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# On Regional Division of Suitable Producing Areas of Yu *Salvia miltiorrhiza*

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**Abstract** With the aid of the Traditional Chinese Medicine Geographic Information System (TCMGIS-I), on the basis of planting base of Yu *Salvia miltiorrhiza* in Fangcheng County of Henan Province, we selected key ecological factors such as the temperature, altitude, soil type, and precipitation that affect growth of Yu *Salvia miltiorrhiza*, and analyzed ecological suitability of Yu *Salvia miltiorrhiza* in China and in Henan Province. Results show that Yu *Salvia miltiorrhiza* has large suitable area in China, up to 10 provinces. At the similitude degree of 90% to 100%, its suitable distribution area can reach 309 205 km<sup>2</sup> theoretically. Among the suitable areas, the distribution area is large in Sichuan, Shaanxi, Jiangsu, Hubei and Henan provinces, each of which up to 24 000 km<sup>2</sup>. At the similitude degree of 80% to 90%, the suitable areas of Yu *Salvia miltiorrhiza* are mainly in Fangcheng, Xichuan, Dengzhou, Xinyang and Nanzhao counties, which are consistent with record of relevant data.

**Key words** Yu *Salvia miltiorrhiza*, TCMGI –I, Suitability of producing areas, Regional Division

## 1 Introduction

*Salvia miltiorrhiza* (Labiatae, Laminaceae) is an annual sage mainly found in China and neighboring countries. Its (dried) root has many functions, including invigorating blood circulation and eliminating stasis, nourishing blood and tranquilization, and treating anxiety disorder, as well as reducing blood pressure. In *Chinese Pharmacopeia*, *Salvia miltiorrhiza* is the sole origin plant under the Labiatae and Laminaceae<sup>[1]</sup>. Grown in ancient Yuzhou (now Fangcheng County) of Henan Province with purplish red and high quality, it is praised as Yu *Salvia miltiorrhiza*<sup>[2–4]</sup>.

The Traditional Chinese Medicine Geographic Information System (TCMGIS-I) is a system developed on the platform of Geographic Information System (GIS) for analyzing and evaluating ecological suitability of medicinal materials<sup>[5–9]</sup>. With the aid of this research achievement, it is able to realize comprehensive analysis and prediction about suitable producing areas of Yu *Salvia miltiorrhiza*, find out distribution laws of Yu *Salvia miltiorrhiza* resources, and provide theoretical and technical support for choosing ecological environment similar to producing areas of Yu *Salvia miltiorrhiza*.

## 2 Analysis software and method

With the aid of Traditional Chinese Medicine Geographic Information System (TCMGIS-I) developed on the basis of the Geographic Information System (GIS) platform, the Spatial Clustering Algorithm, and correlated factors, as well as various

databases already established, we analyzed the distribution of ecological suitable producing areas of Yu *Salvia miltiorrhiza* in China and the regional area. Taking the Yu *Salvia miltiorrhiza* planting base in Fangcheng County of Henan Province as the analytical basis, we analyzed the ecological suitability of Yu *Salvia miltiorrhiza* in Henan Province and in China by the method of weighted absolute value distance.

## 3 Analysis results of regional division of suitable producing areas

**3.1 Distribution of suitable producing areas of Yu *Salvia miltiorrhiza* in China** From Fig. 1, it can be known that 11 provinces are suitable for producing Yu *Salvia miltiorrhiza*. When the similitude is 90% to 100%, 9 provinces are suitable for growth of Yu *Salvia miltiorrhiza*. The theoretical value of distribution area of suitable producing area is up to 309 205 km<sup>2</sup>. Sichuan Province has the largest distribution area, up to 150 000 km<sup>2</sup> (listed in Table 1), followed by Shaanxi Province, Jiangsu Province, Hubei Province and Henan Province, each of which covers an area greater than 24 000 km<sup>2</sup>. We recommend particularly considering these points when carrying out investigation, development and utilization of Yu *Salvia miltiorrhiza* resources. Among those suitable producing areas, Sichuan, Hubei, 14 cities or counties in Shaanxi (shown in Table) have suitable producing areas greater than 2 500 km<sup>2</sup>. For example, Sichuan Province has 9 cities or counties that are suitable for producing Yu *Salvia miltiorrhiza*, and the number of counties with suitable producing area larger than 2 000 km<sup>2</sup> is up to 30. These values are theoretical values and have certain difference with actual values. Therefore, local actual situations should also be taken into account when considering actual planting of Yu *Salvia miltiorrhiza*.

