Pol. J. Environ. Stud. Vol. XX, No. X (XXXX), 1-9
DOI: *10.15244/pjoes/211159* ONLINE PUBLICATION DATE: 2026-06-30

Original Research

Ethnobotanical Studies on the Medicinal and Food Plants of the *Argentina anserina* of the Qinghai-Tibet Plateau

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Received: 23 February 2025
Accepted: 21 September 2025

Abstract

Argentina anserina（*A. anserina*, a perennial herb endemic to the Qinghai-Tibet Plateau, develops unique root structures commonly referred to as "ginseng fruit." These roots possess significant nutritional and medicinal properties. This study utilizes ethnobotanical methodologies to document the traditional knowledge associated with *A. anserina* among Tibetan communities in the Qinghai-Tibet Plateau region, supplemented by food science analyses to ascertain its fundamental nutritional composition. The principal findings indicate that *A. anserina* plays a multifaceted role in traditional Tibetan livelihoods. Quantitative analyses reveal that its edible (RFC0.92) and medicinal (RFC0.78) applications significantly exceed other uses in terms of relative citation frequency, establishing these as the predominant utilization patterns. Traditional harvesting methods yield *A. anserina* specimens characterized by high dietary fiber content, low sodium levels, abundant amino acids, and a diverse array of mineral elements. These findings highlight the substantial potential for the development and utilization of *A. anserina*. Strategic artificial cultivation could enhance production, potentially increasing residents' income and promoting rural revitalization in remote areas. This investigation provides a theoretical foundation for the subsequent processing and utilization of edible *A. anserina*.

Keywords: *A. anserina*, Qinghai-Tibet Plateau, Tibetans, traditional knowledge, medicinal and food plants

Introduction

Argentina anserina (*A. anserina*), a perennial herbaceous species within the genus *Argentina* of the *Rosaceae* family [1], is indigenous to North America, Asia, and Europe. In China, it is distributed across the northern and southwestern regions, yet it notably forms tuberous roots exclusively on the Qinghai-Tibet Plateau, where it is colloquially known as the "ginseng fruit", and is thus extensively harvested by local residents (Fig. 1a-c). At lower altitudes, the roots of *A. anserina* remain non-tuberous, and the plant is predominantly

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utilized as forage and ground cover, commonly referred to as "goose-down cinquefoil" (Fig. 1d-f) [1-2]. The tuberous roots of *A. anserina* are abundant in dietary fiber, starch, protein, triterpenoid saponins, amino acids, vitamins, and minerals [3, 4], and they demonstrate considerable nutritional and medicinal properties. These properties include immune enhancement, blood glucose regulation, cholesterol reduction, antioxidant and anti-inflammatory effects, and cardiovascular disease prevention [4-8], establishing it as a distinctive medicinal and nutritional resource of the Qinghai-Tibet Plateau.

The utilization of *A. anserina* is closely intertwined with the cultural customs of Tibetan communities in this region. Historically, the whole plant has been used in traditional Chinese medicine (TCM) to treat hematemesis and remains a cornerstone of Tibetan traditional medicine and folk remedies [3]. In ancient times, Tibetans offered "*A. anserina*" as tribute to emperors and lamas, and it is still often given as a gift today [3].

The Qinghai-Tibet Plateau, commonly referred to as the "Third Pole" and the "Roof of the World," is a unique geomorphic unit and the world's highest plateau [9, 10]. Historically, the region's isolation, limited arable land, and low crop yields necessitated reliance on wild edible plants as vital livelihood supplements [11, 12]. Over millennia, Tibetan communities have developed a unique traditional knowledge of utilizing wild edible plants, which supports their survival and health. In recent years, research on wild edible plant resources has emerged as a key focus in ethnobotany, garnering widespread attention for its role in preserving traditional knowledge and promoting sustainable resource use [13, 14]. While extensive ethnobotanical studies have been conducted in regions such as Yunnan and Inner Mongolia [15-20], the Qinghai-Tibet Plateau remains underexplored.

