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Determination of Nutrient Elements in Seven Species of Ganodermataceae

PENGCHENG JIN[1], TAO LI[2], YANLI ZHAO[3], JIEQING LI[4], TAO SHEN[2], XI CHEN[1], YUANZHONG WANG[3,*] and HONGGAO LIU[4,*]

[1]Department of Chinese medicine, Beijing University of Chinese Medicine Dongfang College, Langfang 065001, P.R. China
[2]College of Resources and Environment, Yuxi Normal University, Yuxi 653100, P.R. China
[3]Institute of Medicinal Plants, Yunnan Academy of Agricultural Sciences, Kunming 650200, P.R. China
[4]Yunnan Agricultural University, Kunming 650201, P.R. China

*Corresponding authors: E-mail: boletus@126.com; honggaoliu@126.com

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The nutrient elements (C, Ca, Cr, Cu, Fe, K, Mg, Mn, N, Na, Ni, P, Pb, Sr and Zn) in seven species of Ganodermataceae collected from different locations of Yunnan were established by atomic absorption spectrometry. Ganodermataceae samples contained C (571.31-722.93 μg g^{-1}), Ca (52.14-3044.32 μg g^{-1}), Cr (0.49-12.47 μg g^{-1}), Cu (7.22-48.34 μg g^{-1}), Fe (77.88-2591.02 μg g^{-1}), K (1372.07-6944.67 μg g^{-1}), Mg (291.95-660.48 μg g^{-1}), Mn (12.63-240.45 μg g^{-1}), N (1.25-3.74 μg g^{-1}), Na (119.41-3205.38 μg g^{-1}), Ni (1.22-5.23 μg g^{-1}), P (160.54-356.54 μg g^{-1}), Pb (0.75-16.9 μg g^{-1}), Sr (0.18-52.27 μg g^{-1}) and Zn (16.95-72.03 μg g^{-1}). The nutrient contents of Ganodermataceae showed a wide variability among different species. The results would be useful for exploitation and quality evaluation of wild Ganodermataceae in Yunnan province of China.

Key Words: Nutrient element, Atomic absorption spectrometry, Ganodermataceae.

INTRODUCTION

In Yunnan province, complex terrain, various climate and rich vegetation type provide appropriate natural conditions for the growth and differentiation of wild fungus, which makes Yunnan as the richest area of wild fungus resource in China[1]. Ganodermataceae, one of the best-known traditional Chinese medicines, an oriental fungus, has been widely used as a medical drug or health-promotion product in China and other Asian countries. The fruiting bodies and cultured mycelia of Ganodermataceae have been demonstrated to possess anti-tumor activities. Recently, the fungus has attracted much attention owing to the fact that dozens of polysaccharides and protein-bound polysaccharides isolated from it have shown obvious antitumor activities. It has also been reported to be effective in the treatment of many diseases, such as chronic hepatopathy, hypertension and neoplasia[2-4].

The research of nutrient element contents in higher fungus as well as in medicinal plant is necessary, because the elements take part in the formation of the active constituents in direct and indirect ways[5]. The differences of the nutrient element in Ganodermataceae may suggest that some polysaccharides produced both anti-genotoxic and antitumor promoting activities *in vitro* models and therefore, might be considered as potential agents for cancer chemoprotective[6].

In this study, we determined the contents of 15 elements in seven species of Ganodermataceae from different locations in Yunnan Province of China and analyzed the correlation among nutrient elements. The results would be useful for exploitation and quality evaluation of wild Ganodermataceae in Yunnan province of China.

EXPERIMENTAL

Sample preparation: All the samples were dried at 80 ºC until constant weight. The dried materials were finely ground in a mortar and kept in seal until analysis[7].

Dried sample 0.5 g was digested with 12 mL of 5:1 HNO_3/$HClO_4$ (analytical grade) and heated until evolution of white fumes, which marking the end of the digestion process[8-10]. The digestive solution was filtered into standard 25 mL volumetric flask and made up to the mark with distilled water. This was subsequently analyzed for 12 elements (Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn) by AAS.

Exactly 0.5 g finely ground Ganodermataceae sample was put into flask and mixed with 5 mL pure H_2SO_4 and three drops of H_2O_2. Then, the sample was digested until clear solution. The solution was filtered into standard 100 mL volumetric flask and made up to the mark with distilled water[11]. This was subsequently analyzed for N and P elements.

0.02 g of dry powdered sample was weighed into 100 mL tube and mixed with 20 mL $K_2Cr_2O_7$ (0.1 mol L^{-1}) and 5 mL of H_2SO_4 (analytical grade). Then, burette was used for determination. The organic carbon was measured by the potassium dichromate oxidation-Ferrous sulfate titrimetry[12].

Seven species of Ganodermataceae samples were collected from diffe-rent locations in Yunnan, China. The species location and acquisition time of Ganodermataceae are given in Table-1.