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Fig.1 Regional division of suitable producing areas of Yu *Salvia miltiorrhiza* in China when the similitude is 90% to 100% (yellow part)

Table 1 Area of Yu *Salvia miltiorrhiza* suitable producing areas when the similitude between provinces is 90% to 100%

Provinces	Area of suitable production//km <sup>2</sup>
Sichuan	154 027
Shaanxi	44 829
Jiangsu	34 577
Hubei	26 806
Henan	24 932
Yunnan	9 553
Shandong	6 954
Anhui	6 512
Shanxi	1 014
Guizhou	760
Total	309 974

Table 2 Several cities or counties suitable for planting Yu *Salvia miltiorrhiza* when the similitude reaches 90% to 100% in China

Provinces	Cities or Counties	Area of suitable producing area//km <sup>2</sup>	Proportion of suitable producing areas//%
Sichuan	Tongjiang County	3 842	100
Sichuan	Xuanhan County	3 746	90
Sichuan	Guangyuan City	3 483	70
Sichuan	Wanyuan County	2 933	90
Sichuan	Jian'ge County	2 916	100
Sichuan	Nanjiang County	2 875	90
Hubei	Fangxian County	2 799	60
Hubei	Yunxian County	2 722	70
Hubei	Zhushan County	2 716	80
Shaanxi	Xixiang County	2 713	90

**3.2 Distribution of suitable producing areas of Yu *Salvia miltiorrhiza* in Henan Province** From Fig. 2 and Table 3, Henan Province has 41 cities and counties that are suitable for growth of Yu *Salvia miltiorrhiza*. The total theoretical distribution area is up to 24 932 km<sup>2</sup>. 11 cities and counties have suitable area greater than 1 000 km<sup>2</sup> at the similitude of 80% to 100%. Fangcheng County has the largest distribution area (1 666 km<sup>2</sup>) and the highest proportion of suitable area, followed by Xichuan, Dengzhou, Xinyang and Nanzhao counties. Relevant historical data indicates that Fangcheng County is the genuine producing area of Yu *Salvia miltiorrhiza*<sup>[2,3]</sup>.

Table 3 Several large areas suitable for planting Yu *Salvia miltiorrhiza* in Henan Province at the similitude of 80% to 100%

City or County	County area//km <sup>2</sup>	Area suitable for planting km <sup>2</sup>	Proportion of suitable areas %
Fangcheng County	2 445	1 666	68
Xichuan County	2 678	1 593	59
Dengzhou City	2 333	1 393	60
Xinyang County	3 302	1 333	40
Nanzhao County	2 819	1 262	45
Queshan County	2 134	1 155	54
Lushan County	2 288	1 153	50
Neixiang County	2 236	1 128	50
Xixia County	3 367	1 093	32
Tongbai County	1 840	1 085	59
Biyang County	2 717	1 042	38

