Pak. J. Bot., 44(2): 635-638, 2012.

NUTRIENT COMPOSITION IN LEAVES OF CULTIVATED AND WILD *CAMELLIA NITIDISSIMA*

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Abstract

Camellia nitidissima is widely used to make tea in south China. The purpose of this research was to investigate the effect of cultivation on the nutrients of *C. nitidissima.* In this paper, we make comparative analyses of the nutrient content in leaves in cultivated and wild *C. nitidissima*. The results indicate that both cultivated and wild *C. nitidissima* had a full complement of amino acids with rich contents and a variety of mineral nutrients. There were no significant differences between cultivated and wild *C. nitidissima* in terms of water, vitamin C, gross sugar, protein, fat, nitrogen, phosphorous, potassium, magnesium or zinc content, but cultivated *C. nitidissima* had significantly higher contents of essential amino acids (26.05%) and total amino acids (33.27%) than that of wild *C. nitidissima*.

Introduction

Camellia nitidissima is an evergreen shrub or small tree species of the genus *Camellia* (Theaceae). It is a rare ornamental plant characterized by yellow waxy petals (Fig. 1). The species is the germplasm of the rare yellow flower camellia and has caused much excitement in the horticultural world since it was first identified and described in the 1960s (Cheng *et al*., 1994). It is distributed in a narrow region of southwestern Guangxi province, South China, and north of Vietnam (Bin *et al*., 2005; Su & Mo 1988). *C. nitidissima* has been introduced into Japan, Australia, and North America as a useful genetic resource for commercial cultivation of camellias, attracting extensive attention from horticultural workers worldwide (Nishimoto *et al*., 2004; Parks 2000; Tang *et al*., 2006). This endangered plant is listed in the China red data book as a national class I protected species (Fu, 1992; Yang *et al*., 2010). In addition to its ornamental function, *C. nitidissima* is widely used to make tea in South China. Health teas and beverages made from C. *nitidissima* leaves including camellia teabag, camellia oral liquid, camellia essence, camellia-bud tea and camellia beverages have been successfully developed and are sold in Southeast Asian countries (Liang 1993; Peng *et al*., 2011). A state-level camellia natural reserve has been established in the primary distribution areas of this plant, Fengcheng city. At present, the raw material (camellia) for manufacturing the tea products could be obtained only through artificial cultivation.

Fig. 1. *Camellia nitidissima*

The nutrients essential for life are proteins, fat and carbohydrates, all contribute to caloric content of the dietary, minerals including trace elements, vitamins and water (Hameed *et al*., 2008; Nisar *et al*., 2009). The study on leaf nutrient composition of *C. nitidissima* has not been undertaken comprehensively. The objectives of this study were to investigate the nutrient effect of cultivation on the nutrients of *C. nitidissima* and whether the cultivated *C. nitidissima* has the same level of nutrients as that of wild type.

Materials and Methods

Wild *C. nitidissima* leaves were taken from four populations of plants in the original growth areas (Fengcheng) with ten plants being selected for plucking the leaves. Guangxi Institute of Botany started an ex situ conservation program for C. nitidissima since 1989, Germplasm pool of C. nitidissima have established and Its area is about 2ha. Cultivated *C. nitidissima* leaves were taken from four populations in the germplasm pool.

Sampled leaves were collected in current year leaves of *C. nitidissima*. The soils for both wild and cultivated camellia plants were lateritic red loam soils. The collected leaves were taken to the laboratory immediately after sampling, washed briefly with distilled water, dried at 80°C for 72h, weighed, ground in a mill and then passed through 1-mm sieve. The powders were stored under desiccant conditions for chemical analyses.

