Original Research Article

Panax sp. in Tuyen Quang, North Vietnam – A Potential Plant for Poverty Reduction

.

ABSTRACT

Ginsengs are perennial forest herbs, belonging to genus *Panax* L. A species of ginseng was found in Tuyen Quang province, North Vietnam and named as *Panax sp*. – Tuyen Quang ginseng. Understanding the ecology, morphology, and saponin of Tuyen Quang ginseng becomes important for development, which can contribute to poverty reduction in the province. Field survey was conducted for ecology and samples were collected for morphology description and saponin analysis. The results indicates Tuyen Quang ginseng distributes in evergreen broadleaved forests in elevation of 980-1,200 m above sea level. It grows in forest with canopy cover of >50% and low vegetation cover of >80%. The soil must be acidic with pH of 4.5-5. Soil contains high ratio of sandy particles and is drainage. Morphology indicates some differences of Tuyen Quang ginseng with other described ginsengs in Vietnam. Saponin content of Tuyen Quang ginseng is 13.7%, which is much higher than that of *Panax stipulealatus* (7.1%) and *P. bipinnatifidus* (7.5%), two widely planted and marketed ginsengs in Vietnam. In addition, current price of Tuyen Quang ginseng is up to 2,600 US$/1 kg. It is concluded that Tuyen Quang ginseng could be considered as a potential forest herb for poverty reduction. However, study on growing techniques should be conducted before practical application.

Keywords: Ethnic community; Panax sp.; poverty reduction; saponin; Tuyen Quang.

1. INTRODUCTION

The genus *Panax* L. belonging to family Araliaceae is called ginseng. Until recently, 19 *Panax* species and subspecies have been described worldwide, most of them grow in eastern Asia [1]. Ginsengs have been widely used as traditional medicines [2-3]. The ginsenosides (triterpene glycosides) are the main biologically-active compounds of *Panax* L, which was first found 50 years ago. Until recently, more than 150 different ginsenosides have been isolated from different *Panax* species[4-5].

In Vietnam the first ginseng was found in 1973 and named as *Panax vietnamensis* Ha et Grushv. [6]. In 2003, a subspecies of *P. vietnamensis* was described and named as *P. vietnamensis* var *fuscidicus* K. Komatsu, S. Zhu & S.Q. Cai. This subspecies has natural distribution in south part of Yunnan province, China and Laichau province, North Vietnam [7-8]. Until recently, three ginseng species (*P. vietnamensis* Ha et Grushv, *P. stipulealatus* Tsai & K.m. Feng, and *P. bipinnatifidus* Seem.) and two subspecies (*P. vietnamensis* var *fuscidicus* and *P. vietnamensis* var. *langbianensis*) have been found in Vietnam.

Tuyen Quang province locates in North Vietnam with diversity of vegetation types, topography, and climate conditions. A ginseng (*Panax* sp.) was found to have natural distribution in narrow areas of Lam Binh and Na Hang districts of Tuyen Quang province, so called “Tuyen Quang ginseng”. It has been harvested from natural for health improvement and marketing to generate income for local ethnic communities for decades. The objectives of this study were (1) to describe ecological and morphological characteristics and (2) to analyze roots for saponin content of Tuyen Quang ginseng, which could be used to develop and manage this economically valuable ginseng sustainably.

2. MATERIALS AND METHOD

2.1 Materials

By interviewing local authorities and ethnic people, it was reported that Tuyen Quang ginseng has natural distribution in Sinh Long commune, Na Hang district and Thuong Lam commune, Lam Binh district of Tuyen Quang province (Fig. 1). Therefore, those two communes were selected for field survey.

2.2 Methods

2.2.1 Natural and Ecological Characteristics

By interviewing local people, who have found and harvested Tuyen Quang ginseng, the areas of natural distribution became known. With their field guidance, it was easy for the survey team to get the desired survey locations. In the field, if plant of Tuyen Quang ginseng was found, natural and ecological characteristics were described including forest type, height of forest canopy, vertical structure of forest canopy, forest canopy cover, and low vegetation layer. In addition, a soil pit of 1.2 m depth and 60 cm width was dug up for soil profile, and a soil sample was collected from 0-20 cm soil depth for analyzing in Lab.

