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*Full Length Research Paper*

# Evaluation of mineral element contents in *Paris polyphylla* var. *yunnanensis* from Southwest China

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***Paris polyphylla* var. *yunnanensis* is known to be used as medicine for anti-cancer and traumatic injuries. The present investigation was carried out to estimate the mineral elements in *P. polyphylla* var. *yunnanensis* collected from different locations of South West China by atomic absorption spectroscopy. The contents of its mineral elements were found in the order of Ca > K > Mg > Fe > Na > Cu > Mn > Zn > Cr. The content levels of some elements, such as Cr, Cu, Ca and Mn in the samples were usually affected by environmental conditions, whereas the contents of Mg and K were rather stable in the same species or variety. The contents of the most determined elements in *P. polyphylla* var. *yunnanensis* is different from other medicinal species in genus *Paris*.**

**Key words:** Mineral elements, medicinal plant, Trilliaceae, *Paris polyphylla* var. *yunnanensis*.

## INTRODUCTION

Medicinal plants are widely used to treat many human diseases due to their mild features and low side effects (Başgel and Erdemoğlu, 2006; Nafiu et al., 2011). These plants can synthesize variety of chemical substances which interact directly or indirectly with the body chemistry in human body. The mineral elements play a very important role in the formation of these active compounds (Kolasani et al., 2011), and remain complexed with organic ligands and make them bioavailable to the body system (Choudhury and Garg, 2007). The appropriate mineral element supplementation, such as Cu, Mn and Zn, can enhance the functions of immune system after a major trauma, thereby reducing the risk of death (Yuan et al., 2010). Cu is an essential nutrient that plays a role in the production of hemoglobin, myelin, collagen and melanin (Cobanoglu et al., 2010). Low levels of zinc can induce the pathogenesis of lung cancer (Cobanoglu et al., 2010). Breast cancer patients had low Ca, Mg, Fe, Cu, Mn and Zn in their hair (Joo et al., 2009). However, essential metals can also produce toxic effects when the metal intake is in high concentrations for human health (Jabeen et al., 2010). Determination of mineral elements in plants is also very important, because the quality of many foods and medicines depends on the content and type of minerals (Bahadur et al., 2011).

*Paris* (Trilliaceae) is a genus of about 24 species distributed from Europe to Eastern Asia (Li, 1986; Li, 1998). Most species are restricted to East Asia, with its diversity center in the Yunnan-Guizhou Plateau of China as the diversity centre of this genus. The rhizomes of *Paris* plants, such as *Paris polyphylla* var. *yunnanensis* and *Paris polyphylla* var. *chinensis*, are a well known Chinese traditional medicine popularly named “Chonglou” which is widely used to treat cancer, traumatic injuries, snake bite, abscess and parotitis (Tang, 2003; Huang et al., 2005; Wang and Liu, 2010; Yang et al., 2011). It is also the key raw material of many Chinese patent drug or prepared Chinese medicines such as “Yunnan Baiyao” (Ye et al., 2011).

Previous studies have determined some elements in a few species or mixed-species of medicinal *Paris* samples (Wu et al., 2007; Li et al., 2009). Earlier, we reported the determination of 8 elements in *P. polyphylla* var. *yunnanensis* from Northwest Yunnan (Zhang et al., 2009). Recently, Wang and Liu (2010) provided an insight into the patterns of 14 elements in *P. polyphylla* samples from market. The above earlier discussed researches showed that some mineral element contents

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**Table 1.** Sample locations *P. polyphylla* var. *yunnanensis*.