TABLE-1
SPECIES AND LOCATION OF GANODERMATACEAE SAMPLES

Species	Location	Acquisition time
Ganoderma capense	Pingbian Yunnan	2012-08-12
Ganoderma applanatum	Lanba Yunnan	2012-08-06
Ganoderma lucidum	Yuxi Yunnan	2012-07-16
Amauroderma guangxiense	Puer Yunnan	2011-05-14
Amauroderma niger	Lanba Yunnan	2012-08-06
Ganoderma tsugae	Lanba Yunnan	2012-08-06
Ganoderma philippii	Puer Yunnan	2011-05-14

Twelve nutrient elements (Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn) were determined by atomic absorption spectrometer (TAS-990F, China). Instrumental parameters used for the determined elements are shown in Table-2.

Nitrogen and phosphorus elements were determined by Ultraviolet-visible Spectrophoto-meter (UV160A, Japan) and nitrogen analyzer (K9840, China), respectively.

RESULTS AND DISCUSSION

The arithmetic mean values of the nutrient element concentrations obtained in seven different species of Ganodermataceae are given in Table-3.

According to the results, copper contents ranged from 8.27 µg g^{-1} (*Ganoderma applanatum*) to 48.34 µg g^{-1} (*Amauroderma guangxiense*). Potassium content was highest (6944.67 µg g^{-1}) in *Amauroderma guangxiense* and lowest (1372.07 µg g^{-1}) in *Ganoderma applanatum*. The level of carbon ranged from 571.31 µg g^{-1} (*Ganoderma applanatum*) to 722.93 µg g^{-1} (*Amauroderma niger*). Manganese contents varied from 12.63 µg g^{-1} (*Ganoderma capense*) to 240.45 µg g^{-1} (*Ganoderma tsugae*). Nitrogen was low in most cases and ranged from 1.25 µg g^{-1} (*Ganoderma applanatum*) to 3.74 µg g^{-1} (*Amauroderma guangxiense*). On the other hand, among these *Ganodermataceae* samples, iron was found in large amounts between 77.82 µg g^{-1} (*Ganoderma philippii*) and 2591.02 µg g^{-1} (*Ganoderma applanatum*).

Compared with Luo's study on *ganoderma* spore, contents of Ca (216.68 µg g^{-1}), Cu (3.98 µg g^{-1}), Mg (55.32 µg g^{-1}), Mn

TABLE-2
INSTRUMENTAL CONDITIONS FOR 12 MINERAL ELEMENTS

Element	Detection wavelength (nm)	Lamp current (mA)	Spectral bandwidth (nm)	Gas flowrate (mL min^{-1})	Burner height (mm)
Ca	422.7	3	0.4	1500	6
Cr	357.9	4	0.4	1700	8
Cu	324.7	3	0.4	1500	6
Fe	248.3	4	0.2	1500	8
K	766.5	2	0.2	1500	5
Mg	285.2	2	0.4	1500	6
Mn	279.5	2	0.2	1500	6
Na	589	2	0.4	1500	5
Ni	232	4	0.2	1500	6
Pb	283.3	2	0.4	1500	5
Sr	460.7	4	0.4	1700	10
Zn	213.9	6	0.4	1500	6

TABLE-3
CONTENTS (µg g^{-1}) OF THE ELEMENTS IN DIFFERENT SPECIES OF GANODERMATACEAE SAMPLES

Element	*Ganoderma capense*	*Ganoderma applanatum*	*Ganoderma lucidum*	*Amauroderma guangxiense*	*Amauroderma niger*	*Ganoderma tsugae*	*Ganoderma philippii*
C	666.6	571.31	594.27	693.5	722.93	680.25	689.16
Ca	ND	2427.45	ND	52.14	210.61	152.35	3044.32
Cr	0.49	12.47	11.26	6.84	ND	2.75	4.65
Cu	12.77	8.27	9.42	48.34	14.78	7.22	46.12
Fe	82.46	2591.02	1401.48	314.2	181.02	239.31	77.82
K	5017.31	1372.07	3004.53	6944.67	3689.17	2938.41	4762.62
Mg	291.95	586.15	312.47	494.61	660.48	369.46	633.37
Mn	12.63	223.75	48.82	47.25	175.01	240.45	54.07
N	2.1	1.25	1.87	3.74	1.83	1.74	2.53
Na	3205.38	196.54	119.41	164.8	271.57	154.11	161.83
Ni	2.44	5.23	2.45	4.96	2.62	1.32	1.22
P	240.21	160.54	285.5	311.73	356.54	230.47	199.72
Pb	3.69	16.9	ND	0.75	4.45	3.43	6.99
Sr	ND	52.27	0.18	0.2	0.33	1.35	6.18
Zn	23.49	34.46	16.95	72.03	25.77	21.26	38.78

ND: Not detected.