Materials and Methods

Overview of the Study Area

The Qinghai-Tibet Plateau (TP), located in southwestern China, spans 26°–39° N latitude and 73°–104°E longitude, covering an area of approximately 2.5 million square kilometers – one-fourth of China's total land area [21, 22]. It includes the Tibet Autonomous Region (TAR), Qinghai Province (QHP), Sichuan Province (SCP), and parts of Yunnan Province (YNP) and Xinjiang Autonomous Region (XAR). As the highest plateau on Earth, with an average elevation exceeding 4,000 meters, it is commonly referred to as the "Roof of the World" and the "Third Pole of the Earth" [23, 24]. Dominated by alpine meadows and

Fig. 1. (a)-(c): Tibetan *A. anserina* harvesting on the Qinghai-Tibet Plateau; (d)-(f): field habitats and morphological characteristics of *A. anserina* on the Qinghai-Tibet Plateau; (g)-(i): ethnobotanical surveys of *A. anserina*; (j)-(l): *A. anserina* products or foods made from *A. anserina* on the Qinghai-Tibet Plateau.

grasslands, the region constitutes one of the world's most environmentally challenging pastoral areas. Its alpine meadow and grassland ecosystems are highly vulnerable and sensitive to climate change [9, 10, 25].

Ethnobotanical Methods

In the selection of investigation sites, this study established specific criteria to meet the conditions of ethnobotanical investigation [16]. The selected sites included natural villages with relatively concentrated populations, a history of over 100 years of residence, 50-80 households per site, well-preserved traditional culture with minimal external influence, and being primary production areas of *A. anserina*. Based on these criteria, six sites on the Qinghai-Tibet Plateau were chosen for ethnobotanical surveys (Fig. 1g-I; Fig. 2).

The ethnobotanical field survey method involved visits to the six selected sites and interviews with 86 informants, including key individuals such as elders, village leaders, and herbalists. Through key person interviews and semi-structured interviews, detailed information on the traditional utilization of *A. anserina* was gathered, including collection methods, edible parts, processing techniques, and other uses [16].

Voucher specimens of *A. anserina* were collected, with plant growth seasons and habitats recorded. The specimens were numbered and identified by Associate Researcher Yang Jingtian of the Key Laboratory of Ecology of Sichuan Province, following the Flora Reipublicae Popularis Sinicae (FRPS). All voucher specimens and photographs were archived at the Key Laboratory of Ecology of Sichuan Province.

For quantitative analysis, the Relative Citation Frequency (RFC) method was employed to assess the cultural importance of *A. anserina*. RFC was calculated as:

$$RFC = FC/N$$

Where FC is the number of respondents mentioning a specific use, and N is the total number of respondents. RFC values range from 0 to 1, with higher values indicating greater cultural importance. The importance of each wild edible plant was determined by its FC value, allowing for the ranking of species based on their cultural significance [15].

Scientific Approach to Food

A. anserina samples were collected from each of the six traditional knowledge investigation sites and pre-treated for analysis. The collected samples were first washed with tap water, rinsed with deionized water, and excess water was removed using gauze. The samples were then dried naturally in a cool, ventilated environment. After drying, the samples were crushed through a 100-mesh sieve and stored in a desiccator for further analysis.

Nutritional and chemical analyses were conducted following Chinese national standards (GB). Ash content was determined using the first method of GB5009.4-2016, fat content was measured using the Soxhlet extraction method (GB 5009.6-2016), and protein content was analyzed using the Kjeldahl method (GB 5009.5-2016). Dietary fiber was quantified