Plant water content was determined using a normal pressure drying method; crude fat was determined using the Soxhlet extraction method; gross sugar was determined using Fehling's Reagent Volume Method; crude fiber and ash content were determined via weight method; vitamin C was determined using fluorescence spectrophotometry; the determination of protein was via Kjeldahl method; the contents of eighteen amino acids were determine using an automatic amino acid analyzer (Hitachi L-8800); total nitrogen (N) levels were determined via macro-Kjeldahl method (Yoshida *et al*., 1972). Phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), ferrum (Fe), Zn and Mo determinations were carried out using inductively coupled argon plasma atomic emission spectrometry (model: IRIS intrepid II) (Yazzie *et al*., 1994).

Data analysis: Data were processed by one-way analysis of variance (ANOVA) with SPSS11.5 (SPSS Inc. USA) and a t-test for two-tailed was used to identify for the means at p <0.05.

Results and Discussion

Leaves nutrients: The contents of main nutrients of cultivated and wild *C. nitidissima* leaves (Table 1). No significant differences existed between cultivated and wild *C. nitidissima* leaves in terms of water, vitamin C, gross sugar, protein or fat content. However, highly significant differences existed between them in terms of crude fiber and ash content. Contents of nutrients of cultivated *C. nitidissima* are similar to levels for wild *C. nitidissima*. Contents of Vitamin C, crude protein, crude fiber and ash of *C. nitidissima* leaves were higher than the reported for *Camellia. Sinensis* and contents of total sugar was lower (Yang, 2005).

Table 1. Nutrient content of cultivated and wild *C. nitidissima* leaves.

Nutrients	Water %	Vitamin C (μg g^{-1})	Total sugar %	Protein %	Fat %	Crude fiber %	Ash %
Wild *C. nitidissima*	59.73 ± 0.46^a	241.8 ± 16.4^a	3.35 ± 0.32^a	7.40 ± 0.09^a	1.54 ± 0.15^a	32.53 ± 0.64^a	6.94 ± 0.34^a
Cultivated *C. nitidissima*	56.25 ± 1.95^a	192.3 ± 6.7^a	3.25 ± 0.12^a	7.46 ± 0.28^a	1.24 ± 0.04^a	26.39 ± 0.82^b	10.7 ± 0.40^b

*Within each column, values followed by the same letter are not significantly different at p<0.05

Mineral elements content: Mineral elements content of *C. nitidissima* are presented in table 2. Leaves of cultivated and wild camellia had a complete component of macro- and micronutrients, both with high N, K, Ca and Mg contents, and lower contents of Mo and Zn. Among the analyzed macronutrients in the leaf, the concentration of N was the highest (11.9±0.15 mg g^{-1} dry wt in wild and 12.0±0.05 mg g^{-1} DW in cultivated). The K content were the second most abundant nutrients in the leaf. Both cultivated and wild *C. nitidissima* had the following the order of contents of mineral elements: N>K>Ca>Mg>P>Fe>Zn>Mo.

Table 2. Mineral nutrient content of cultivated and wild *C. nitidissima* leaves (mg g^{-1} DW).

Nutrients	N	P	K	Ca	Mg	Fe	Zn	Mo
Wild *C. nitidissima*	11.9±0.15^a	0.515±0.027^a	11.2±2.02^a	8.60±0.82^a	3.42±0.24^a	0.069±0.015^a	0.017±0.001^a	6.5×10^{-5a}
Cultivated *C. nitidissima*	12.0±0.05^a	0.477±0.003^a	10.4±0.42^a	8.70±1.02^a	3.55±0.14^a	0.113±0.005^b	0.016±0.001^a	4.3×10^{-5b}

*Within each column, values followed by the same letter are not significantly different at p<0.05

Table 3. Amino acid content of cultivated and wild *C. nitidissima* leaves (mg g^{-1} DW).

