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Analysis of the Response and Benefits of Medicinal Plant Chinese Skullcap (*Scutellaria baicalensis*) to Ecological Environment under Different Planting Modes

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Abstract This study explores the response and benefits of the medicinal plant *Scutellaria baicalensis* to the ecological environment under different planting modes, aiming to gain a deeper understanding of its ecological characteristics and the impact of planting modes. This study analyzes the ecological characteristics of *Scutellaria baicalensis*, with a focus on its growth environment requirements. Further investigation into the impact of different planting modes on the ecological environment, including traditional cultivation, organic farming, and comparison between hydroponics and soil cultivation, is conducted. In arid regions, hydroponic cultivation demonstrates advantages, albeit with higher costs, while soil cultivation proves economically viable with broad adaptability. This study provides a detailed analysis of the benefits of *Scutellaria baicalensis* in the ecological environment, encompassing medicinal component content, soil improvement effects, and ecosystem services. Organic farming has a positive impact on increasing medicinal component content and improving soil quality. This study discusses continuous planting management and future prospects, emphasizing eco-friendly planting techniques and the practice of sustainable agriculture. Future research directions are proposed, including in-depth studies on the interaction between *Scutellaria baicalensis* and ecosystems, and exploration of new concepts and technologies for eco-friendly agriculture. This study offers a comprehensive overview of *Scutellaria baicalensis* cultivation, providing valuable insights for the sustainable development of agriculture and environmental conservation in the future.
Keywords Chinese skullcap (*Scutellaria baicalensis*); Planting modes; Ecological environment response; Benefit analysis; Sustainable agriculture

Chinese skullcap *(Scutellaria baicalensis)*, a perennial herbaceous plant belonging to the *Scutellaria* genus in the faily of Lamiaceae. It is found in regions such as Heilongjiang, Liaoning, Inner Mongolia, Hebei, Shandong, Sichuan, and other northern provinces of China. The roots of *Scutellaria baicalensis* can be used as herbs, with the Chinese name of Huángqín, known as Baical skullcap root in English. It has a bitter taste and a cold nature, and has the effects of "qīngrè zàoshī, xièhuǒ jiědú, zhǐxuè, āntāi (it roughly means that: clearing heat and drying dampness, relieving fire toxicity, arresting bleeding, and promoting fetal safety)" (Zhao et al., 2019). As a traditional Chinese medicinal herb with a long history, *Scutellaria baicalensis* holds a significant position in the traditional theories of Chinese medicine, showcasing its valuable medicinal properties.

With the development of modern medicine and an increasing focus on health, research and application of traditional herbal medicine have been more deeply explored. *Scutellaria baicalensis*, known as Huang-Qin in traditional Chinese medicine, not only has a long history in Chinese medicine but has also become a hot topic in the international medical community due to the research on its medicinal components. The active ingredients in *Scutellaria baicalensis*, especially baicalin, are believed to have anti-cancer, antiviral, and other beneficial effects. This has led to its frequent use in traditional Chinese medicine for treating conditions such as fever, colds, and hepatitis (Baradaran Rahimi et al., 2021). The acknowledgment of its medicinal value has also spurred increased attention to the ecological study of *Scutellaria baicalensis*, providing new directions and possibilities for contemporary medical research.

However, with the widespread cultivation and harvesting of *Scutellaria baicalensis*, some issues have gradually emerged. Traditional planting modes of *Scutellaria baicalensis* often involve extensive use of pesticides and fertilizers, imposing a certain burden on the ecological environment (Li et al., 2022). Concerns from both the academic community and agricultural producers have arisen due to declining soil quality, excessive water resource utilization, and disruptions to ecological balance. The ecological characteristics of *Scutellaria baicalensis*, including its adaptability to soil and climate, as well as its impact on ecosystems, have become critical research directions (Sun et al., 2023). In this context, the choice of planting mode is not only related to the economic benefits of agriculture but also crucial for the sustainable development of the ecological environment. Therefore, comprehensive and in-depth research on the response of *Scutellaria baicalensis* to the ecological environment under different planting modes is imperative.