| S/N | Location | Latitude (N) | Longitude (E) |
|---|---|---|---|
| 1 | Luquan, Kunming, Yunnan | 25°54′ | 102°51′ |
| 2 | Jingxi, Baise, Guangxi | 23°08′ | 106°25′ |
| 3 | Xixiu, Anshun, Guizhou | 26°14′ | 105°58′ |
| 4 | Menghai, Xishuangbanna, Yunnan | 21°59′ | 100°16′ |
| 5 | Lushui, Nujiang, Yunnan | 25°47′ | 99°05′ |
| 6 | Menghai, Xishuangbanna, Yunnan | 21°60′ | 100°10′ |
| 7 | Xishan, Kunming, Yunnan | 25°04′ | 102°32′ |
| 8 | Luquan, Kunming, Yunnan | 25°45′ | 102°31′ |
| 9 | Yanshan, Wenshan, Yunnan | 23°27′ | 104°30′ |
| 10 | Wuding, Chuxiong, Yunnan | 25°31′ | 102°24′ |
| 11 | Mojiang, Puer, Yunnan | 23°26′ | 101°41′ |
| 12 | Pingba, Wenshan, Yunnan | 23°14′ | 104°05′ |
| 13 | Gongshan, Nujiang, Yunnan | 27°44′ | 98°40′ |
| 14 | Xinping, Yuxi, Yunnan | 24°04′ | 101°60′ |
| 15 | Zhenxiong, Zhaotong, Yunnan | 27°24′ | 104°58′ |
| 16 | Yunxian, Lincang, Yunnan | 24°06′ | 100°16′ |
| 17 | Lushui, Nujiang, Yunnan | 25°51′ | 99°01′ |
| 18 | Yanshan, Wenshan, Yunnan | 23°48′ | 104°15′ |
| 19 | Jinggu, Puer, Yunnan | 23°32′ | 100°45′ |
| 20 | Gejiu, Honghe, Yunnan | 23°14′ | 103°09′ |
| 21 | Beicheng, Yuxi, Yunnan | 24°25′ | 102°34′ |
| 22 | Songming, Kunming, Yunnan | 25°25′ | 102°60′ |
| 23 | Xichou, Wenshan, Yunnan | 23°15′ | 104°29′ |
| 24 | Lushui, Nujiang, Yunnan | 25°17′ | 98°47′ |
| 25 | Songming, Kunming, Yunnan | 25°18′ | 103°03′ |
| 26 | Heqing, Dali, Yunnan | 26°35′ | 100°19′ |
| 27 | Xingyi, Qianxinan, Guizhou | 24°55′ | 104°43′ |
| 28 | Lanping, Nujiang, Yunnan | 26°12′ | 99°07′ |
| 29 | Xinping, Yuxi, Yunnan | 23°57′ | 101°28′ |
| 30 | Menghai, Xishuangbanna, Yunnan | 21°57′ | 100°27′ |
| | Range | 21°57′ - 27°44′ | 98°40′ - 106°25′ |

are significantly different between *P. polyphylla* var. *yunnanensis* and *P. polyphylla*. However, the samples tested were rather limited in consideration of a great diversity of their living environments and their wide distribution.

In this study, we have assessed the content of mineral elements (Ca, Cr, Cu, Fe, K, Mg, Mn, Na, and Zn) in *P. polyphylla* var. *yunnanensis* from Yunnan, Guihou, and Guangxi of China.

## MATERIALS AND METHODS

*P. polyphylla* var. *yunnanensis* rhizome samples were collected from 30 different locations ranging from N21°57′ to 27°44′ and from E98°40′ to 106°25′ in South West China (Table 1). The reference substances (standard solutions of metal elements 1000 µg/ml) were provided by the National Research Center for Certified Reference Materials (NRCCRMS). The analytical reagents (nitric acid and muriatic acid) were from Beijing Beihua Fine Chemical Co., Ltd. The water was deionized water (18.25 MΩcm).

The samples were dried at 60°C until constant weight. 0.5000 g of powdered samples were weighed accurately and put in the silica crucibles (25 ml) and added into the moderate concentrated $HNO_3$ at room temperature for one night, and then heated until the reddish brown fumes disappear, volatilizing to dryness (Yuan, 2011). The mixture was heated again at 550°C for 4 h, and then was dissolved in 1.00 mol/L HCl up to 25.00 ml (Yuan, 2011). A blank control group was carried out in the same way. The samples from the same site were determined for five parallel processings.

All mineral elements were determined by a Solaar AA Series atomic absorption spectrometer (Thermo Elemental, USA). Detection limit values (µg/g), operating condition and standard curve of determined elements are shown in Table 2.

