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Review

Rheum tanguticum, an endangered medicinal plant endemic to China

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***Rheum tanguticum*, endemic to east part of Qinghai- Tibet Plateau in China, is one of three genuine species of rhubarb and has better medicinal quality than other two species, *Rheum palmatum* and *Rheum officinale.* The roots and rhizomes of *R. tanguticum* have been used for more than a thousand years in China as the well-known traditional medicines with the purgation, antibacterial, antipyretic and hemostatic effects etc. The young stems and petioles of the species are recently made as a nourishing food. However, the wild resources of *R. tanguticum* decrease rapid annually and the species becomes an endangered species because of the very limited distribution, poor living habitat, and over-harvest due to the increasing market request. However, since some new medicinal effects, such as antineoplastic and immune activity, were reported recently, more detailed research on the species is necessary. On the other hand, *R. tanguticum* is poorly known in the Western countries. The morphology, distribution, habitat, chemistry, properties, pharmacology, and planting of the species are reviewed in the present paper.**

Key words: *Rheum tanguticum*, botany, distribution, property, chemistry, pharmacology.

INTRODUCTION

Rheum tanguticum (Maxim. ex Regel), Maxim. ex Balf. (Polygonaceae) is one of the three genuine species that is *R. tanguticum, Rheum palmatum* Linn. and *Rheum officinale* Bail., of rhubarb and was listed in Pharmacopoeia of the People's Republic of China (Chinese Pharmacopoeia Committee, 2005). The Chinese name is "Tangut Rheum" or "chicken feet Rheum" because the young leaves of the species are like the chicken feet. Rhubarb, the roots and rhizomes of these species, is used as a very common traditional Chinese medicine and one of the important ingredients in Chinese traditional prescriptions with strong antibacterial, antipyretic, antineoplastic and antipasmolytic effects and also as an agent to reduce blood- lipid, blood pressure, obesity and blood urea nitrogen (Li et al., 2006). Comparing with the other two species, the rhubarb from *R. tanguticum* has the best quality, so it is not only commonly used in Chinese and Tibetan medicine products, but also in Chinese community all over the world and some Asia countries. The usage of the plant has been recently extended into the functional food due to the advent of new functional and biologically active compounds. As a commonly used herb, the market requirement of *R. tanguticum* is becoming higher and higher. But on the other hand, *R. tanguticum* is distributed in a very limited area that is in the east part of Qinghai-Tibetan Plateau, has a highest elevation range and very arid and poor habitat resulting to low growth speed and therefore more excessive exploitation comparing with *R. palmatum* and *R. officinale*. The wild resources of *R. tanguticum* decrease rapid annually and the species becomes endangered (Yang et al., 2001). Therefore, a review and systemic analysis of botany, distribution, cultivation, chemistry and medicinal properties of *R. tanguticum* become necessary and timely.

BOTANY

The plant of *R. tanguticum* is herb, perennial and 1.5 - 2 (occasionally up to 2.5) m tall (Figure 1a). The root is stout, straight, up to 30 cm in length, up to 10 cm in diameter and

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Figure 1a. Morphology of *Rheum tanguticum*; Plant and microhabitat.

Figure 1b. Morphology of *Rheum tanguticum*; Root.

dark brown outside and yellow or red-yellow inside in color (Figure 1b). The rhizomes are shortened and erect. The stem is stout, hollow, finely sulcate, glabrous or pube-

Figure 1c. Morphology of *Rheum tanguticum*; Leaves.

Figure 1d. Morphology of *Rheum tanguticum*; Branches of inflorescence.

scent. Leaves are basal and cauline. Basal leaves are orbicular or broadly ovate, large, 30 - 60 cm long, abaxially pubescent, adaxially papilliferous or muricate, basal veins 5, base subcordate, deeply palmately 5-lobed, middle 3 lobes pinnatisect, apex narrowly acute (Figure 1c). Stem leaves are few and smaller than the basal ones. Ocrea are large, membrane, entire and brown. Panicle is large (Figure 1d). The flowers are small and bisexual. The pedicels are articulate. The tepals are six, white, purple-red, rarely light red, orbicular. The stamens are 9. The ovary is broadly ovoid, 1-locular and 1- ovule. The styles are three, horizontal in axis. The stigmas are inflated and recurved. The fruits are oblong-ovoid to oblong, 8 - 9.5
× 7 - 7.5 mm; the wings are 2 - 2.5 mm wide, with longitudinal veins near the margin (Figure 1e). The seeds are black and ovoid (Bao and Grabovskaya-Borodina, 2003).

