Analysis of Main Nutritional Components in Flowers and Leaves of 2 *Lonicera cuminata* Germplasm

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**Abstract.** The research is mainly aimed at the comparative analysis of the flower bud in different growth steps and in leaves of two kinds of *Lonicera cuminata*. The result reflects that there are high contents of soluble protein, amino acids contents, soluble sugar contents, Vc, K, Ca and Mg, but little contents of Fe and Mn in the flower bud and leaves of “Cuilei 001” and “Cuilei 003”. What’s more, the contents of soluble protein, amino acids, soluble sugar and K in flower bud are much higher than those of leaves. However, the contents of Vc, Ca and Mg in leaves are higher than those of flower bud. There are high levels of the nutritional components of flower bud between the stages of Sanqing and Dabai-Erbai and leaves of 10~45 d. The highest contents of various nutrient elements in flower bud were: soluble protein content 15.51%, amino acids 17.05 mg/g•FW, Vc 32.54 mg/100g•FW, soluble sugar 15.93%, K 15.63 mg•DW, Ca 3.25 mg•DW, and Mg 4.93mg•DW. The highest contents of various nutrient elements in leaves were: soluble protein content 13.50%, amino acids 10.45 mg/g•FW, Vc 52.48 mg/100g•FW, soluble sugar 10.89%, K 13.60 mg•DW, Ca 15.01 mg•DW, and Mg 5.94mg•DW.

1. **Introduction**

*Lonicera cuminata* is also known as honeysuckle and it is a perennial semi-evergreen woody vine of the family of Lonicera [1]. From young buds to open buds, honeysuckle’s buds are divided into 7 stages: young buds (green small buds, 1cm), Sanqing (green buds, 2.2~3.4cm), Erbai (light white buds, 3.0~3.9cm), Dabai (white buds, 3.8~4.6cm), silver flowers (newly opened white buds, 4.2~4.8cm), golden flower (yellow flowers, 4.0~4.5cm), withered flower (brown yellow). Among these stages, honeysuckle commodity often includes flower bud of three green period to golden flower stage [2], for the flower bud of second white period and big white stage is very short and difficult to distinguish. In the production of medical and commercial honeysuckle flower buds, the picking period is concentrated on the second white period and big white period. However, some studies also showed that the contents of nutrients and active substances in flower buds were high in silver and golden flower stages.

The chemical constituents in honeysuckle flower are complex. More than 60 components have been identified in the leaves and flowers of *Lonicera cuminata*, including volatile oil, organic acids, flavonoids, amino acids, inorganic elements and so on [3]. As a common traditional Chinese medicine, honeysuckle has the functions of bacteriostatic and antiviral, anti-tumor [4], antipyretic and anti-inflammatory, protecting liver and gallbladder, preventing the occurrence of colon cancer and oral cancer [5-6] and so on. Honeysuckle is one of the raw materials of Yinhuang granule, compound Shuanghuanglian injection and honeysuckle syrup [7-8].

The studies on honeysuckle are mainly focused on the active substances such as chlorogenic acid, flavonoids, triterpenoid saponins and volatile oils, while few studies were made on the main nutrients.
such as protein and mineral nutrients, soluble sugar and amino acids in the leaves and buds of honeysuckle. In this experiment, the main nutrient components of buds and leaves of two superior lines in acclimation cultivation of Lonicera in Muchuan County were compared and analyzed in different developmental stages to provide scientific basis for the nutritional evaluation and application of flower buds and leaves of wild Lonicera in Muchuan County.

2. Materials and methods

2.1. Experimental materials
The test material was “Cuilei 003”, a yellowish-white variety of Lonicera in Muchuan County and the yellowish-red superior line “Cuilei 001”, planted in Chuan Yinhua base, located in four groups of Jianhe Xiang Miaoping village, Muchuan county, Sichuan province.

The flower buds and leaves of the tested materials were analyzed and tested. All the samples were collected from 56 plants which had the same growth in the middle of the garden. The buds and leaves with uniform size were picked from the top, middle and lower parts of 20 branches in the same tree. The mature leaves and the old leaves with the age of 30 ~ 45 days and 70 ~ 90 days of the leaf age of about 30 ~ 45 days and the flower buds were picked from five stages: Sanqing, Erbai, Dabai, silver flower and golden flower, respectively. The samples were packed in ice box and brought back to the laboratory. The fresh samples were stored in -80 ℃ refrigerator for the determination of soluble protein content, amino acid content and Vc content. Dry samples were used for determination of mineral nutrition and soluble sugar content. Preparation of dry samples: put in the oven to dry, drying at 60 ℃ to constant mass, after taking out, crushed, 60 mesh sieve, prepared to be used.

2.2. Items and method of determination
The content of soluble protein in the sample was determined by Coomassie brilliant blue G-250 method. The content of amino acids in the sample was determined by ninhydrin colorimetry. The content of vitamin C in the sample was determined by titration of dichloroindophenol. The content of soluble sugar in the sample was determined by anthrone colorimetry. The content of six mineral nutrient elements (K, Ca, Cu, Fe, Mg, Mn) in the samples was determined by Flame Atomic absorption Spectrophotometry (Faas) with R standing Z-2000 atomic absorption spectrometer.

