

## Distribution patterns of the contents of five biologically activate ingredients in the root of *Scutellaria baicalensis*

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**[ABSTRACT]** As an important herbaceous plant, *Scutellaria baicalensis* Georgi (Chinese skullcap) is geographically widespread and commonly used throughout the world. In the Chinese medicine market, *S. baicalensis* has been divided into two primary types, “*Ku Qin*” (WXR) and “*Tiao Qin*” (TST). Moreover, TST is also divided into different grades according to the diameter of roots. To explore the distribution patterns of the contents of five biologically activate ingredients (FBAI), we used six-year-old cultivated *S. baicalensis* and analyzed its growth characteristics as well as the quality difference among different types and diameters in roots. Throughout the entire root, we discovered that contents of the FBAI all initially increased and subsequently decreased from the top to the bottom of the roots. The baicalin content of WXR was less than that of TST. On the contrary, the contents of baicalein, wogonin, and oroxylin A in WXR were up to about two times higher than that in TST. We also found that the 0 to 40 cm part of the *S. baicalensis* root possessed about 87% of the root biomass and about 92% of the contents of the active ingredients.

**[KEY WORDS]** *Scutellaria baicalensis*; Distribution patterns; Type; Diameter; Biologically active ingredients

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### Introduction

*Scutellaria baicalensis* Georgi, is one of the most important herbaceous plants of the Lamiaceae family [1]. It is geographically widespread and widely used all over the world, especially in Japan, Korea [2], and other Southeast Asian countries. According to the historical materials of traditional Chinese medicine (TCM), *Scutellaria baicalensis* has been used as ethnobotanical herbs for various purposes, such as clearing away heat, promoting diuresis, cooling blood, and clearing away toxic materials, based on the theory of TCM. It has main treatment effects on the follow-

ing: night sweat, stuffy feeling in chest, vomit, fever, and others. However, it is now generally used to treat pneumonia, diarrhea [3], fever, jaundice [4], liver cirrhosis, and anxiety [5]. The effects have been attributed to the flavonoids [6] and phenol glycosides [7] contained in roots. The main medicinal ingredients are baicalin [8-9], wogonoside [10-11], baicalein [12-13], wogonin [14-15], and oroxylin A [16-17] (Fig. 1). *S. baicalensis* has been proven to possess various bioactivities, such as anti-inflammatory [18-19], antibacterial [20], anticoagulant [21], antitumor [22-23], liver protection [24], cardiovascular protection [25], antioxidant [26], anticancer [27-28] activities and inhibition of HIV-RT [29-30]. Due to its properties of absorbing ultraviolet light and dyeing, it also has been widely used in cosmetics and fabric dyeing [31]. In recent years, with constant enlargement of *S. baicalensis* application domain, the demand for *S. baicalensis* is increasing, which leads to the depletion of its wild resources. As a consequence, more and more cultivated *S. baicalensis* is circulating in the market instead of wild *S. baicalensis*. However, Yu J *et al.* [32] have discovered the quality of cultivated *S. baicalensis* is unstable. Therefore, it is important to study *S. Baicalensis*, especially

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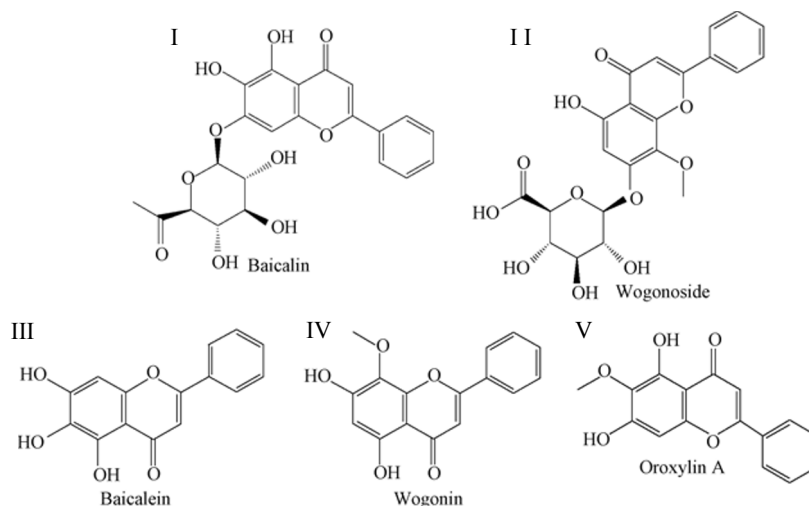


Fig. 1 Structures of baicalin (I), wogonoside (II), baicalein (III), wogonin (IV), and oroxylin A (V)

the quality of medicinal materials and the influencing factors.

According to the historical materials of TCM, the appearance of Chinese medicinal materials is an important index to evaluate their quality. According to its appearances, *S. baicalensis* had been divided into two main types, “*Ku Qin*” and “*Tiao Qin*”. “*Ku Qin*” refers to *S. baicalensis* with xylem rotten (WXR), and the strip type of *S. baicalensis* is commonly called “*Tiao Qin*” (TST) (Fig. 2). Moreover, according to its diameter, TST had been divided into different grades, the first diameter grade of *S. baicalensis* is 1–1.5 cm, the second is 0.4–0.8 cm, and the lowest grade is less than 0.4 cm<sup>[33]</sup>. The ancient Chinese physicians thought that WXR and TST also had the effect of purging fire; WXR was good at clearing lung fire, but TST was good at clearing away large intestine's fire. The different effects of the varieties were incarnated in the different contents of biologically active ingredients to some extent. According to Li's research<sup>[34]</sup>, the sum of baicalin, wogonoside, baicalein and wogonin contents in TST is approximately 25% higher than that in WXR. Since the growth years are not unified among the

different medicinal materials, one cannot eliminate the impact of growth years on the contents of their biologically active ingredients. In our research, we have discovered the segments that are close to the fibrous root are WXR, and the others are TST<sup>[33]</sup>. Extending to the root tips, the diameter of TST gradually becomes smaller. Therefore, it is significant to study the contents of biologically active ingredients in different types and diameters of *S. baicalensis* for analyzing their quality.

Guo *et al.*<sup>[35]</sup> have discovered the distribution patterns of the contents of activate components in taproot and stolon of *Glycyrrhiza uralensis* Fischer, but there has been no relevant report about *S. baicalensis*. In the present study, the cultivated roots of *S. baicalensis* (100 cm length, 6 years old) were collected, and the distribution patterns of the contents and the amounts of the five biologically active ingredients (FBAI) in different segments of the roots were investigated. The purposes of this study were two folds: (1) to investigate the contents of biologically active ingredients in roots of different types and diameters, based on the premise of excluding individual and microenvironment differences, and (2) to provide a theoretical basis for selecting the particular part of roots as raw materials to extract and analyzing the different contents of the FBAI in segments from the same plant.

## Materials and Methods

### Materials

The cultivated six-year-old *S. baicalensis* were collected from Luanping of Chengde city in Hebei, China, on October 2014, and were identified as *Scutellaria baicalensis* Georgi by Professor Shengli Wei, Beijing University of Chinese Medicine, Beijing, China.

Nine cultivated roots were collected and divided into three groups with three in each group. The roots were then cut into consecutive 5-cm segments from the fibrous head to one meter for a total of 60 samples each (Fig. 3). All of the sam-



Fig. 2 Different types of *Scutellaria baicalensis* roots in different segments

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