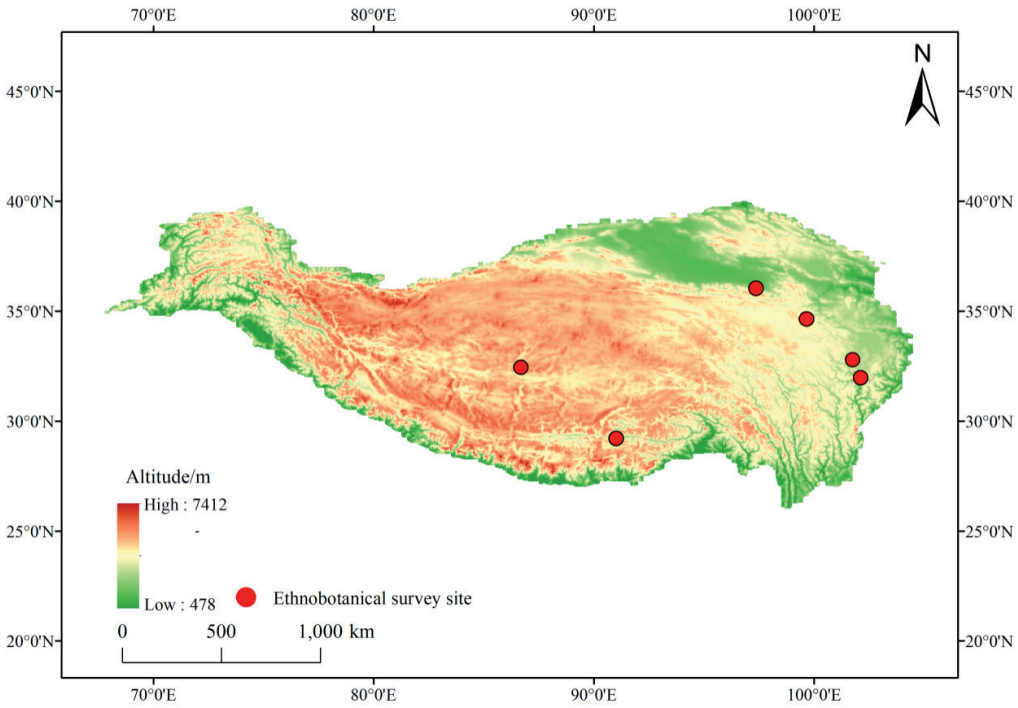

Fig. 2. Traditional knowledge survey points on *A. anserina* utilization.

according to GB5009.88-2014, while crude fiber was determined using GB/T 5009.10-2003. Amino acids were analyzed following GB 5009.124-2016, and fatty acids were measured using the external standard method with hydrolysis-extraction pretreatment (GB 5009.168-2016). Starch content was determined using the acid hydrolysis method (GB 5009.9-2016), total saponins were quantified according to the Health Food Physical, Chemical and Hygienic Indicators Inspection and Evaluation of Technical Guiding Principles" (2020 Edition), total flavonoids were analyzed using SN/T 4592-2016, and tannins were measured following NY/T 1600-2008. Selenium content was determined using hydride atomic fluorescence spectrometry (GB 5009.93-2017), and other mineral elements were analyzed using inductively coupled plasma emission spectrometry with microwave digestion (GB 5009.268-2016).

These standardized methods ensured the accuracy and reliability of the nutritional and chemical analyses, providing a comprehensive understanding of the composition and value of *A. anserina*.

Results and Discussion

Characteristics of Informants

Across the six survey sites, a total of 86 informants were selected. The majority of these informants were male, with ages predominantly concentrated between 41 and 60 years. Most informants had attained a primary school education level. Analysis of the survey results indicates that once the number of informants exceeded 30, no new traditional knowledge regarding the utilization of *A. anserina* emerged. Consequently, we consider the sample size of 86 informants to be sufficient to represent the traditional knowledge concerning the utilization of *A. anserina* within the studied communities of the Qinghai-Tibet Plateau region.

Multi-Purpose Analysis of *A. anserina*

The ethnobotanical survey revealed that *A. anserina* is utilized by Tibetans in the Qinghai-Tibet Plateau region for multiple purposes, including food, medicine, forage, ecological applications, and dyes (Table 1). The Relative Citation Frequency (RFC) was used to quantify the cultural importance of each use, with higher RFC values indicating greater local significance. Analysis of RFC values for *A. anserina* showed the following ranking: edible value>medicinal value>forage value>brewing value>dye value. The significantly higher RFC for edible use underscores its primary importance as a food resource for local communities. These findings highlight that *A. anserina* is a culturally significant plant, particularly valued for its edible and medicinal applications on the Qinghai-Tibet Plateau.