This study aims to comprehensively understand the response of *Scutellaria baicalensis* to the ecological environment under different planting modes. It delves into the ecological characteristics of *Scutellaria baicalensis* and explores the impact of planting modes on its medicinal components. Through a systematic investigation and analysis of factors such as soil, water resource utilization, and ecosystem services during the cultivation of *Scutellaria baicalensis*, this study aims to reveal the ecological characteristics of *Scutellaria baicalensis* under different ecological conditions, providing a scientific basis for its more rational cultivation. By comparing the influence of different planting modes on the medicinal component content of *Scutellaria baicalensis*, practical guidance is offered to enhance its medicinal value. Additionally, the study analyzes the impact of *Scutellaria baicalensis* cultivation on soil structure and quality, providing insights and recommendations for achieving sustainable agricultural production.

Through the achievement of these research objectives, we aim to provide scientific foundations for the cultivation and production of *Scutellaria baicalensis*, promote the sustainable development of the *Scutellaria baicalensis* industry, and minimize the negative impact on the ecological environment. This aligns with the current societal expectations for sustainable development, making a positive contribution to the industrial upgrade of traditional Chinese medicine and the construction of an ecological civilization.

1 Ecological Characteristics of *Scutellaria baicalensis*

1.1 Growth environment requirements of *Scutellaria baicalensis*

1.1.1 Soil adaptability

Scutellaria baicalensis demonstrates strong adaptability to soil, primarily thriving in clayey and sandy soils. However, its adaptability to acidic and alkaline soils is relatively poor. Research indicates that *Scutellaria baicalensis* prefers neutral to slightly alkaline soils, aligning with its natural distribution in the wild (Li et al., 2022). Neutral soil conditions contribute to the normal growth and development of *Scutellaria baicalensis* roots, influencing the accumulation of its medicinal components. Nevertheless, further research is needed to delve into the regulation of soil acidity and alkalinity under different planting modes, as well as the impact on soil enzyme activity and microbial communities.

In addition to pH levels, *Scutellaria baicalensis* also has specific requirements regarding soil texture. The growth rate of *Scutellaria baicalensis* is slower in sandy soil, while it exhibits better adaptability in clayey soil. This is related to the development of its root system, as clayey soil provides a more favorable environment for root anchorage and development, facilitating the absorption of water and nutrients by the plants. Therefore, under different planting modes, the proper regulation and management of soil will directly impact the growth and development of *Scutellaria baicalensis*, consequently influencing the outcomes of its ecological responses.

1.1.2 Climate conditions

Scutellaria baicalensis exhibits a wide adaptability to climate, primarily thriving in warm conditions. Its optimal growth temperature typically falls within the range of 15°C to 30°C. Within this range, it demonstrates accelerated growth rates, allowing for a more robust accumulation of medicinal components. However, under colder climate

conditions, the growth of *Scutellaria baicalensis* may encounter certain limitations, posing challenges to cultivation and production in specific regions (Xu et al., 2020).

Climate factors have a direct impact on the ecological response of *Scutellaria baicalensis*. Against the backdrop of global climate change, long-term monitoring and research on the climate in regions where *Scutellaria baicalensis* is cultivated will contribute to a better understanding of its adaptability variations. This, in turn, will provide scientific foundations for future cultivation and management practices. Consequently, changes in climate conditions will become one of the focal points of attention.

1.2 Life cycle and reproductive characteristics of *Scutellaria baicalensis*

1.2.1 Seed germination of *Scutellaria baicalensis*

Seed germination is a critical stage in the life cycle of *Scutellaria baicalensis*, and the environmental conditions during seed germination directly impact the growth and development of its seedlings (Li et al., 2019). Typically, the seeds of *Scutellaria baicalensis* require a certain level of moisture and suitable temperatures for successful germination. Therefore, the treatment and management of seeds under different planting modes will directly influence the germination rate and early-stage growth of *Scutellaria baicalensis*.