## RESULTS AND DISCUSSION

The repeatability (n = 20) for all determined elements, in terms of relative standard deviation (RSD) was below 5%. The GBW10014 cabbage standard reference

**Table 2.** The detection limit, operating condition and standard curve of determined mineral elements.

| Element | DL (μg/g) | Operating condition | | Standard curve | $R^2$ |
|---|---|---|---|---|---|
| | | Detection wave length (nm) | Pass band (nm) | | |
| Ca | 0.0956 | 422.7 | 0.5 | $Y= -0.00032X^2 + 0.02858X + 0.0148$ | 0.9994 |
| Cr | 0.0465 | 357.9 | 0.5 | $Y= -0.00424X^2 + 0.04343X - 0.0017$ | 0.9994 |
| Cu | 0.0633 | 324.8 | 0.5 | $Y= -0.00801X^2 + 0.08855X - 0.0024$ | 0.9988 |
| Fe | 0.0813 | 248.3 | 0.2 | $Y= -0.00373X^2 + 0.05574X + 0.0049$ | 0.9956 |
| K | 0.2474 | 776.5 | 0.5 | $Y= -0.00055X^2 + 0.05449X + 0.0159$ | 0.9994 |
| Mg | 0.1650 | 285.2 | 0.5 | $Y= 0.33038X^2 + 0.84680X + 0.0763$ | 0.9976 |
| Mn | 0.0016 | 279.5 | 0.2 | $Y= 0.00094X^2 + 0.07267X + 0.0061$ | 0.9980 |
| Na | 0.1721 | 589.0 | 0.2 | $Y= -0.01588X^2 + 0.23558X + 0.2140$ | 0.9967 |
| Zn | 0.0262 | 213.9 | 0.5 | $Y= -0.01526X^2 + 0.17498X + 0.0015$ | 0.9987 |

**Table 3.** Determined and certified values of mineral elements in GBW10014 cabbage (n = 10).

| Element | Certified value (μg/g) | Determined (μg/g) |
|---|---|---|
| Ca (mg/g) | 7.0 ± 0.2 | 7.2 |
| Cr (μg/g) | 1.8 ± 0.3 | 1.9 |
| Cu (μg/g) | 2.7 ± 0.2 | 2.8 |
| Fe (μg/g) | 98 ± 10 | 101 |
| K (mg/g) | 15.5 ± 0.6 | 15.8 |
| Mg (mg/g) | 2.41 ± 0.15 | 2.48 |
| Mn (μg/g) | 18.7 ± 0.8 | 18.6 |
| Na (mg/g) | 10.9 ± 0.6 | 11.2 |
| Zn (μg/g) | 26 ± 2 | 25 |

material (National Analysis Center, Beijing, China) was used for quality control and method validation. As shown in Table 3, the obtained results were in good agreement with certified values.

The contents of trace elements, such as Ca, Cr, Cu, Fe, K, Mg, Mn, Na and Zn in different rhizome samples of *P. polyphylla* var. *yunnanensis* are given in Table 4. Among these elements, Cr had the highest coefficient of variation (CV) which was 93.73% followed by Cu (84.64%), Ca (66.23%), Mn (59.62%), Fe (45.43%), Zn (43.11%), Na (30.37%) and Mg (16.38%) while K was found to have the lowest CV (8.01%). It implied that the determined elements with higher CV values were strongly affected by the environment (soil and climate). However, the elements with lower CV values were affected by internal factors of the plants.

Ranges and means ± SD of contents, for all the elements in *P. polyphylla* var. *yunnanensis* samples, along with a comparison with the literature reports (Wu, 2007; Li et al., 2009; Wang and Liu, 2010) on those of some other *Paris* plants, are listed in Table 5. Among the determined mineral elements, Ca had the highest content (2624.32 μg/g) followed by K (2051.17 μg/g), Mg (1470.06 μg/g), Fe (246.96 μg/g), Na (142.81 μg/g), Cu (67.08 μg/g), Mn (18.52 μg/g) and Zn (19.87 μg/g), while Cr (9.01 μg/g) was found to have the lowest content. The comparison of our data with those reported in the literature shows that the contents of Cr and Cu content are much higher than those reported on *P. polyphylla* by Wang and Liu (2010) and those reported on multi-species samples (Wu, 2007; Li et al., 2009), and K and Mg contents are much higher than those reported on multi-species samples (Wang and Liu, 2010). Ca content was comparable to those reported by Wang and Liu (2010) and Li, et al. (2009), Fe and Mn were comparable with those reported (Li et al., 2009), while Na and Zn were similar to those reported (Li et al., 2009).