Connotation of Food Culture of *A. anserina*

In the Tibetan food culture of the Qinghai-Tibet Plateau, *A. anserina* holds a position of significant importance. Although widely available in natural grasslands across the region, it is often used as a "tribute" or "gift" and served as a delicacy during auspicious occasions to express joy and goodwill. The symbolic use of plants to convey emotion is a distinctive feature of Tibetan traditional culture in this region. This study examines the role of *A. anserina* in Tibetan dietary culture through three dimensions: raw material selection, presentation, and dietary metaphors (Table 2). The choice of raw materials reflects the level of food production technology. This is influenced by geographic environment, technological advancement, and economic development. In the traditional production of *A. anserina*. Methods are predominantly manual, emphasizing simplicity, naturalness, and ecological harmony. The presentation highlights cultural preferences for color, shape, taste, and texture. Tibetans in the Qinghai-Tibet Plateau region favor the natural color and geometric symmetry of dietary products. They prefer sweet flavors over spicy ones, often preparing *A. anserina* as desserts or sweet porridge. Dietary metaphors reveal how food is perceived both as a physical entity and a cultural symbol. Due to the limited variety of food resources in Tibet, most dietary items are natural, leading Tibetans to imbue the natural foods they consume with cultural significance.

Table 1. Uses of *A. anserina* on the Qinghai-Tibet Plateau.

Value	Utilization area	Relative citation frequency
Food value	Starchy tuber on the roots of plants	0.92
Medicinal value	Starchy tuber on the roots of plants	0.78
Feeding value	Whole plant	0.57
Oenological value	Starchy tuber on the roots of plants	0.05
Value of dyestuffs	Stem and leaf	0.04

Table 2. Tibetan food culture patterns on the Qinghai-Tibet Plateau using *A. anserina* as a carrier.

Name	Raw materials	Presentation	Food and drink metaphor
Tibetan confectionery	The main ingredients are fresh milk, ghee, tulsi, *A. anserina*, brown and white sugar, raisins, red dates, etc.	Pastry (patterned, round, rectangular, square, semicircular, etc.) Sweet, natural color	It is a symbol of good luck, harvest, and celebration.
A. anserina rice	Rice, ghee, *A. anserina*, brown and white sugar, raisins, dates, etc.	Rice, sweet, natural color	Ceremonial Symbol, Metaphorical Blessing for the Couple
stir-fried rice with green oil	Starch (soybean, barley, or buckwheat noodles), *A. anserina*, oil, sesame seeds	Onigiri, sweet, natural color	/
A. anserina in oil sauce	Ghee, *A. anserina,* sugar	*A. anserina* grains, sweet, natural color	Symbols of festivals are used as metaphors for good luck, harvest, celebration, etc.
Stir-fried *A. anserina*	Fried barley, boiled and dried *A. anserina*	Barley grain, sweet flavor, natural color	Joyous festivities
A. anserina congee	Congee, *A. anserina*	Porridge, sweet, natural color	/

The Medicinal and Cultural Connotations of *A. anserina*

In the daily lives of Tibetans residing on the Qinghai-Tibet Plateau, *A. anserina*i serves as a crucial medicinal herb. As illustrated in Table 3, the entire plant is utilized for its therapeutic properties to address a range of ailments, including intestinal bleeding, dryness, gastric adhesions, and eye disorders. Additionally, it is employed to replenish blood, invigorate the spleen, promote digestion, and enhance overall health and vitality. The Qinghai-Tibet Plateau is the highest inland plateau in Asia. Its climatic conditions are characterized by low temperatures, significant diurnal temperature variations, prolonged sunlight, intense solar radiation, low humidity, and substantial regional differences in annual precipitation [9-10]. These harsh environmental conditions, combined with limited accessibility and underdeveloped medical infrastructure, have necessitated the reliance of Tibetans on medicinal plants like *A. anserina* for disease prevention and treatment. Over centuries of practice, Tibetan communities have developed a deep understanding of the properties and functions of *A. anserina*, accumulating extensive traditional knowledge and fostering a rich medical culture centered on its use.

A. anserina is predominantly found as a wild food and medicinal plant on the Qinghai-Tibet Plateau. It is used to prepare six distinct diets, reflecting its culinary significance (Table 2). And it serves as a key ingredient in four medicinal recipes for treating common ailments, underscoring its medicinal value (Table 3). Wild food plants like *A. anserina* not only address food shortages but also play a crucial role in ensuring community livelihood security and generating economic income [15-16]. The fragile ecosystems of the Qinghai-Tibet Plateau, coupled with its challenging climatic conditions, result in limited arable land and low crop

Table 3. Mode of medicinal use and efficacy of Pterocarpus indicus on the Qinghai-Tibet Plateau.