The seed germination of *Scutellaria baicalensis* is also influenced by light conditions. Generally, its seeds require a certain amount of light for normal germination. Therefore, when selecting planting locations and planting density, careful consideration of lighting conditions will play a positive role in increasing the yield and medicinal component content of *Scutellaria baicalensis*.

1.2.2 Stem and leaf structure

The stem and leaf structure of *Scutellaria baicalensis* is closely related to its response to the ecological environment. Stem and leaves are vital organs for photosynthesis in plants and serve as the primary site for the accumulation of medicinal components in *Scutellaria baicalensis*. The structure and function of stems and leaves may vary under different planting modes. For instance, in hydroponic cultivation, the growth rate and photosynthetic intensity of stems and leaves may be relatively higher, while in soil cultivation, constrained by soil quality and root development, the growth of stems and leaves may be comparatively slower (Atherton and Li, 2023).

Studying the anatomical structure and physiological characteristics of stems and leaves will contribute to a deeper understanding of the adaptability of *Scutellaria baicalensis* to different ecological environments (Figure 1). By analyzing the stems and leaves, targeted adjustments and improvements can be made to the planting modes, thereby enhancing the ecological adaptability and yield of *Scutellaria baicalensis*.

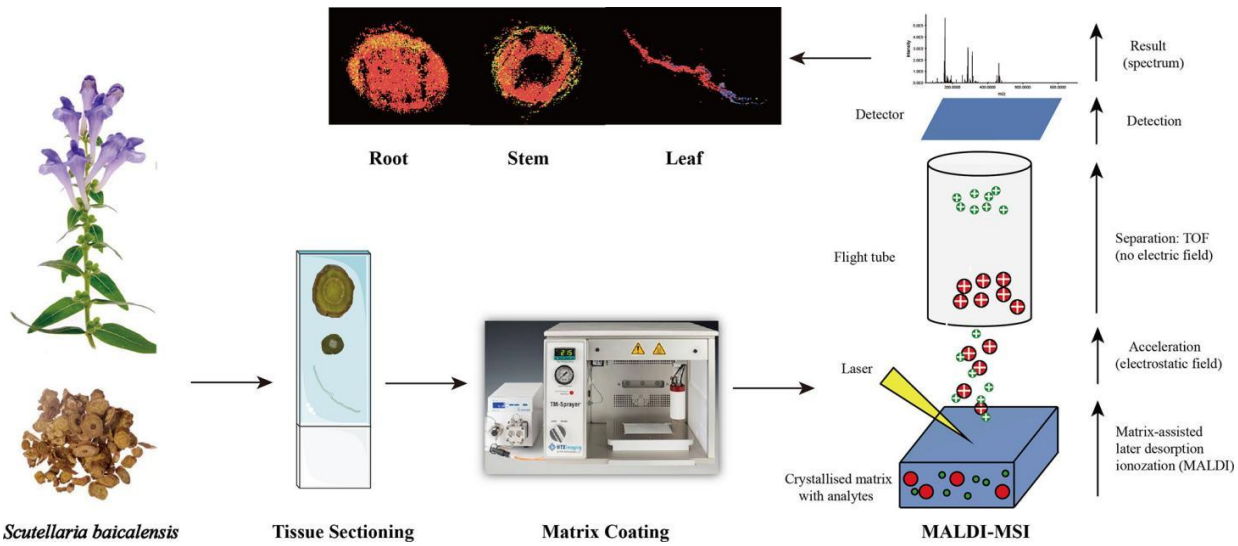

Figure 1 *Scutellaria baicalensis* plant and structural analysis (Zhou et al., 2023)

2 Impact of Different Planting Modes on the Ecological Environment Response of *Scutellaria baicalensis*

2.1 Traditional cultivation mode

2.1.1 Advantages and disadvantages of traditional planting methods

Traditional cultivation mode is a common method for cultivating *Scutellaria baicalensis*, and its advantages and disadvantages are reflected in the ecological environment response of *Scutellaria baicalensis* (Zou et al., 2016).