3. Results and analysis

3.1. Comparison of soluble protein content between flower buds and leaves
The contents of soluble protein in flower buds and leaves of “Cuilei 001” and “Cuilei 003” in different developmental stages are shown in Table 1. Table 1 shows that the content of soluble protein in flower buds and leaves of two cultivars of Lonicera cuminata. increased first and then decreased. In general, the content of soluble protein in flower buds was higher than that in leaves. The content of soluble protein in flower buds was the highest at the Erbai stage, while the soluble protein content in the young leaves was the highest at 10~15 days of leaf age.

| Materials  | Sanqing | Erbai | Silver flower | Golden flower | Spire | Climax leaf | Old leaf |
|------------|---------|-------|---------------|---------------|-------|-------------|---------|
| Cuilei 001 | 13.76   | 15.51 | 11.56         | 11.90         | 12.26 | 8.32        | 9.86    |
| Cuilei 003 | 11.32   | 14.56 | 11.44         | 9.54          | 13.50 | 9.74        | 9.70    |

3.2. Comparison of Amino Acid content in Flower Bud and Leaf.
The contents of total amino acids in buds and leaves of "Cuilei 001" and "Cuilei 003" in different developmental stages are shown in Table 2. Table 2 shows that the contents of total amino acids in flower buds of two cultivars of *Lonicera cuminata* decreased in different developmental stages, but the contents of total amino acids in leaves of different maturity were relatively stable, with little change. In general, the content of total amino acids in flower buds was significantly higher than that in leaves. The content of total amino acids was the highest in the Sanqing stage, but lower in the silver flowering stage and the golden flower stage.

| Materials | Bud development stages | Leaf maturity |
|-----------|------------------------|--------------|
|           | Sanqing                | Erbai        | Silver flower | Golden flower | spire | climax | old leaf |
| Cuilei 001 | 15.90                  | 12.23        | 11.67         | 12.06         | 10.45 | 10.31  | 10.23   |
| Cuilei 003 | 17.05                  | 13.19        | 10.17         | 10.06         | 10.31 | 10.46  | 10.28   |

3.3. Comparison of Vc content between flower buds and leaves.

The Vc contents of flower buds and mixed leaves (young leaves, mature leaves and old leaves) in "Cuilei 001" and "Cuilei 003" are shown in Table 3. From Table 3, we can see that the Vc content of flower buds of two cultivars of *Lonicera cuminata* is obviously lower than that of mixed leaves (young leaves, mature leaves and old leaves). The Vc content of "Cuilei 001" was significantly lower than that of "Cuilei 003", while the Vc content of mixed leaves of "Cuilei 001" was significantly higher than that of "Cuilei 003".

| Materials | Buds at Erbai stage | Mixed blade |
|-----------|---------------------|-------------|
| Cuilei 001 | 17.55               | 52.48       |
| Cuilei 003 | 32.54               | 36.88       |

3.4. Comparison of soluble Sugar content in Flower Bud and Leaf.

The contents of soluble sugar in flower buds and leaves of "Cuilei 001" and "Cuilei 003" in different developmental stages are shown in Table 4. Table 4 shows that the content of soluble sugar in flower buds and leaves of "Cuilei 001" and "Cuilei 003" varies greatly. The soluble sugar content of "Cuilei 001" flower bud increased and decreased, the content of soluble sugar in flower bud maintained a high level from Dabai period to golden flower stage, and the soluble sugar content in golden flower bud reached 15.87%, which increased with maturity. The soluble sugar content in the leaves showed an increasing trend, and the soluble sugar content in the old leaves over 70 days was higher, reaching 11.24%. The content of soluble sugar in flower bud of "Cuilei 003" rose from Sanqing stage to golden flower stage, and the soluble sugar content of flower bud in silver flower stage was the highest, reaching 14.80%, which was opposite to "Cuilei 001". With the increase of maturity, the soluble sugar content of "Cuilei 003" decreased, and the content of soluble sugar in young leaves have reached 10.89%.

| Materials | Bud development stages | Leaf maturity |
|-----------|------------------------|--------------|
|           | Sanqing                | Erbai        | Silver flower | Golden flower | spire | climax | old leaf |
| Cuilei 001 | 5.88                  | 15.87        | 14.09         | 15.93         | 6.78  | 8.05   | 11.24   |
3.5. Comparison of mineral nutrient contents in leaves and buds.