	Wild *C. nitidissima*	Cultivated *C. nitidissima*
Asp	5.0 ± 0.7	7.2 ± 0.4
Thr	2.5 ± 0.4	3.4 ± 0.2
Ser	2.6 ± 0.4	3.3 ± 0.2
Glu	6.8 ± 1.1	8.5 ± 0.4
Pro	3.1 ± 0.4	4.4 ± 0.1
Gly	3.1 ± 0.4	4.5 ± 0.2
Ala	3.4 ± 0.6	4.3 ± 0.2
Cys	0.6 ± 0.4	0.5 ± 0.02
Val	3.0 ± 0.4	4.2 ± 0.1
Met	0.3 ± 0.1	0.4 ± 0.1
Ile	2.9 ± 0.1	3.5 ± 0.1
Leu	5.7 ± 0.3	6.9 ± 0.1
Tyr	2.1 ± 0.1	2.1 ± 0.1
Phe	2.9 ± 0.5	4.0 ± 0.2
Lys	4.8 ± 0.2	4.8 ± 0.3
His	1.2 ± 0.1	1.4 ± 0.1
Arg	2.3 ± 0.6	5.4 ± 0.2
Trp	0.04 ± 0.01	0.05 ± 0.01
EAA	21.5 ± 0.6^{a}	27.1 ± 0.8^{b}
Total amino acids	51.44 ± 2.9^{a}	68.55 ± 1.6^{b}

* Within each row, values followed by the same letter are not significantly different at $p<0.05$

Table 4. EAA composition of cultivated and wild *C. nitidissima* leaves compared with the FAO/WHO reference protein (mg g^{-1} DW).

EAA	FAO/WHO	Wild *C. nitidissima*	Cultivated *C. nitidissima*
Leu	6.6	5.7	6.9
Lys	5.7	4.5	4.8
Met + Cys	2.6	0.42	0.78
Phe + Tyr	6.2	5.5	6.1
Thr	3.3	2.7	3.4
Val	3.5	3.0	4.1
Ile	2.8	2.9	3.5

There was no significant difference between cultivated and wild camellia plants in terms of mineral contents, except Fe and Mo. Both types of *C. nitidissima* had similar contents of N, P, K, Ca, Mg and Zn, but significantly higher Fe content and significantly lower of Mo contents. Contents of Ca and Mg are higher, but contents of N, P, K, Fe, Zn and Mo are lower than the reported for *C. sinensis* (Yang 2005).

Amino acids composition and content: There are eighteen kind of amino acids were found in leaves of *C. nitidissima*, including the seven essential amino acids (EAAs): threonine, valine, methionine, leucine, phenylalanine, lysine, Isoleucine (Table 3). Total amino acids of cultivated and wild *C. nitidissima* leaves were 68.55±1.6 mg g^{-1} DW and 51.44±2.9 mg g^{-1} DW, respectively. The most abundant amino acid was Glutamate (8.5±0.4 mg g^{-1} dry wt in cultivated and 6.8±1.1 mg g^{-1} DW in wild), contributing 12.34% and 13.22% of the total amino acid content. Aspartic acid, which is the second most abundant amino acid of cultivated *C. nitidissima* leaves, was present 7.2 ± 0.4 mg g^{-1} dry wt, comprising 10.50% of the total amino acid content. Leucine, which is the second most abundant amino acid of wild *C. nitidissima* leaves, was present 5.7±0.3 mg g^{-1} DW, comprising 11.08% of the total amino acid content. The contents of Tryptophane, Methionine and Cysteine were in lower quantities, ranging between 0.03 and 0.6 mg g^{-1} DW. Both the EAA and the total amino content of cultivated *C. nitidissima* leaves were significantly higher (26.05% and 33.27%, respectively) than those of wild *C. nitidssima* (Table 3). Such variation in EAA and total amino content might be related to their level of soil fertility. Furthermore, as assessed in terms of EAA pattern (Table 4), Some EAAs, e.g., Lys, Met +Cys and Phe + Tyr were lacking from *C. nitidssima* leaves than of the WHO standard (Anon., 1985).

Conclusion: In conclusion, both cultivated and wild *C. nitidissima* had eighteen kinds of amino acids, and both had complete component of mineral nutrients. Compared with wild *C. nitidissima*, no significant changes were seen in cultivated *C. nitidissima* in terms of water, vitamin C, gross sugar, protein, fat, N, P, K, Ca, Mg or Zn, but cultivated *C. nitidissima* had significantly higher EAA and total amino acids contents.