The advantages of traditional planting methods lie in the simplicity and familiarity for farmers, making it easy to operate. Under this approach, *Scutellaria baicalensis* is typically planted in open fields, utilizing traditional irrigation and fertilization methods. The management under this mode is relatively convenient, and the initial investment is relatively small.

However, the traditional cultivation mode also presents potential issues. For instance, there is a high reliance on pesticides and fertilizers, which may lead to soil pollution and ecosystem degradation. Moreover, the traditional planting methods may not optimize soil structure to the fullest extent, affecting the growth of *Scutellaria baicalensis* and the accumulation of its medicinal components. This has been one of the reasons prompting exploration into more sustainable planting modes in recent years.

2.1.2 Impact on soil structure and quality

Under the traditional mode of farming, frequent cultivation of the soil and excessive use of chemicals such as pesticides and fertilizers may lead to a decline in soil quality and structural disorders. The residues of pesticides and the excessive use of fertilizers not only affect the diversity and activity of soil microorganisms but may also trigger soil erosion and water pollution. This is a significant concern, particularly for plants like *Scutellaria baicalensis*, which are sensitive to soil conditions.

Changes in soil structure also directly influence water retention and aeration. This can potentially restrict the access of *Scutellaria baicalensis* to water and nutrients under traditional cultivation methods, thereby impacting its growth and the quality of medicinal components. Therefore, a more scientific approach to soil management is required for *Scutellaria baicalensis* cultivation under traditional farming practices, aiming to mitigate the declining trend in soil quality.

2.2 Organic farming mode

2.2.1 Adaptability of organic farming to *Scutellaria baicalensis*

Organic farming, as an environmentally friendly agricultural model, has gradually gained attention. In the cultivation of *Scutellaria baicalensis*, the organic farming mode, compared to traditional methods, emphasizes the protection of the ecological environment and respect for natural ecosystems.

Under the organic farming mode, *Scutellaria baicalensis* undergoes growth without the use of synthetic pesticides and fertilizers; instead, organic fertilizers and biological control methods are employed. This approach plays a positive role in alleviating soil burdens, enhancing soil biodiversity, and maintaining ecological balance (Yun et al., 2017). The principles and methods of organic farming align more closely with the operating laws of natural ecosystems, making it easier for *Scutellaria baicalensis* to establish a beneficial interaction with the ecological environment in this mode.

2.2.2 Positive effects of organic farming on the ecological environment

Under the organic farming mode, the cultivation of *Scutellaria baicalensis* is often accompanied by more scientific soil management practices, such as proper crop rotation and the use of green manure. This helps to improve soil structure, enhance soil fertility, and reduce the risk of soil pollution.

Organic farming also emphasizes the diversity of ecosystems. Under this mode, various plants may coexist in the fields, increasing the stability of the agricultural ecosystem. This provides a more natural environment for the growth and development of *Scutellaria baicalensis*, contributing to the maintenance of the richness of its medicinal components.

2.3 Hydroponic and soil cultivation modes

2.3.1 Impact of hydroponic and soil cultivation on the growth of *Scutellaria baicalensis*

Hydroponic and soil cultivation are two common modes in the cultivation of *Scutellaria baicalensis*, employing hydroponic systems and traditional soil cultivation systems, respectively. In the hydroponic system, the plant roots are exposed to water, and growth is achieved through nutrient supply in the water. This mode allows for precise control of nutrient content, favoring the enhancement of medicinal components. *Scutellaria baicalensis* exhibits faster growth and a more uniform plant structure in hydroponic systems (Geng et al., 2023).