CLASSIFICATION

According to Gao (1998), there are eight sections in *Rheum*. *R. tanguticum* belongs to Sect. *Palmata* and is

Figure 1e. Morphology of *Rheum tanguticum*; Fruits.

closely related to *R. palmatum* and *R. officinale*. However, we found in the field survey that the differences among these three species are morphologically interwoven. The results of the anatomical studies also indicated that the three species are similar and can not be distinguished from one another (Li and Zhang, 1983).

There are other varieties of *R. tanguticum* except *R. tanguticum* var. *tanguticum*, *R. tanguticum* var. *liupanshanense* is only 0.5 - 1 m tall, with slender stems, smaller leaves and usually only once branched panicle which sometimes has branchlets in lower part of the inflorescence (Kao and Cheng, 1975; Bao and Grabovskaya-Borodina, 2003). Stapf (1927) and Yang et al. (1992) published *R. palmatum* subsp. *dissectum* Stapf and *R. tanguticum* var. *viridiflorum*, respectively, but were treated as the synonyms of var. *tanguticum* (Bao and Grabovskaya-Borodina, 2003).

DISTRIBUTION AND HABITAT

R. tanguticum is endemic to China and distributed mainly in the eastern part of Qinghai-Tibet Plateau and occurs occasionally in Hengduanshan, Minshan, Qilianshan, Qionglaishan (for var. *tanguticum*) and Liupanshan Mountains (for var. *liupanshanense* only) (Figure 2 and Table 1); this is based on the herbarium specimens, the references (Bao and Grabovskaya- Borodina, 2003) and the field survey of the authors of the present paper.

R. tanguticum grows in small bundles consisting of less than ten to about a hundred individuals in the mountains from (2500 m) 2,800 to 4,200 m (4400 m) in elevation (Gao, 1998; this study) and is usually found in the alpine or subalpine meadow, degraded meadow, shrubs and occasionally at the Picea forest edge (Table 1). In the meadow or the degraded meadow, *R. tanguticum* can be the dominant species, or as the main companion species, but only grows dispersedly in the shrubs and forest edge. The living environment of *R. tanguticum* is usually cool and dry with sandy loam or calcareous soil and occasionally warm and wet with humous soil at the forest edge. In the subalpine shrubs, *R. tanguticum* lives on the rocky and sere river bed or riverain of small brook.

CHEMISTRY

Before 2005, chemical studies focus on the rhubarb as the traditional Chinese medicine, including the roots and rhizomes of *R. officinale, R. palmatum and R. tanguticum.* The chemical compounds in rhubarb are highly diverged, including anthraquinones, anthraglycosides, anthrones, stilbenes, tannins, polyphenols, essential oil and organic acids, in which anthraquinone derivatives (e.g., emodin, aloe-emodin, rhein, physcion, chrysophanol and their glucosides) and anthrones (e.g., sennoside A, B, C, D, E and F) are the accepted important bioactive components (Nonaka et al., 1977; Zheng and Zhang, 1993; Zhang and Liu, 2004). In addition, glucose gallates (Kashiwada et al., 1988; Abe et al., 2000), naphthalenes (Tsuboi et al., 1977) and catechins (Kashiwada et al., 1986) were isolated from rhubarb.

Jin et al. (2006) studied the chemistry compounds of the rhubarb from *R. tanguticum* for the first time. Twenty compounds were isolated and purified by various chromatographic methods and their structures were elucidated by mass spectrometry and nuclear magnetic resonance. Among these compounds, seven are anthraquinone and glycosides of anthraquinone that is chrysophanol, aloe-emodin, physcion, rhein, emodin, chrysophanol-8-O- -D-glucopyranoside and aloe-emodin-8-O- -D-glucopyranoside) which showed highly purgative activity (Tang et al., 2007). In addition, two phenylbutanone glucopyranosides, lindleyin and isolindleyin, four stilbene derivatives, trans-3, 5, 4'-trihydroxystilbene, trans-3, 5, 4'-trihydroxystilbene-4'-O- -D-glucopyranoside, trans-3, 5, 4'-trihydroxystilbene-4'-O- -D-(2''-O-galloyl)-glucopyranos ide and trans-3, 5, 4'-trihydroxystilbene-4'-O- - D-(6''-O-galloyl)-glucopyranos ide, catechin, -sitosterol, epicatechin-3-O- gallate, and torachrysone-8-O- - D-glucopyranoside were also isolated from ethanol extract of rhubarb from *R. tanguticum* (Jin et al., 2006).