Medicinal part	Processing method	Usage	Potency
Whole plant	Decoction of *A. anserina* leaves, Tannenbaum, Schisandra, brown sugar, etc.	Ingest	Small intestine bleeding, dryness of the small intestine, adhesion to the stomach lining, and eye closure not working
Bracken leaf	Medicinal use of bamboo rhubarb, Tibetan rhubarb, sub rhubarb, turmeric, gentian, gentiana, *A. anserina* leaves, artemisia, bean flower shellfish, tile reed, etc., mashed	Apply externally	Stopping bleeding through astringency, relieving cough and inducing phlegm, treating various types of bleeding and dysentery, it also has a nourishing effect
Starchy tuber on the roots of plants	Stir-frying and cooking	Ingest	Stopping hot diarrhea, strengthening the stomach and replenishing the spleen, promoting the production of body fluid and quenching thirst, benefiting the vital energy, and replenishing blood
Starchy tuber on the roots of plants	Serve with beef and mutton stews	Ingest	Strengthening and malnutrition

yields, making local communities heavily dependent on natural resources. *A. anserina*, typically cultivated as a tuberous root, thrives even in saline and alkaline soils. Its "scattering" reproductive strategy enhances soil coverage [26], contributing to ecological sustainability. The utilization of *A. anserina* by Tibetans thus embodies both ecological and cultural significance.

Nutrient Analysis of *A. anserina*

Wild vegetables remain a crucial dietary component for people in remote or impoverished mountainous regions of developing countries [27-29]. They provide essential nutrients such as carbohydrates, proteins, vitamins, minerals, and fiber, while some species also possess medicinal properties that contribute to local healthcare and disease prevention [26, 27]. The basic components and active substances in *A. anserina* were analyzed, with results for ash, fat, protein, crude fiber, dietary fiber, starch, total saponins, total flavonoids, and tannins presented in Table 4. The analysis revealed a fat content of 1.31 g/100 g, protein content of 13.7 g/100 g, dietary fiber content of 16.4 g/100 g, and a notably high starch content exceeding 50%. Compared to cultivated root vegetables in the Chinese Food Composition Table (CFCT), *A. anserina* from the Qinghai-Tibet Plateau contains significantly higher levels of ash, fat, dietary fiber, and starch, while its crude fiber content is comparable [30]. These findings underscore the high nutritional and health-promoting value of *A. anserina*, which is vital for enhancing daily dietary nutrition and maintaining health.

Studies have demonstrated that saponins exhibit anti-hypoxia and anti-hepatitis B virus properties, with clinical efficacy surpassing commercially available products and no reported toxic side effects [31]. In this study, the average saponin content was 1.82 g/100 g, indicating relatively low levels. This necessitates the extraction of saponins from large quantities of *A. sanserina*, resulting in high-value products with elevated costs. Therefore, screening germplasm resources with high saponin content for artificial cultivation is imperative. Additionally, *A. anserina* is rich in flavonoids (1.54 g/100 g) and tannins (1.63 g/100 g), which, along with saponins, contribute to its unique efficacy in treating high cholesterol, enhancing immunity, and providing antioxidant and anti-inflammatory benefits [32]. These properties further validate its role in blood glucose regulation, cholesterol reduction, and cardiovascular disease prevention. In summary, *A. anserina* is a distinctive wild vegetable with significant nutritional and medicinal value, making it a valuable resource for dietary and healthcare applications.

Mineral elements are critical for human physiological functions, and imbalances in trace elements can lead to disorders and diseases. *A. anserina* provides a valuable source of these essential minerals, with a notably low sodium content that is particularly beneficial for preventing and managing kidney disease and hypertension [27]. This plant is exceptionally rich in macronutrients such as potassium (1211 mg/100 g), calcium (171.7 mg/100 g), and magnesium (102.7 mg/100 g), as shown in Table 5; these levels significantly exceed those found in common vegetables like cabbage, spinach, and celery, as well as other wild vegetables. The potassium content aligns with the "safe and appropriate intake" range of 1875-5625 mg/day recommended by the Chinese Nutrition Society, while the calcium content contributes meaningfully towards the recommended daily intake of 800-1000 mg [33-34], making *A. anserina* an excellent natural source of these minerals. Furthermore, *A. anserina* contains essential trace elements, including iron (19.9 mg/100 g), zinc (2.50 mg/100 g), manganese, and copper (0.578 mg/100 g), all present at higher concentrations than typically found in common vegetables. Iron and copper play vital roles in maintaining normal physiology, delaying aging, and preventing anemia [35], and zinc supports nervous system development, immune function, and wound healing [36]. These findings collectively highlight the significant potential of *A. anserina* to enhance dietary