In contrast, in the soil cultivation system, plant roots are anchored in the soil, obtaining necessary nutrients for growth from the soil. This mode aligns more with the natural growth pattern of plants. However, compared to hydroponics, soil cultivation mode has a higher reliance on soil quality and structure, which play a crucial role in plant growth.

2.3.2 Comparison of water and soil cultivation in water resource utilization

In comparison to soil cultivation, hydroponic cultivation is more water-efficient. In a hydroponic system, water is recycled, while in soil cultivation, water tends to be more susceptible to loss. This presents a certain advantage for the cultivation of *Scutellaria baicalensis* in arid regions. However, hydroponic cultivation also comes with some challenges, such as the need for additional equipment and energy input, resulting in relatively higher costs. On the other hand, soil cultivation is comparatively cost-effective and exhibits broader adaptability.

When choosing between hydroponic and soil cultivation modes, it is essential to consider factors such as water availability, soil quality, and climatic conditions comprehensively. This ensures the optimal balance between ecological responsiveness and yield benefits.

3 Benefits of *Scutellaria baicalensis* in the Ecological Environment

3.1 Medicinal component content

3.1.1 Impact of different planting modes on medicinal components

The medicinal value of *Scutellaria baicalensis* is primarily attributed to its flavonoid compounds, such as baicalin (10.11%), baicalein (5.41%), wogonoside (3.55%), wogonin (1.3%), and oroxylin A (Liao et al., 2021) (Figure 2). Different planting modes may influence the medicinal component content of *Scutellaria baicalensis*, thereby affecting its therapeutic effects.

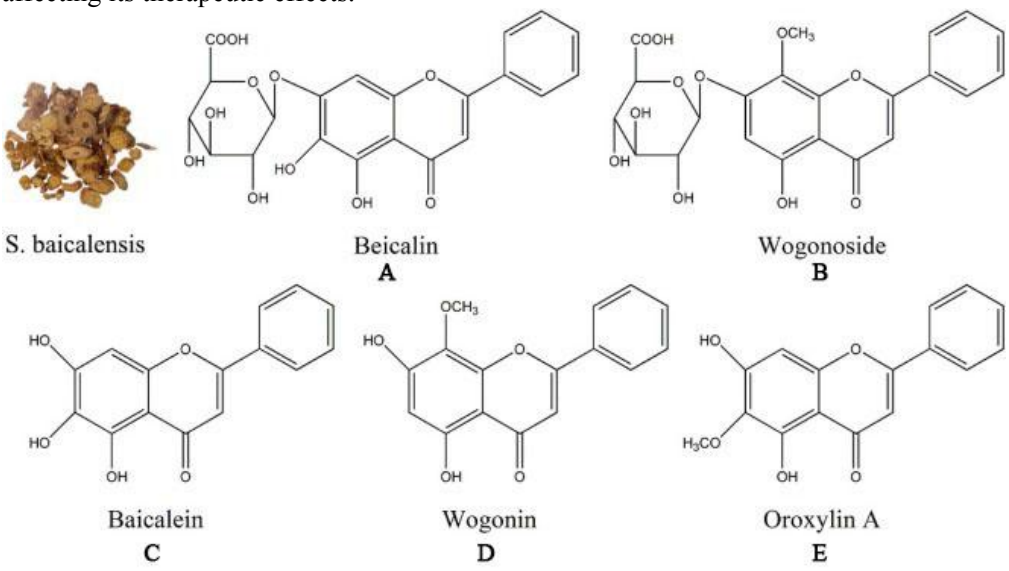

Figure 2 The chemical structures of flavonoid in *Scutellaria baicalensis* (Liao et al., 2021)

Note: A: Baicalein, B: Wogonoside, C: Baicalin, D: Wogonin, E: Oroxylin A

In hydroponic cultivation, precise control over nutrient supply may lead to a relatively higher content of baicalein in *Scutellaria baicalensis*, as suggested by research conducted in hydroponic systems (Grzelka et al., 2023). This could be attributed to the more accurate nutrient absorption by plants in hydroponic systems, facilitating the accumulation of medicinal components.