Besides, three compounds, 4-(4'-hydroxyphenyl) -butanone, 4-(4'-hydroxyphenyl) -2-butanone -4'-O- -D-(2''-O-cinnamoyl-6''-O-galloyl)-glucopyranoside, and 4-(4'-hydroxyphenyl) -2-butanone-4'-O- -D -(2''-O-galloyl- 6''-O-p-coumaroyl) – glucopyranoside, isolated from the roots and rhizomes of *R. tanguticum* were identified for the first time (Jin et al., 2006). Zheng et al. (2005) reported another stilbene glycoside, rhaponti-

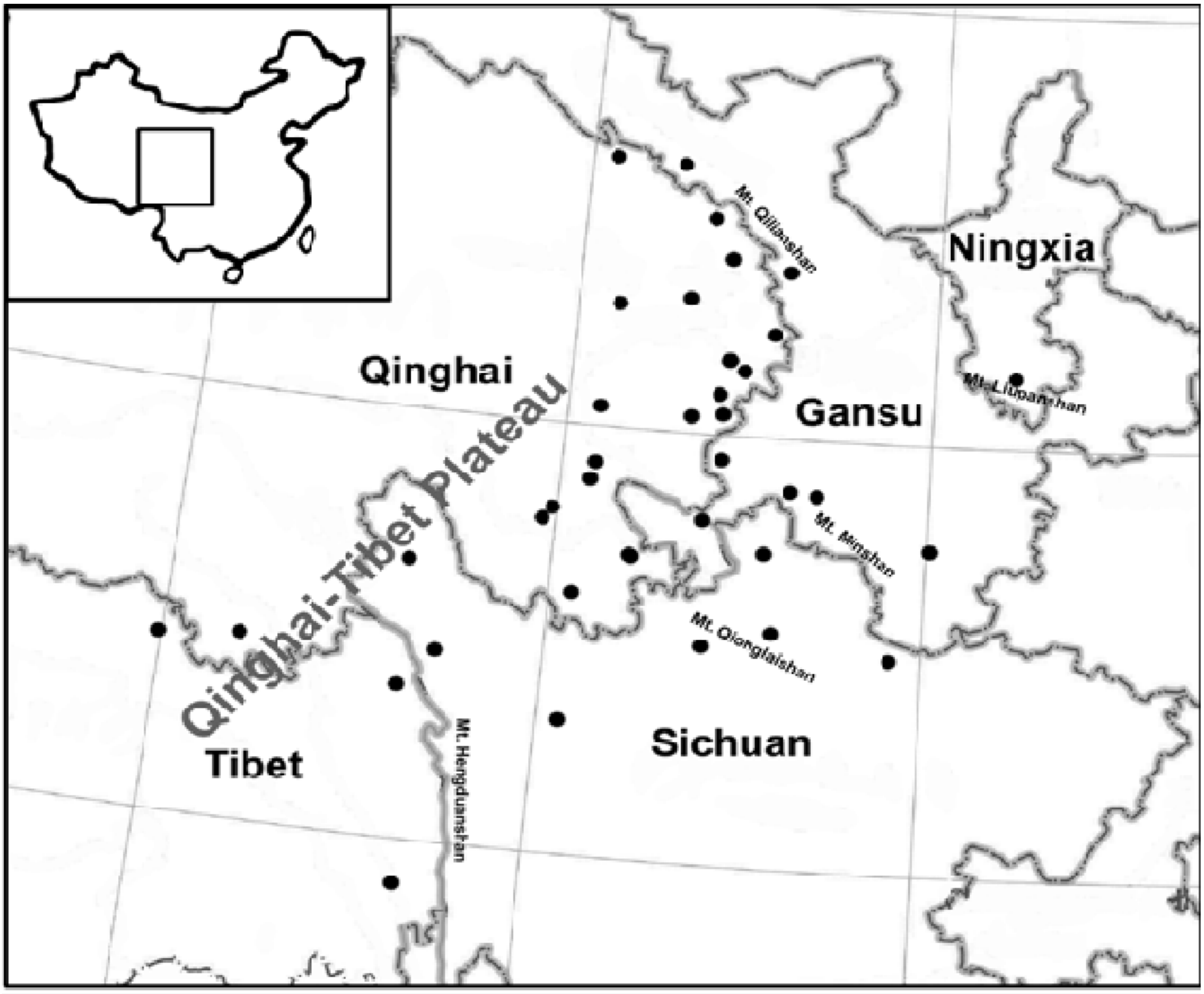

Figure 2. Distribution pattern of *Rheum tanguticum* and its varieties based on herbarium specimens and references.

num (3, 3', 5'-trihydroxy-4-methoxystilbene-3'-13-D-glucopyranoside)
, which has anti-aging effect (Xu et al., 2002), was obtained from *R. tanguticum*.

Ye et al. (2007) compared the compounds of *R. tanguticum*, *R. palmatum*, and *R. officinale*, for the first time by using liquid chromatography coupled with electrospray ionization mass spectrometry. They found that sennoside A, which has been considered as the major purgative component of rhubarb, was only detected in *R. officinale*, while its close isomers were found in *R. palmatum* and *R. tanguticum*. In addition, the predominant anthraquinone glycosides in *R. officinale* were found to be rhein 8-O-glucoside and emodin 1-O-glucoside, whereas those in *R. palmatum* and *R. tanguticum* be rhein 1-O-glucoside and emodin 8-O-glucoside. They also reported that the contents of sennosides and anthraquinones in *R. tanguticum* are apparently higher than those *in R. officinale*.

MEDICINAL AND NUTRITIONAL PROPERTIES

Rhubarb has been used as an important component in a lot of Chinese patent medicine or Chinese compound medicine for more than one thousand years in China. According to traditional Chinese medicinal theory, rhubarb has the effect of purgation, purging heat, loosening the bowels, curing gastric and renal disorders, removing bacterial dysentery, removing heat from the blood, clearing toxins away, promoting blood circulation and removing blood stasis. In present Chinese medicine, rhubarb is largely employed as purgation and liver cleanser in the treatment of indigestion and jaundice and is also applied as a haemostatic agent (Tsai et al., 2004; Yu et al., 2005).

It has been known for hundreds of years that the rhubarb of *R. tanguticum* is called “Xining Rhubarb” in local herbal market because *R. tanguticum* is mainly distributed in Qinghai province and Xining is the capital of Qinghai and has better medicinal effect. Therefore the “Xining Rhu-

Table 1. The representative specimens from the distribution of *Rheum tanguticum*.