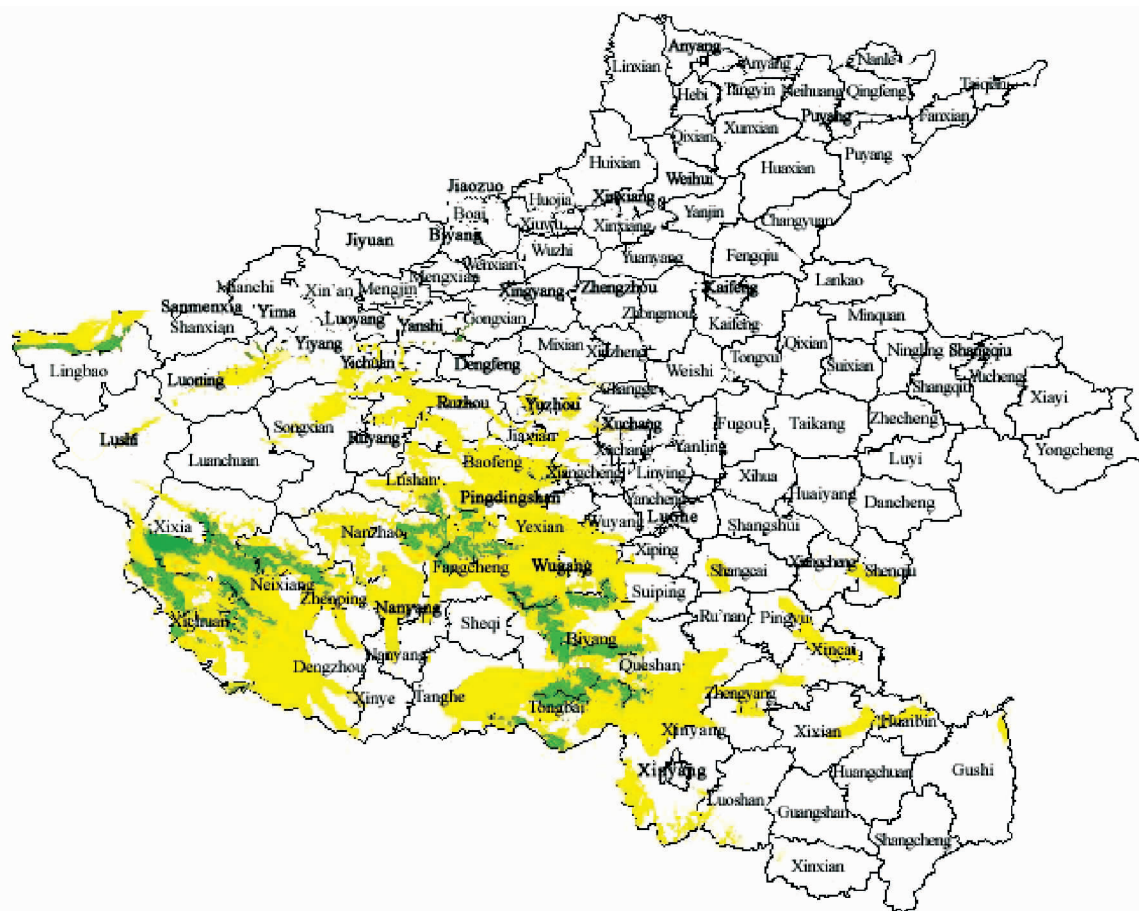


Fig.2 Regional division of Yu *Salvia miltiorrhiza* suitable producing areas in Henan Province when the similitude is in 90% to 100% (green part) and 80% to 90% (yellow part)

## 4 Conclusions and discussion

(i) With the help of the Traditional Chinese Medicine Geographic Information System (TCMGIS-I), we analyzed the ecological suitability of Yu *Salvia miltiorrhiza* in China and major producing areas of Henan Province. At the similitude of 90% to 100%, 9 provinces are suitable for planting Yu *Salvia miltiorrhiza*, and the theoretical distribution area is up to 30 9205 km<sup>2</sup>. Thus, we recommend taking these cities and counties as preferential regions for developing Yu *Salvia miltiorrhiza*.

(ii) Research results indicate that Yu *Salvia miltiorrhiza* has a wide suitable growth area in China. It can be planted in 10 provinces. This research will provide guidance for carrying out introduction and planting of Yu *Salvia miltiorrhiza* in China. However, in the real actual production, it is required to plant Yu *Salvia miltiorrhiza* in accordance with actual local conditions.

(iii) Research also shows that the suitable distribution area of Yu *Salvia miltiorrhiza* at the similitude of 90% to 100% is consistent with relevant historical records.

## References

[1] National Pharmacopoeia Committee. Pharmacopoeia of People's Republic of China [M]. Beijing: Chemical Industry Press, 2010. (in Chinese).

- [2] DING BZ, WANG SY. Henan plant flora Vol.3 [M]. Zhengzhou: Henan Science and Technology Press, 1997. (in Chinese).
- [3] Department of Health of Henan Province. Henan traditional Chinese medicine standard [M]. Zhengzhou: Zhongyuan Farmers' Press, 1992. (in Chinese).
- [4] Chinese Academy of Sciences, China Flora Editorial Committee. Chinese plant flora Vol. 66 [M]. Beijing: Science Press, 1977. (in Chinese).
- [5] CHEN SL, XIAO PG. Introduction of Chinese medicine sustainable utilization [M]. Beijing: Chinese Medicinal Science and Technology Press, 2006. (in Chinese).
- [6] SUN CZ, LIU ZQ, CHEN SL, et al. Design and realization of traditional Chinese medicine adaptability analyzing system based on GIS [J]. World Science and Technology - Modernization of Traditional Chinese Medicine, 2006, 8(3): 112 - 117. (in Chinese).
- [7] CHEN SL, QEI JH, SUN CZ, et al. Development of TCMGIS - I and its application in suitable producing area evaluation of Astragalus membranaceus [J]. World Science and Technology - Modernization of Traditional Chinese Medicine, 2006, 8(3): 47 - 53. (in Chinese).
- [8] XIAO XH, CHEN SL, CHEN SY. On Sichuan Aconitum conuclaei climate ecology suitability [J]. Resource Development and Protection, 1990, 6(3): 151 - 153. (in Chinese).
- [9] CHEN SL, XIAO XH, CHEN SY. Numerical zoning of Chinese medicinal plants [J]. Resource Development and Market, 1994, 10(1): 8 - 10. (in Chinese).