In contrast, traditional cultivation methods may face issues related to soil quality degradation and residual fertilizer, potentially negatively impacting the medicinal component content of *Scutellaria baicalensis*. Therefore, when selecting planting modes, it is essential to comprehensively consider various factors that may influence the medicinal component content of *Scutellaria baicalensis*.

3.1.2 Impact of organic farming on medicinal component content

Under the organic farming mode, due to the absence of chemical pesticides and synthetic fertilizers, the soil is more natural, and the ecosystem is more stable. This may provide a more suitable growth environment for *Scutellaria baicalensis*, thereby contributing to an increase in the content of medicinal components. The principles of organic farming are more in line with the natural growth of plants and are conducive to the accumulation of medicinal components.

Some studies suggest that the content of medicinal components in *Scutellaria baicalensis* is relatively higher under organic farming practices (Jiang et al., 2022). This could be attributed to the eco-friendly management of soil and plants in organic agriculture, making it easier for plants to synthesize medicinal components.

3.2 Soil Improvement effects

3.2.1 Biological and physical soil improvement effects of *Scutellaria baicalensis*

Scutellaria baicalensis has certain soil improvement effects, as the development of its root system and secretion during the growth process contribute to the enhancement of soil structure. Biologically, the root system of *Scutellaria baicalensis* can increase the organic matter content in the soil, thereby enhancing the diversity and activity of soil microorganisms. This is of significant importance for maintaining soil fertility and ecological balance (Do et al., 2021).

On the physical aspect, the root system of *Scutellaria baicalensis* also improves soil aeration and water retention. The rooting of the root system helps to slow down water loss, enhancing the soil's water retention capacity. Additionally, root growth contributes to soil loosening, mitigating soil compaction and improving soil aeration.

3.2.2 Comparison of soil quality under different planting modes

There may be variations in soil quality under different planting modes (He et al., 2023). In the organic farming mode, the ecologically friendly management of soil contributes to a relatively stable soil quality, better meeting the growth requirements of plants.

In contrast, in traditional cultivation modes, soil may bear a heavier burden due to excessive use of pesticides and fertilizers. This can lead to a decline in soil quality, structural disorder, and subsequently affect the growth and yield of *Scutellaria baicalensis*.

In the comparison between hydroponic and soil cultivation modes, the soil dependency is lower in hydroponic mode, making it more environmentally friendly. However, in some arid regions, soil cultivation mode may be more practical and feasible.

3.3 Ecosystem services

3.3.1 Contribution of *Scutellaria baicalensis* to ecosystem stability and services

Scutellaria baicalensis, a plant with significant medicinal value, plays a crucial role in the ecosystem. Its robust growth capabilities and soil improvement effects make it an indispensable component of the ecosystem (Ji et al., 2021).

The growth of *Scutellaria baicalensis* has a positive impact on the stability of the ecosystem. Its dense growth effectively enhances vegetation coverage, forming a stable plant community. This not only helps prevent soil erosion and slows down the rate of water and soil loss but also effectively maintains the integrity of soil structure. Additionally, *Scutellaria baicalensis* plays a crucial role in soil improvement. Its root system has strong permeability, contributing to improved soil aeration and water retention. By increasing the organic matter content in the soil, *Scutellaria baicalensis* further enhances soil water retention, reducing water loss and combating soil erosion under arid conditions.

The contribution of these ecosystem services not only elevates the esteem of *Scutellaria baicalensis* in the field of medicine but also actively contributes to maintaining local ecological balance. By preserving soil stability and the sustainability of water sources, *Scutellaria baicalensis* provides crucial support to the surrounding ecosystem, aiding in slowing down the degradation of the ecological environment.