Variety	Location	Geographical range	Altitude (m)	Habitat	Voucher or reference
var. *tanguticum*	Qilian county, Qinghai province	Mt. Qilianshan	3120	Alpine Shrub	Li et al., 2007
	Minshi county, Qinghai province	Qinghai-Tibet Plateau	3870	Shade slope and shrub	Yu-hu Wu 25700, HNWP
	Angqian county, Qinghai province	Qinghai-Tibet Plateau	4050	Valley, mountain slope, and forest	Yong-Chang Yang 1148, KUN
	Minhe county, Qinghai province	Qinghai-Tibet Plateau		Under forest	Ben-Zhao Guo, 7180, HNWP
	Menyuan county, Qinghai province	Qinghai-Tibet Plateau	3120	Alpine Shrub	Li et al., 2007
	Huzhu county, Qinghai province	Qinghai-Tibet Plateau	2600	Forest edge	Li et al., 2007
	Huangzhong county, Qinghai province	Qinghai-Tibet Plateau	2800	Alpine Shrub	Li et al., 2007
	Tongren county, Qinghai province	Qinghai-Tibet Plateau	3200	Forest edge	Li et al., 2007
	Xunhua county, Qinghai province	Qinghai-Tibet Plateau	2650	Ditch	Ben-Zhao Guo. 25276, HNWP
	Henan county, Qinghai province	Qinghai-Tibet Plateau	3410	Flood land	Yong-Chang Yang 1799, HNWP
	Maqin county, Qinghai province	Qinghai-Tibet Plateau	3700	Shrub meadow	Yu-Hu Wu 18388, HNWP
	Tongde county, Qinghai province	Qinghai-Tibet Plateau	3740	Forest edge	Yu-Hu Wu 5287, HNWP
	Jiuzhi county, Qinghai province	Qinghai-Tibet Plateau	4350	Semi-shady slope	Guoluo Team 396, HNWP
	Gande county, Qinghai province	Qinghai-Tibet Plateau	3875	Alpine meadow	Yu-Hu Wu 25791, HNWP
	Dari county, Qinghai province	Qinghai-Tibet Plateau	4050	Hillside meadow	Li et al., 2007
	Zeku county, Qinghai province	Qinghai-Tibet Plateau	3500	Hillside shrub	Yong-Chang Yang 2009, HNWP
	Banma county, Qinghai province	Qinghai-Tibet Plateau	3760-4250	Hillside meadow or Alpine shrub	Li et al., 2007
	Pingwu county, Sichuan province	Mt. Minshan	3193	Forest edge	Xu-mei Wang 08123, SANU
	Songpan county, Sichuan province	Mt. Minshan	3300	Sunny mountain	Xu-mei Wang 08035, SANU
	Daofu county, Sichuan province	Mt. Qionglaishan	4000		Sichuan Medicinal Plant Survey Team 15789, NAS
	Ruoergai county, Sichuan province	Mt. Minshan	3600	meadow	Sichuan Medicinal Plant Survey Team 2083, NAS
	Barkam county, Sichuan province	Mt. Qionglaishan	4000	Sunny slope	Sichuan Medicinal Plant Survey Team 22396, NAS
	Dege county, Sichuan province	Mt. Hengduanshan	4400	Shady meadow	Sichuan Vegetation Survey Team 4184, CDBI
	Shiqu county, Sichuan province	Qinghai-Tibet Plateau	4000	Alpine meadow	Yu-hu Wu 29976, HNWP
	Min county, Gansu province	Mt. Minshan	2500	-	Zuo-bin Wang 14064, HNWP
	Yongchang county, Gansu province	Mt. Qilianshan	2575	Forest edge	Xu-mei Wang 08135, SANU
	Diebu county, Gansu province	Mt. Minshan	3200	-	Ze-xiang Peng 312, LZU
	Tianzhu county, Gansu province	Mt. Qilianshan	2560	-	Shi-lin Shen 570123, Herbarium of Lanzhou College of Medicine
	Maqu county, Gansu province	Mt. Minshan	3550	Meadow	Xue-rui Chen 65, LZU
	Li county, Gansu province	Mt. Minshan	2800	Forest edge	Ru-neng Zhao 616002, Herbarium of Lanzhou College of Medicine

Table 1. Contd.

	Xiahe county, Gansu province	Mt. Minshan	2800	Among forest at wet place	K.T.Fu 1007, PE
	Baqing county, Tibet	Qinghai-Tibet Plateau	4300	Meadow	De-ding Tao 11111, HNWP
	Jiangda county, Tibet	Mt. Hengduanshan	4000	Meadow	Guang-chen Xia 1358, KUN
	Zuogong county, Tibet	Mt. Hengduanshan	4410	Side of stream	Anonymous 76-792, PE
var. *liupanshanense*	Jinyuan county, Ninxia province	Mt. Liupanshan	2220	Forest edge	Xu-mei Wang 08236, SANU

barb" is popular both in herbal market and the hospitals of traditional Chinese medicine.

It is well known for a long time that the young stems and petioles of some of *Rheum* species are eatable both in some east and the west countries. The young stems and petioles of *Rheum rhaponticum* are taken as vegetable in the west, *R. officinale* in north of China and *R. tanguticum* in north-west of China for a long time for example and the nutrition contained in these species is similar to that of some fruits and vegetable and can be processed into can or directly as a vegetable (Su et al., 1998) . The species of *Rheum* has been listed as one of the new resources of food and could be used in health foods (Miao, 2001). According to "Jing Zhu Materia Medica'' and "Four Medical Classics" and other Tibetan Pharmacopoeia records, *R. tanguticum* can be used as food by local people apart from its digestion, defecation and other medicinal uses. It is estimated that 100 g dry petiole of *R. tanguticum* contains total sugar 18.96 g, protein 5.84 g, fat 0.59 g, crude fiber 14.86 g, vitamin C 12.91 mg, K 4680 g, Ca 630 mg, Mg 224.4 g, P 160 mg, Mn 10.6 mg, Na 33 mg, Fe 8.24 mg and Zn 2.94 mg. And the contents of amino and organic acids in dry petiole of *R. tanguticum* are shown in Tables 2 and 3 (Xiong and Zhang, 2003).