The contents of mineral elements in flower buds and leaves of "Cuilei 001" and "Cuilei 003" in different developmental stages are shown in Table 5.

| Materials     | mineral nutrient contents | Bud development stages | Leaf maturity |
|---------------|---------------------------|-------------------------|---------------|
|               | Ca                        | Sanqin                  | Erbai         | Silver flower | Golden flower | spire         | clima x leaf | old leaf    |
| Cuilei 001    | 0.95                      | 0.86                    | 1.44          | 2.74          | 7.76          | 13.84         | 6.01         |
|               | 4.13                      | 2.84                    | 2.73          | 1.64          | 5.64          | 4.32          | 3.97         |
|               | 15.60                     | 15.63                   | 14.21         | 13.74         | 10.80         | 9.40          | 9.81         |
|               | 0.26                      | 0.26                    | 0.26          | 0.28          | 0.26          | 0.23          | 0.14         |
|               | 1.10                      | 1.14                    | 1.15          | 1.43          | 1.25          | 1.33          | 1.29         |
|               | 0.25                      | 0.31                    | 0.29          | 0.21          | 0.15          | 0.27          | 0.35         |
| Cuilei 003    | 3.25                      | 1.97                    | 1.72          | 1.88          | 7.93          | 15.01         | 10.14        |
|               | 3.17                      | 4.47                    | 4.93          | 2.86          | 5.94          | 5.75          | 3.63         |
|               | 13.26                     | 11.26                   | 13.12         | 15.55         | 13.60         | 6.40          | 8.43         |
|               | 0.23                      | 0.23                    | 0.24          | 0.24          | 0.21          | 0.15          | 0.18         |
|               | 1.11                      | 1.18                    | 1.14          | 1.13          | 1.28          | 1.51          | 1.24         |
|               | 0.20                      | 0.34                    | 0.14          | 0.16          | 0.08          | 0.09          | 0.12         |

With the increase of maturity, the content of Ca in leaves of "Cuilei 001" and "Cuilei 003" increased first and then decreased. The content of Ca in mature functional leaves was the highest at the age of 30 ~ 45 days. The variation of Ca content in flower buds of the two materials was opposite, from the Sanqing stage to the golden flower stage. The content of Ca in "Cuilei 001" flower bud showed an upward trend, the highest in golden flower bud, and the highest in "Cuilei 003" bud in Sanqing stage. The content of Mg in leaves was higher than that in buds, and the content of Mg in young leaves was the highest. With the increase of bud development degree, the Mg content of "Cuilei 001" flower bud decreased, while that of "Cuilei 001" flower bud increased first and then decreased, and the content of Mg in flower bud was higher at the stage of silver flower. Compared with the contents of Ca and K, the K contents of flower buds and leaves were higher in different developmental stages, and the changes were relatively stable, and K content in flower buds was slightly higher than that in leaves. In accordance with the law of Mg content, the K content of young leaves was the highest in the two materials. The contents of Mn and Fe between the two materials and between flower buds and leaves were small and the differences were small. The Cu content of the two materials was slightly higher than that of the leaves, and the content of Cu in the buds and the old leaves was the highest in the Erbai stage. In addition, the content of Cu in flower buds and leaves of "Cuilei 001" was slightly higher than that of "Cuilei 003".

4. Discussion and summary

The content of soluble protein in flower bud of both materials was higher than that of Lycium barbarum L. (protein content: 6%-10.31%) [9], and the content of soluble protein in leaves was higher than that in jujube (protein content: 2.40%-3.22%) [10]. The content of amino acids in the leaves of the two materials was about the same and higher than that of the common fruits (amino acid content 2.4
mg/g~8.48 mg/g). The content of amino acid in flower bud of "Cuilei 003" was 17.05%, and the content of amino acid in flower bud of "Cuilei 003" was similar to that of cabbage and other 21 vegetables (amino acid content 6.98 mg/g~21.61 mg/g) [11]. The contents of Vc in leaves and buds of Lonicera cuminata were higher than those of common vegetables, such as carrot (11.84 mg/hg), lettuce (10.13 mg/hg), celery (16.94 mg/hg), etc. [12].

Soluble sugar is a direct product of plant photosynthesis, a main form of carbohydrate metabolism and temporary storage, and a material basis of macromolecular compounds such as polysaccharide, protein, fat and so on. It plays an extremely important role in plant carbon metabolism [13]. The soluble sugar content of flower buds and leaves of two lines "Cuilei 001" and "Cuilei 003" of Lonicera cuminata in Muchuan County is rich in different developmental stages.

Mineral trace elements are one of the essential nutrient elements in human body. The study shows that trace elements are the core components of Chinese traditional medicine and the material basis of quantification of their pharmacodynamics [14]. Junsheng Qi [15] discussed the correlation between trace element content and medicinal properties of traditional Chinese medicine, and revealed the correlation between trace element content and curative effect of traditional Chinese medicine. Honeysuckle contains rich trace elements, which is beneficial to human health. Baoguo Li [16] found that honeysuckle contains a large amount of Fe, Mn, Zn, Mg, Cu, especially Fe, Mn. In this experiment, the contents of six trace elements in the wild Lonicera cuminata var. "Cuilei 001" and "Cuilei 003" in Muchuan County were determined in the order of: K> Ca> Mg> Fe> Cu> Mn,. The order of mineral element contents in honeysuckle was basically the same as that in the previous studies [17-20]. In general, the content of Ca, Mg element in "Cuilei 001" was significantly lower than that in "Cuilei 003". In terms of the contents of soluble protein, amino acid, soluble sugar and Fe, the "Cuilei 001" and "Cuilei 003" in this experiment can be used in production, but "Cuilei 003" is better than "Cuilei 001".

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