3.3.2 Maintenance of local ecological balance through *Scutellaria baicalensis* cultivation

Whether the cultivation of *Scutellaria baicalensis* contributes to the maintenance of local ecological balance involves various factors. As a plant, *Scutellaria baicalensis* collaboratively builds vegetation within the ecosystem, contributing to the preservation of plant diversity. Additionally, the soil improvement effect during the growth process of *Scutellaria baicalensis* helps enhance soil fertility, providing a better growth environment for other plants. The growth of *Scutellaria baicalensis* may also attract natural predators, influencing the local ecological chain and increasing ecosystem stability (Wang et al., 2022).

However, caution is needed, as excessive cultivation of *Scutellaria baicalensis* may exert competition pressure on local plant diversity, affecting the normal growth of other plants. Therefore, in *Scutellaria baicalensis* cultivation, it is essential to consider the local ecological environment and scientifically formulate cultivation plans to achieve optimal ecosystem service benefits.

In conclusion, the benefits of *Scutellaria baicalensis* in the ecological environment are diverse. It not only promotes its own growth and yield but also has a positive impact on soil quality and the stability of the ecosystem. This provides a comprehensive scientific basis for the cultivation of *Scutellaria baicalensis*, aiming for sustainable development and environmentally friendly agricultural production.

4 Continuous Planting Management and Future Prospects

Continuous planting management is crucial for achieving the sustainable development of *Scutellaria baicalensis*. By adopting eco-friendly planting techniques, practicing circular agriculture, and delving into new concepts and technologies related to the interaction with ecosystems, more scientific and viable management approaches can be provided for the cultivation of *Scutellaria baicalensis.* This will contribute to the coordinated promotion of economic, social, and ecological benefits, aligning with the expectations for sustainable development.

4.1 Sustainable management of *Scutellaria baicalensis* cultivation

4.1.1 Eco-friendly planting techniques and management methods

To achieve sustainable cultivation of *Scutellaria baicalensis*, a series of eco-friendly planting techniques and management methods are essential. The promotion of organic farming is a key aspect, and it has demonstrated positive effects in *Scutellaria baicalensis* cultivation by reducing dependence on pesticides and fertilizers. This contributes to improving soil health and enhancing the ecological adaptability of plants (Yun et al., 2017). Introducing crop rotation and fallow systems helps improve soil structure, mitigate issues related to continuous cropping, and reduce the risk of soil-borne diseases. Such management practices not only contribute to maintaining the balance of the soil ecosystem but also enhance the yield and quality of *Scutellaria baicalensis*.

Furthermore, efficient irrigation management is crucial for sustainable cultivation. Precision irrigation systems help control water use efficiency, reduce water wastage, and enhance the drought resistance and ecological adaptability of *Scutellaria baicalensis.*

4.1.2 Practices and prospects of sustainable agriculture

Sustainable agriculture, emphasizing resource recycling and utilization, holds significant implications for the sustainable cultivation of *Scutellaria baicalensis*. In the sustainable cultivation of *Scutellaria baicalensis*, the application of composting agricultural residues and returning organic matter to the fields is employed in a circular agricultural approach, achieving the recycling of nutrients. This practice contributes to enhancing soil fertility, reducing dependence on chemical fertilizers, and promoting the overall health of the soil (Zhang and Wong, 2023).

Furthermore, adopting a circular agricultural model with a field-fishpond system involves using aquaculture wastewater for irrigation. This approach not only addresses the issue of wastewater disposal but also provides essential nutrients for plant growth. Such a system has positive effects on water resource management and nutrient supply for Chinese Skullcap cultivation.