PHARMACOLOGY

As a matter of fact, the current knowledge on pharmacological effect of *R. tanguticum* derives are mostly from rhubarb. Different solvent extracts or various compounds of rhubarb have exhibited purgative, anti-inflammatory, antibacterial, hemostatic, hepatoprotective, antitumor and antimutagenicity activities etc. (Arosio et al., 2000; Shang and Yuan, 2002; Tseng et al., 2006; Huang et al., 2007). For example, sennosides (bianthrones) and anthraquinone glycosides are considered as the main purgative components, while free anthraqui-nones possess anti-inflammatory effects (Xiao et al., 1984). Here, we focused on the pharmaco-logical studies of rhubarb from *R. tanguticum* in recent years.

Polysaccharide is a non-specific immune modulator. It has a significant effect on the anti-tumor, anti-hepatitis and anti-aging areas and people have given it more concern in recent years (Tian et al., 1995). Polysaccharide extracted from the roots and rhizomes of *R. tanguticum* is one of its major active ingredients. *R. tanguticum* polysaccharide (RTP) could significantly protect against acute hepatic injury and oxidation injury (Liu et al., 1999; 2001). Liu et al. (2003) has explored that RTP exhibited marked protective effects on inflammation and ulceration in rats with 2,4,6-trinitrobenzene sulfonic acid (TNBS)-induced colitis. In order to validate whether RTP had protective effects on intestinal epithelial cells *in vitro*, effects of RTP against hydrogen peroxide-induced intestinal epithelial cell injury was investigated by Liu et al. (2005) and they found that RTP may have cytoprotective and antioxidant effects against H_2O_2-induced intestinal epithelial cell injury by inhibiting cell apoptosis and necrosis and that might be one of the possible mechanisms of RTP for the treatment of ulcerative colitis in rats. In addition, RTP can stimulate the function of phagocytes, thus protecting livers function and others (Buffinton and Doe, 1995; Liu et al., 2003). Liu et al. (2008) reported the effect of RTP on protection from inflammation and colonic damage in TNBS-induced colitis in rats and found that RTP protected against diarrhea, colon weight increase, and ulceration induced by TNBS. It was at least as effective as dexamethasone.

Tannins and anthraquinone from *R. tanguticum* exhibited strong bacteriostasis (Liu et al., 2006). Staphylococcus was inhibited significantly.

R. tanguticum extracts have also been investigated for their effect on immunity function activity (Gao et al., 2008). In different constituents extracted from *R. tanguticum*, only the polysaccharide could improve the humoral immunity function and cell immunity function, but the other extracts (tannin, butyrophenone, sennoside and anthraquinone glycoside etc.) had inhibitory effects.

Aside the pharmacological values of the roots and rhizomes of *R. tanguticum*, water extract obtained from the petiole of the species had significantly anti-inflammatory effects and the anti-inflammatory effects of the 95% ethanol extract were lower than that of water extract at the

Table 2. Amino acids in petiole of *Rheum tanguticum* (mg/100g dry wt) (Xiong and Zhang, 2003).

Essential AA	Total contents	Other AA	Total contents
Isoleucine	198.66	Tyrosine	117.01
Leucine	337.76	Aspartic acid	395.54
Lysine	239.15	Serine	204.68
Methionine	92.36	Glutamic acid	800.22
Phenylalanine	159.73	Glycine	197.88
Thrwonine	192.08	Alanine	250.08
Valine	269.27	Cysteine	5.35
Histidine	83.99	Arginine	209.82
		Proline	275.85
		Tryptophan	55.00

Table 3. Contents of organic acid in petiole of *Rheum tanguticum* (mg/100 g dry wt) (Xiong and Zhang, 2003).

Variety	Malic acid	Tartaric acid	Citric acid	Lactic acid	Acetic acid	Oxalic acid	Succinic acid
Petiole	7704.72	1.75	761.63	51.87	104.18	573.23	574.57

same dose (Xiong et al., 2002).

