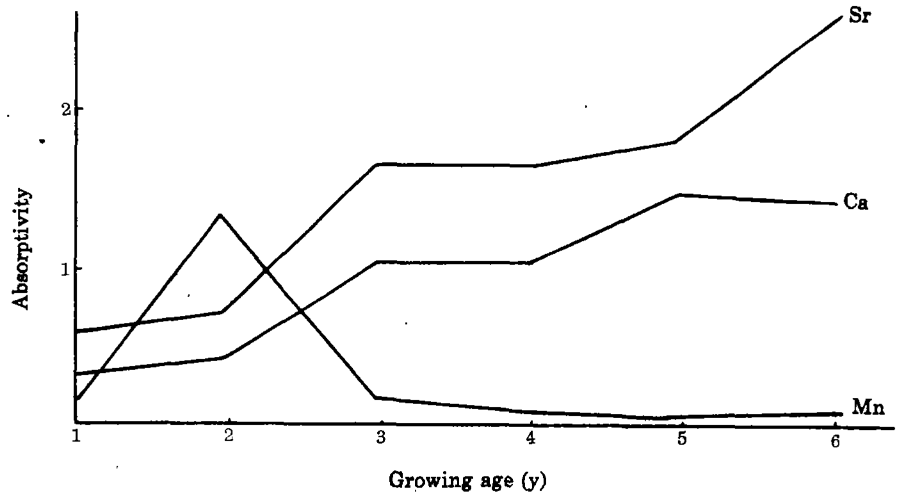

Fig.2 Absorptivity of Sr and Ca

It is well known that ion Ca is an activator of some enzymes in plant and Ca is an element which is not readily to move and built up in the old tissue. When lack of Ca, the cell division can not be normally in progress. We have found no report related to the physiological action of Sr. The relation of the presence of Ca and Sr to forming of ginsenoside is an interesting matter that we are intending to investigation in the future.

From table 3, it is also seen that the absorptivities of elements in rhizome and fibrous root are much higher than those in main root. The contents of ginsenosides in rhizome and fibrous root are also higher than those in main root[8,9]. At the same time, concentrated elements and their degree of concentration are various in different tissues. K is concentrated by a factor of several tens in all tissures. Except for K, the elements Ca, Cu, Zn and Sr are concentrated in rhizome; while Ca, Cu and Sr are concentrated in main root; Cu, Fe, Zn and Sr are concentrated in fibrous root; Cu, Zn and Sr are concentrated in stem with the concentrations of Cu and Sr higher up to more than ten times; Ca, Fe, Cu, Zn and Sr are concentrated in leaf with the concentration of Zn higher up to tens times; Fe, Cu and Zn are concentrated in seed; Ca, Fe, Cu and Zn are concentrated in fibrous root of wild ginseng. Whether or not all these relate to the content of single species of ginsenoside in variation with different tissues? These problems are well worth to be further investigated. In all tissues, Mn is not concentrated and its absorptivity is lower year by year. The effect of enriching sap by Mn is well worth to be investigated.

4 CONCLUSIONS

The dried weight of ginseng's root is exponentially increased with growing ages.

The concentrations of soluble elements in soil decrease with planting ages. This fact prompt us to apply relevant fertilizers year by year for increasing production.

Elements can be concentrated in sections of ginseng differently. With this understanding of the features of concentrations and then using them to direct the ginseng production, it is possible to increase the output of ginseng and to improve it's quality.

Absorptivities of Ca and Sr increase with planting age is an intrinsic attribute. The relation of the presence of Ca and Sr to the forming of ginsenosides is an interesting matter that we are intending to investigate in the future.

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