## Conclusion

The contents of mineral elements were found in the order of Ca > K > Mg > Fe > Na > Cu > Mn > Zn > Cr. The contents of Mg and K in *P. polyphylla* var. *yunnanensis* were quite regulated and they showed little variation over a wide range of the original environment (Table 1). This might have a correlation with the physiological responses of this species. Our results suggested that *P. polyphylla*

**Table 4.** Contents of minerals in *P. polyphylla* var. *yunnanensis* samples (μg/g).

| S/N | Ca | Cr | Cu | Fe | K | Mg | Mn | Na | Zn |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4110.50 | 3.22 | 76.62 | 165.36 | 1750.61 | 1819.78 | 7.45 | 111.97 | 25.82 |
| 2 | 3962.53 | 5.05 | 100.27 | 195.54 | 2238.50 | 1678.87 | 15.50 | 279.52 | 22.65 |
| 3 | 4453.64 | 2.42 | 45.06 | 134.55 | 1713.98 | 1742.80 | 8.05 | 224.14 | 7.74 |
| 4 | 1193.91 | 2.24 | 44.12 | 145.62 | 1966.49 | 1231.56 | 5.71 | 138.21 | 17.08 |
| 5 | 5418.82 | 3.70 | 215.20 | 220.23 | 2264.67 | 1337.71 | 9.71 | 177.15 | 35.01 |
| 6 | 3540.75 | 3.83 | 171.28 | 411.92 | 2081.69 | 1718.03 | 25.83 | 133.50 | 33.23 |
| 7 | 2281.69 | 4.93 | 21.88 | 176.04 | 2239.45 | 1618.05 | 12.52 | 166.50 | 19.78 |
| 8 | 1049.93 | 36.70 | 30.66 | 219.81 | 2076.21 | 1471.47 | 6.20 | 110.32 | 23.98 |
| 9 | 793.90 | 12.38 | 16.54 | 184.30 | 1933.31 | 1120.71 | 9.28 | 142.97 | 23.51 |
| 10 | 875.18 | 40.68 | 72.55 | 180.64 | 1890.41 | 1535.50 | 18.39 | 179.96 | 30.67 |
| 11 | 3141.99 | 4.43 | 80.24 | 357.88 | 2038.26 | 1234.78 | 26.80 | 143.64 | 14.26 |
| 12 | 3867.96 | 6.30 | 94.26 | 305.32 | 2188.21 | 1585.51 | 30.82 | 117.47 | 16.96 |
| 13 | 868.11 | 5.96 | 46.91 | 315.32 | 2076.99 | 1244.62 | 9.19 | 176.61 | 11.64 |
| 14 | 7317.07 | 5.89 | 44.97 | 213.49 | 2230.88 | 1729.03 | 56.98 | 136.14 | 31.17 |
| 15 | 788.24 | 8.53 | 23.56 | 191.71 | 2127.99 | 1500.76 | 14.73 | 95.77 | 10.33 |
| 16 | 3469.05 | 5.94 | 56.89 | 139.64 | 2256.03 | 1578.10 | 34.48 | 103.30 | 2.29 |
| 17 | 1157.96 | 7.25 | 15.21 | 153.95 | 2077.28 | 1291.13 | 7.41 | 119.86 | 12.72 |
| 18 | 955.87 | 6.22 | 19.56 | 94.78 | 1583.08 | 1000.30 | 13.68 | 116.10 | 12.32 |
| 19 | 1083.11 | 10.10 | 24.04 | 540.77 | 1963.73 | 1252.59 | 18.08 | 138.89 | 20.93 |
| 20 | 927.23 | 7.89 | 37.61 | 254.80 | 2032.66 | 1085.18 | 14.07 | 89.42 | 15.96 |
| 21 | 1395.98 | 7.59 | 19.56 | 399.33 | 1861.42 | 1221.71 | 11.25 | 114.15 | 11.39 |
| 22 | 1532.02 | 7.51 | 33.24 | 311.10 | 2082.96 | 1329.51 | 16.52 | 168.04 | 15.59 |
| 23 | 849.96 | 9.81 | 29.19 | 160.38 | 2112.95 | 1464.11 | 13.25 | 148.92 | 10.95 |
| 24 | 2673.27 | 8.61 | 62.86 | 126.73 | 2167.02 | 1305.40 | 22.33 | 109.72 | 30.88 |
| 25 | 3385.81 | 7.83 | 53.21 | 253.40 | 2012.62 | 1618.92 | 20.14 | 164.23 | 19.67 |
| 26 | 4855.94 | 9.46 | 217.35 | 442.11 | 2127.24 | 1521.98 | 30.65 | 121.34 | 31.75 |
| 27 | 3250.31 | 8.01 | 27.88 | 128.19 | 2140.26 | 1850.82 | 18.00 | 184.77 | 11.42 |
| 28 | 3569.39 | 10.01 | 58.13 | 405.74 | 2121.14 | 1467.58 | 24.62 | 89.88 | 22.70 |
| 29 | 4769.17 | 9.16 | 169.13 | 234.73 | 2019.29 | 1928.61 | 20.85 | 196.65 | 28.55 |
| 30 | 1190.19 | 8.78 | 104.31 | 345.31 | 2159.63 | 1616.63 | 33.04 | 85.15 | 25.22 |
| CV (%) | 66.23 | 93.73 | 84.64 | 45.43 | 8.01 | 16.38 | 59.62 | 30.37 | 43.11 |