Table 4. Determination of conventional nutrient and active substance contents of *A. anserina* in the Qinghai-Tibet Plateau region (g/100 g).

Norm	Quantity contained
Ash content	3.5
Fat	1.31
Carbohydrate	13.7
Crude fiber	3.4
Dietary fiber	16.4
Total saponin	1.82
Total flavonoids	1.54
Tannin	1.63
Aamylum	50.1

Table 5. Determination of mineral element content of *A. anserina* on the Qinghai-Tibet Plateau (mg/100 g).

Minerals	Quantity contained
Fe	19.9
Mg	102.7
Se	0.46
Na	8.69
Cu	0.578
Zn	2.50
K	1211
Ca	171.7

nutrition by providing a valuable source of diverse, essential minerals crucial for human health.

Seventeen amino acids were identified in *A. anserina* from various origins, including seven essential, two semi-essential, and eight non-essential amino acids. The type, content, and composition ratio of essential amino acids are critical indicators of nutritional value, with closer alignment to human requirements indicating higher quality [31]. Branched-chain amino acids (BCAAs)-leucine (Leu), isoleucine (Ile), and valine (Val)-which cannot be synthesized by the human body and must be obtained through diet, accounted for 14.4% of the total amino acid content in *A. anserina* from the Qinghai-Tibet Plateau (Table 6), making it a valuable dietary source of BCAAs. Medicinal amino acids, including arginine (Arg), aspartic acid (Asp), glutamic acid (Glu), glycine (Gly), leucine (Leu), lysine (Lys), methionine (Met), phenylalanine (Phe), and tyrosine (Tyr), constituted 68.0% of the total amino acid content, highlighting the plant's therapeutic potential. Additionally, flavor-enhancing amino acids such as alanine (Ala), aspartic acid (Asp), glutamic acid (Glu), glycine (Gly), phenylalanine (Phe), and tyrosine (Tyr) accounted for 35.4% of the total content. Notably, glutamic acid (12.22%) contributes to the umami flavor, while alanine and glycine (8.79%) impart sweetness, enhancing the palatability of *A. anserina*. These findings underscore the dual value of *A. anserina* as both a nutritious food and a medicinal resource, with its amino acid composition contributing to both health benefits and sensory appeal.

Table 6. Determination of amino acid content in *A. anserina* produced on the Qinghai-Tibet Plateau (g/100 g).

Amino acid profile	Quantity contained
Aspartic acid (Asp)	0.95
Threonine (Thr)#	0.25
Serine (Ser)	0.29
Glutamic acid (Glu)	0.88
Glycine (Gly)	0.27
Alanine (Ala)	0.37
Proline (Pro)	0.42
Cysteine (Cys)	0.06
Valine (Val)#	0.36
Methionine (Met)#	0.064
Isoleucine (Ile)#	0.33
Leucine (Leu)#	0.39
Tyrosine (Tyr)	0.15
Phenylalanine (Phe)#	0.32
Histidine (His)*	0.24
Lysine (Lys)#	0.52
Arginine (Arg)*	1.41
Total amino acids	7.28

Note: # denotes essential amino acids;
* denotes semi-essential amino acids.