Acknowledgements

We thank Mr Zhang Ming Wang for comments on the manuscript and language revision and Mr.Zhao Rui Feng have established germplasm pool of C. nitidissima in Guangxi Institute of Botany. This work was supported by the National Natural Science Foundation of China (31040014, 31160137); Knowledge Innovative Program of The Chinese Academy of Sciences (KSCX2-YW-Z-0913, KSCX2-YW-Z-1030); Key Technologies Research and Development Program of Guangxi (1123013-15); Cooperative Program of Guangdong and the Chinese Academy of Sciences 2009B091300137.

References

Anonymous. 1985. Energy and protein requirements, In: Report of a joint FAO/WHO/UNU Expert Consultation, WHO Technical reports series No. 724. Food and Agriculture Organization of that United Nations.

Bin, X.Y, S.Q. Tang, J.Y. Zhou, H.T. Song and Z.Y. Li. 2005. ISSR analysis on genetic diversity of *Camellia nitidissima* CHI (Theaceae) in China. *J. of Wuhan Bot. Res.*, 23: 20-26.

Cheng, J.S., J.Y. Chen and S.W. Zhao. 1994. Interspecific cross breeding for new yellow Camellias. *J. of Beijing Forest. Univer.*, 16: 55-59.

Fu, L.G. 1992. *China red date book of plants*, Vol. 1. Science Press, Beijing.

Hameed, I., G. Dastagir and F. Hussain. 2008. Nutritional and elemental analyses of some selected medicinal plants of the family Polygonaceae. *Pak. J. Bot*., 40(6): 2493-2502.

Liang, S.Y. 1993. *Yellow Camellias*. China Forestry Press, Beijing.

Nisar, M., S.A. Tariq and Ihsanullah.2009.Nutritional levels of *Indigofera gerardiana* WALL and *Crataegus songrica* K.KOCH. *Pak. J. Bot*., 41(3): 1359-1361.

Nishimoto, S.I., F. Hashimoto, K. Shimizu and Y. Sakata. 2004. Petal coloration of interspecific hydrids between *Camellia chysantha* × *C.* Japonica. *J. of the Japanese Soci. Hort. Sci.*, 73: 189-191.

Parks, C.R. 2000. Breeding progress with yellow camellias. American Camellia Yearbook. pp. 9-10.

Peng, X., D.Y. Yu, B.M. Feng, L. Tang, Y.Q. Wang and L.Y. Shi. 2011. Chemical constituents from the flowers of *Camellia nitidissima*.*Guihaia*, 31(4): 550-553.

Su, Z.M. and X. L. Mo.1988. Geographic distribution of *Camellia* section Chrysantha from China. *Guihaia*, 8: 75-81.

Tang, S.Q., X.Y. Bin, L. Wang and Y. Zhong. 2006. Genetic diversity and population structure of Yellow Camellia (*Camellia ninidissima*) in China as Revealed by RAPD and AFLP Markers. *Biochemical Genet*., 44: 449-461.

Yang, Q.H, X.Q. Li, H.S. Yang, X. Wei and X.J. Yin. 2010. Photosynthetic ecophysiological characteristics of Camellia nitidissima seedlings. *J. of Beijing Forest. Univer*, 32(2): 57-63.

Yang, Y.J. 2005. *Cultivation science of China tea*. Shanghai Science and Technology Press, Shanghai

Yazzie, D., D.J. Vanderjagt, A. Pastuszyn, A. Okolo and R.H. Glew. 1994. The amino acid and mineral content of baobab (Adansonia digitata L.). *Journal of Food Composition and Analysis*, 7: 183-193.

Yoshida, S., D.A. Forno, J.H. Cock and K.A. Gomez. 1972. *Laboratory manual for physiological studies of rice* (2nd edition). International Rice Research Institute, Philippines.

(Received for publication 25 May 2009)