**Table 5.** Contents of minerals in *P. polyphylla* var. *yunnanensis* samples (μg/g, *n* = 30) and comparison with the literature data.

| Element | *P. polyphylla* var. *yunnanensis* | | *P. polyphylla* (Wang and Liu, 2010) (n = 30) | Multi-species (Wu et al., 2007) (n = 17) | Multi-species (Li et al., 2009) (n = 20) |
|---|---|---|---|---|---|
| | Range | Mean ± SD | | | |
| Ca | 788.24 - 7317.07 | 2624.32 ± 1737.98 | 909.3 ± 389.9 | 7.29 ± 0.99 | 9155.65 ± 4797.66 |
| Cr | 2.24 - 40.68 | 9.01 ± 8.45 | 1.80 ± 1.53 | 0.21 ± 0.11 | 1.17 ± 0.98 |
| Cu | 15.21 - 217.35 | 67.08 ± 56.77 | 0.79 ± 0.77 | 0.21 ± 0.09 | 3.53 ± 2.10 |
| Fe | 94.78 - 540.77 | 246.96 ± 112.19 | 22.68 ± 15.66 | 4.89 ± 2.25 | 355.25 ± 153.55 |
| K | 1583.08 - 2264.67 | 2051.17 ± 164.35 | 33.49 ± 24.30 | ND | ND |
| Mg | 1000.30 - 1928.61 | 1470.06 ± 240.82 | 22.16 ± 14.72 | 0.32 ± 0.50 | 1448.95 ± 346.64 |
| Mn | 5.71 - 56.98 | 18.52 ± 11.04 | 4.93 ± 4.99 | 2.70 ± 1.51 | 47.69 ± 30.38 |
| Na | 85.15 - 279.52 | 142.81 ± 43.37 | 155.4 ± 183.9 | ND | ND |
| Zn | 2.29 - 35.01 | 19.87 ± 8.57 | 28.76 ± 12.01 | 0.69 ± 0.38 | 55.76 ± 29.51 |

ND: Not defined.

*var. yunnanensis* is a good source of Ca, K, Mg, Fe, Na and Cu.


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