Amino acids are fundamental to human physiology, playing essential roles in maintaining normal physiological functions, metabolism, and fatigue, preventing diseases, and delaying aging [37]. In *A. anserina* from the Qinghai-Tibet Plateau, the top three amino acids by content are arginine (Arg), aspartic acid (Asp), and glutamic acid (Glu) (Table 6). Arginine, which has the strongest pro-insulinogenic effect among amino acids, is crucial for diabetes prevention and treatment [37]. Aspartic acid regulates brain and nerve metabolism, aids in treating heart disease, liver disease, and hypertension, and helps prevent and recover from fatigue, with deficiencies directly affecting intellect and memory [38]. Glutamic acid is primarily used in medicine to treat hepatic coma, promote erythropoiesis, improve brain cell nutrition, and plays a vital role in glucose and protein metabolism [27, 37, 38]. Additionally, alanine (Ala), aspartic acid (Asp), glutamic acid (Glu), glycine (Gly), phenylalanine (Phe), and tyrosine (Tyr) are flavor-enhancing amino acids that contribute to the fresh, sweet taste and improved flavor and texture of *A. anserina* [31]. Furthermore, *A. anserina* contains significant amounts of branched-chain amino acids (BCAAs)-valine, leucine, and isoleucine- which are metabolized outside the liver. Leucine regulates blood glucose levels, repairs muscles, and improves liver function, while isoleucine and valine protect and enhance liver function [38]. Overall, *A. anserina* from the Qinghai-Tibet Plateau is characterized by a rich diversity and high content of amino acids, including BCAAs, medicinal amino acids, and flavor-enhancing amino acids, which collectively contribute to its high nutritional and medicinal value.

A. anserina is Deeply Intertwined with the Cultural and Dietary Habits of Tibetans on the Qinghai-Tibet Plateau

Similar to the Lisu, Nu, and Dulong ethnic minorities in Nujiang Prefecture, Yunnan Province, who have traditionally used lacquer oil extracted from *Toxicodendron vernicifluum* as their primary edible oil, Tibetans have developed a rich tradition of using *A. anserina* as a vital food and medicinal resource. While lacquer oil's perceived nutritional and health benefits lacked scientific validation, modern metabolomic and pharmacological studies have elucidated its anti-inflammatory and anti-postpartum depression properties, supporting its traditional use in treating menstrual disorders [20]. Similarly, *Maianthemum atropurpureum*, a wild vegetable from northwestern Yunnan, has been scientifically validated for its nutritional and medicinal properties, demonstrating the relevance of traditional knowledge [39].

On the Qinghai-Tibet Plateau, where fresh vegetables are scarce in daily diets, *A. anserina* serves as a valuable substitute, offering vitamins, proteins, fats, and trace elements. This plant contains abundant medicinal amino acids, proteins, trace elements, and vitamins, which are closely related to residents' nutritional needs, dietary habits, and cultural customs. This study leverages modern scientific methods to reveal that *A. anserina* from the Qinghai-Tibet Plateau is high in protein, minerals, amino acids, and vitamins with significant nutritional and health benefits. These findings highlight its importance in enhancing daily dietary nutrition and maintaining health, underscoring its cultural and practical significance for the region's inhabitants.

Conclusion

The ethnobotanical study of *A. anserina* underscores its significant role in both culinary and medicinal applications, thereby establishing it as a distinctive "medicine and food" plant resource of the Qinghai-Tibet Plateau. This plant, which thrives across varying altitudes – high, medium, and low – within the region, is notable for its high dietary fiber content, low fat, minimal sodium, and abundance of amino acids and essential mineral elements. Utilizing scientific methodologies, this research investigates the chemical composition of *A. anserina*, elucidating the factors contributing to its extensive use as a food and medicinal resource among the Tibetan population on the Qinghai-Tibet Plateau. The findings highlight the considerable potential of *A. anserina* for broader dissemination within the region, offering theoretical support for the sustainable utilization of wild plants. Furthermore, the study provides a scientific foundation for industrial development and rural revitalization efforts.

Author Contributions

Y.H. planned and supervised the project. L-Y.L. and Z-T.C. performed the experiments, analyzed the data, and contributed reagents/materials/analysis tools. K.C. and Z-Y.L. contributed to data collection and evaluation. J.X. revised the manuscript.

Acknowledgments

This work was funded by the Tibet University Talent Development Incentive Program - Young Scholars Funding Program, the Tibet University 2025 Central Financial Support Special Funds for Local Colleges and Universities ([2025] No. 1), the Tibet University 2024 Graduate Student High-level Talent Cultivation Programme (No. 2022-GSP-B004).

Competing Interests

The authors declare no conflict of interest.

AI Usage Disclosure Statement

During the preparation of this work, the authors used large language model tools (DeepSeek) solely for language polishing and grammar correction.

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