4.2 Future research directions

Future research can delve more deeply into the interaction between *Scutellaria baicalensis* and its ecosystem. This includes exploring its relationships with other plants, soil microorganisms, insects, and more. Utilizing systematic ecological research methods can provide a more comprehensive understanding of the role and function of *Scutellaria baicalensis* in the ecosystem, offering more precise management strategies for its sustainable cultivation. For instance, in-depth investigations into the interaction mechanisms between *Scutellaria baicalensis* and soil microorganisms can optimize the structure of soil microbial communities, enhancing the ecosystem services of the soil (Do et al., 2021). Simultaneously, studying the competition and symbiotic relationships between *Scutellaria baicalensis* and other plants can aid in designing planting patterns that maintain vegetation diversity.

Future research should also focus on new concepts and technologies in the development of eco-friendly agriculture to better address challenges posed by climate change and limited resources. New concepts involve applying ecosystem services theory to *Scutellaria baicalensis* cultivation, achieving a harmonious symbiosis between agriculture and natural ecosystems. Leveraging modern technologies such as big data and artificial intelligence can precisely monitor and manage the growth process of *Scutellaria baicalensis*, enhancing the benefits of ecosystem services (Xu et al., 2020). Regarding new technologies, exploring advanced cultivation techniques, such as gene editing, for improving stress resistance of *Scutellaria baicalensis* and yield is essential. Additionally, researching advanced agricultural equipment and smart irrigation systems can elevate the level and efficiency of agricultural production.

In-depth exploration of these new concepts and technologies in the future can provide more insights and solutions for the sustainable cultivation of *Scutellaria baicalensis* and the development of eco-friendly agriculture.

5 Conclusion

Through a comprehensive analysis of the ecological responses and benefits of *Scutellaria baicalensis* under different planting modes, the following conclusions can be drawn. In the choice of planting modes, organic farming proves more favorable in increasing the medicinal component content of *Scutellaria baicalensis* compared to traditional cultivation methods. Additionally, it has a positive impact on soil quality and the ecosystem. The environmental principles and soil-friendly management practices of organic farming provide a more suitable growth environment for *Scutellaria baicalensis*, contributing to the maximization of ecosystem services.

Hydroponic and soil cultivation modes each have their advantages and disadvantages. Hydroponic cultivation promotes faster growth and higher medicinal component content in *Scutellaria baicalensis* but requires more equipment and energy input. Soil cultivation, on the other hand, is more economical but relies heavily on soil quality and requires careful management. When selecting a planting mode, consideration of soil conditions, water resources, and economic costs is crucial to achieve maximum comprehensive benefits.

In terms of continuous planting management, the introduction of organic and circular agriculture helps enhance soil fertility, reduce dependency on chemical fertilizers, and further optimize the ecosystem structure. Circular agriculture practices, through resource recycling and utilization, achieve nutrient cycling and promote sustainable agricultural development.

The comprehensive study on the planting modes and management methods of *Scutellaria baicalensis* provides valuable insights for the future of agriculture and environmental protection. On one hand, eco-friendly agricultural models are becoming a trend in future agricultural development. The introduction of organic farming not only improves the quality of agricultural products but also reduces negative environmental impacts. By promoting organic and circular agricultural models, a harmonious interaction between agricultural production and natural ecosystems can be achieved, offering feasible solutions for agriculture and environmental conservation.

Furthermore, the role of technological innovation in future agriculture should not be overlooked. The introduction of new technologies, such as gene editing and smart irrigation systems, can enhance agricultural productivity and reduce resource waste. Technology can also provide more precise monitoring and management tools for agriculture, achieving intelligent and sustainable development. In future research, a deeper exploration of the interaction mechanisms between plants and ecosystems is necessary. Through a thorough understanding of the ecological characteristics of plants, better planting management plans can be formulated, achieving both efficient agriculture and environmental protection.

In summary, a comprehensive study on the planting modes and management methods of *Scutellaria baicalensis* can provide beneficial experiences and insights for the future of agriculture and environmental protection. While pursuing agricultural production efficiency, attention must also be given to the health of ecosystems, achieving a harmonious unity of economic, social, and ecological benefits.

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