TABLE-4
CORRELATION OF THE 15 NUTRIENT ELEMENTS IN GANODERMATACEAE

	C	Ca	Cr	Cu	Fe	K	Mg	Mn	N	Na	Ni	P	Pb	Sr	Zn
C	1.000	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ca	-0.217	1.000	–	–	–	–	–	–	–	–	–	–	–	–	–
Cr	-0.856*	0.305	1.000	–	–	–	–	–	–	–	–	–	–	–	–
Cu	0.465	0.316	-0.043	1.000	–	–	–	–	–	–	–	–	–	–	–
Fe	-0.913**	0.315	0.855*	-0.421	1.000	–	–	–	–	–	–	–	–	–	–
K	0.641	-0.262	-0.387	0.782*	-0.705	1.000	–	–	–	–	–	–	–	–	–
Mg	0.280	0.638	-0.037	0.404	0.063	-0.050	1.000	–	–	–	–	–	–	–	–
Mn	-0.117	0.160	0.050	-0.508	0.362	-0.703	0.323	1.000	–	–	–	–	–	–	–
N	0.501	-0.163	-0.115	0.872*	-0.516	0.939**	0.040	-0.604	1.000	–	–	–	–	–	–
Na	0.072	-0.272	-0.451	-0.204	-0.289	0.255	-0.505	-0.456	-0.037	1.000	–	–	–	–	–
Ni	-0.391	0.037	0.538	0.097	0.598	0.023	0.205	0.085	0.185	-0.116	1.000	–	–	–	–
P	0.554	-0.710	-0.405	0.115	-0.458	0.443	0.017	-0.214	0.383	-0.082	-0.011	1.000	–	–	
Pb	-0.445	0.757*	0.334	-0.189	0.634	-0.585	0.516	0.527	-0.518	-0.094	0.385	-0.706	1.000	–	–
Sr	-0.680	0.626	0.614	-0.249	0.852*	-0.630	0.363	0.499	-0.486	-0.195	0.590	-0.670	0.934**	1.000	–
Zn	0.264	0.142	0.156	0.819*	-0.113	0.677	0.351	-0.254	0.837*	-0.230	0.590	0.127	-0.022	0.040	1.000

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level.

(3.49 μg g^{-1}), Pb (2.00 μg g^{-1}), Sr (2.24 μg g^{-1}), Zn (10.92 μg g^{-1}), were lower than our results. However, Cr (29.40 μg g^{-1}) and Fe (698.19 μg g^{-1}) were higher than ours. The content of Ni (2.89 μg g^{-1}) was similar with our result[13].

As shown in the Fig. 1, the order of the average contents of the nutrient elements in samples was K (3961.25 μg g^{-1}) > Ca (1177.37 μg g^{-1}) > Fe (698.19 μg g^{-1}) > C (659.72 μg g^{-1}) > Na (610.52 μg g^{-1}) > Mg (478.36 μg g^{-1}) > P (254.96 μg g^{-1}) > Mn (114.57 μg g^{-1}) > Zn (33.25 μg g^{-1}) > Cu (20.99 μg g^{-1}) > Sr (10.09 μg g^{-1}) > Cr (6.41 μg g^{-1}) > Pb (6.04 μg g^{-1}) > Ni (2.89 μg g^{-1})> N (2.15 μg g^{-1}).

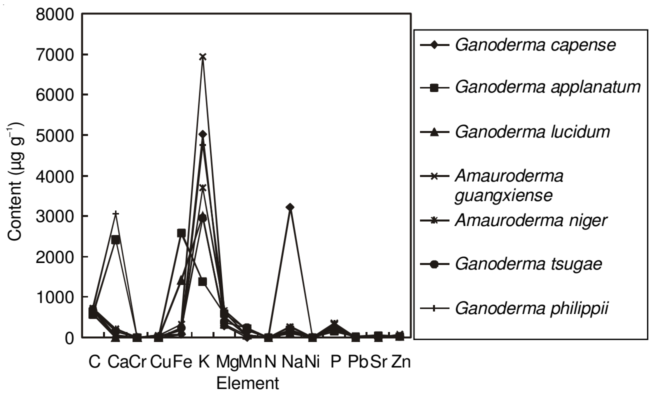

Fig. 1. Mean values of 15 nutrient elements in seven different species of Ganodermataceae

As shown, Ca, Fe, K, Mg and Na contents of all the Ganodermataceae samples were generally found higher than other elements. In addition, C, Cr, Cu, Mn, N, Ni, P, Pb, Sr and Zn were found in a similar and low range for all the detected Ganodermataceae. The correlation analysis of the nutrient elements between seven different species of Ganodermataceae is demonstrated in Table-4.

The results showed that Pb-Sr, K-N had significantly positive correlation at the 0.01 level (r = 0.934, 0.939) in Ganodermataceae. Cu-K, Cu-Zn, Cu-N, Pb-Ca, Cr-Fe, Zn-N, Fe-Sr had significantly positive correlation at the 0.05 level (r = 0.782, 0.819, 0.872, 0.757, 0.855, 0.837, 0.852). On the other hand, Fe-C had significantly negative correlation at 0.01 level (r = -0.913) in Ganodermataceae samples. Cr-C had significantly negative correlation at 0.05 level (r = -0.856).

Conclusion

The contents of nutrient elements of Ganodermataceae samples collected from different locations of Yunnan were investigated. Experimental data showed that Ca, Fe, K, Mg and Na contents of all the detected Ganodermataceae samples were generally higher than other elements. In addition, C, Cr, Cu, Mn, N, Ni, P, Pb, Sr and Zn were established in a similar and low range in the samples. The present study provides baseline data on nutrient element levels in Ganodermataceae.

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