Some of these compounds like lindleyin, a component of some herbal medicines, is a novel phytoestrogen and might trigger many of the biological responses evoked by the physiological estrogens (Usui et al., 2002). Catechin can reduce blood urea nitrogen and inhibit blood coagulation (Huang and Chao, 1998).

ARTIFICIAL REPRODUCTION

Although there is no literal record, it is well known in China that *R. tanguticum* has been cultivated for the medicinal usage for hundreds of years in Qinghai province (Li et al., 2007). But the cultivation is only limited in the courtyard of the farmers and only for the medicinal usage of the farmer themselves. The knowledge on the cultivation of *R. tanguticum* is abundant and well developed (Chen, 2005; Jiao and Zhang, 2006). The cultivation of large scale of *R. tanguticum* processing is in Guoluo (Jiao and Zhang, 2006) and Huangnan (Chen, 2003) of Qinghai province. Some primary experiences have been summarized literally in the artificial cultivation of *R. tanguticum* in Guoluo, Qinghai province (Jiao and Zhang, 2006). The field where *R. tanguticum* is planted should be well-drained sandy loam or highly humic content soil. *R. tanguticum* is commonly reproduced by seeds. In growing period of *R. tanguticum*, weeding, topdressing and earthing up should given proper attention. On the other hand, in the third to fourth years after sowing period, the plant begin blooming and the inflorescence buds should be removed as soon as possible in order to facilitate roots and rhizomes growth because the flowering can consume large amounts of nutrition (Jiao and Zhang, 2006). To fully utilize the limited land and for the unity of economic and environmental benefits, rotation program is adopted in planting base. *R. tanguticum* is intercropped with other herbal drugs or perennial pasture such as *Eragrostis pilosa* (Linn.) Beauv., *Festuca sinensis* Keng, *Salvia miltiorrhiza* Bge., *Rhodiola rosea* Linn. and *Gentiana macrophylla* Pall. (Chen, 2003).

The tissue culture technique is another effective way for the propagation of *R. tanguticum*. This technique has been used for the processing of *R. tanguticum* in 1980s (Li and Li, 2001). It is reported that the sterile shoots, cotyledons, hypocotyls, radicles and young roots of seedlings of *R. tanguticum* were used as explants cultured *in vitro* to induce the plant regeneration. The sterile shoot differentiation medium is B5+NAA 0.1 mg/l + 6-BA 3 mg/l, the medium for rooting is 1/2 MS+NAA 1 mg/l + 3% sucrose and 1/2 MS + NAA 0.5 mg/l + 3% sucrose and the callus inducing medium is MS+2, 4-D 1 mg/l+ NAA 1 mg/l + 6-BA 1 mg/l (Xu et al., 2004).

SUGGESTIONS FOR FUTURE RESEARCH

R. tanguticum has been collected for more than one thousand years in China, especially in Qinghai province because rhubarb from this region are generally considered the best, medicinally, than those from other regions and has been exported from here to Japan, Korea and elsewhere. However, the resources request of *R. tanguticum* is increasing, the wild resource is decreasing significantly and the distribution of resources has continued to become narrow. Therefore, the wildlife resources survey and protection strategy should be done. Firstly, *in situ* conservation strategies should be adopted to protect its habitat. We can also establish wild germplasm recourses areas in different places. Secondly, *R. tanguticum* as one of the important medicinal plants, prohibiting the excavation is unrealistic and using artificial method as the only cultivation means to meet the market request and to release fundamentally the pressure on wild resources. Thirdly, a simple and accurate method for the analysis of bioactive compounds in *R. tanguticum* is necessary for the quality control of crude rhubarb and their pharmaceutical preparations by using the modern technology. Fourthly, in the digging season, a large number of the overground biological resources, such as the leaves and stems, of *R. tanguticum* which contain the similar physiological active substances similar to the roots and rhizomes have been wasted. So far, the pharmacological research on the overground resources is obviously insufficient. Apart from a few ingredients, the pharmacological effects of the most components need to be in-depth study. Finally, as the understanding of the level and distribution of genetic diversity is crucial for the establishment of effective conservation strategies for an endangered species, currently, our group is focusing on investigating the genetic variation of *R. tanguticum*.

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