2.2.2 Morphological and Anatomy Characteristics

Five fully-developed plants of Tuyen Quang ginseng were randomly selected for morphological characteristics including leaves, stem, root, flower, fruit, and seed. Shape, color, and dimension of each organ were described through observation ~~naked eyes~~. In addition, slices of stems and roots were also used for their structure by observing through microscope [9]. Slices of 40-60 µm was cut by using special equipment. The slice was then colored by chrysanvioles (0.5%) and safranin (1%). It was then cleaned by purified water and observed through microscope.

2.2.3 Saponin Content

Total saponin was estimated by ~~be~~ weighing. Approximate one gram powder of the dried root sample were weighed, 100 ml *n*-hexan were then added. The mixture was extracted in Soxhlet extraction apparatus in six hours and filtered. The residue was continuously extracted by Soxhlet extraction apparatus with 100 ml of 70% methanol for 6 hours. The combined filtrate was concentrated under reduced pressure with a rotary evaporator to obtain extract. The methanol extract was diluted in 30 ml of water and then fractionated with water saturated *n*-butanol until no color was observed in n-butanol layer. The filtrated butanol extract was then evaporated under reduced pressure to yield butanol extract. This extract was dissolved into 10 ml of 70% ethanol then transferred into a porcelain beaker and evaporated solvent to

get extract. The obtained extract was dried in an oven at 105 ^{o}C until constant weight. Total saponin content (X) was calculated as: $X = [(b \times 100)/(m \times (100 - d))] \times 100$, where b is obtained saponin weight (g), d is moisture of root powder (%), and m is initial weight of root powder (g).

3. RESULTS

3.1 Ecology

Tuyen Quang ginseng naturally distributes in evergreen broadleaved forests of both disturbed and undisturbed forests. The height of forest canopy is taller than 15 m. The canopy structure includes two or three layers with the shortest layer of 7-10 m tall and the difference between layers of 4-6 m. Tuyen Quang ginseng prefers to grow in forests with canopy cover of >50%. The species composition of forest canopy, where Tuyen Quang ginseng grows, includes tree species of *Saurauia napaulensis* DC., *Callicarpa arborea* Roxb., *Alniphyllum eberhardtii* Guillaumin, *Schefflera macrophylla* (Dunn) R.Vig., *Machilus chinensis* (Benth.) Hemsl., and *Pavetta indica* L. with density of 650-860 trees/ha. The vegetation layer on forest floor includes plants of *Asarum caudigerum* Hance, *Lophatherum gracile* Brongn., *Alpinia chinensis* (Retz.) Roscoe, *Cyclosorus parasiticus* (L.) Farw., and *Polygonum chiensis* L. with cover >80%. The litter layer on forest floor is thick and wet most time of the year.

Suitable climate conditions for Tuyen Quang ginseng include annual precipitation of 1,700-1,900 mm, annual air humidity of >85%, annual air temperature of 23^{o}C, minimum temperature of >5^{o}C, and maximum temperature of <30^{o}C. Tuyen Quang ginseng distributes on elevation zone of 980-1,200 m above sea level, growing well in mountain foots, flat areas, and well drainage soils.

Soil profile indicates the litter layer of 4-5 cm, humus layer of 2-3 cm with dark color and humidity of 56-60%, and total soil depth of >100 cm. Tuyen Quang ginseng naturally grows in acidic soil with pH of 4.5-5.0, high humus soil of 6.5-9% (Table 1). Content of sand particles is high, indicating drainage soil. Nitrogen is not much required by Tuyen Quang ginseng as it can grow in low N content soil of 0.5%.

3.1 Morphology

Tuyen Quang ginseng is a perennial plant, up to 60 cm tall at maturity (Fig. 2). Root lies horizontally without root branching. Each root contains one aerial stem with leaves. In very rare case, it may contains 2-3 aerial stems.

Root is brown to light yellow (Fig. 2) with numerous scars as results of dead aerial stems of each growing year. Scars arranges alternately in root. The head of root is big and global, while the end of root is much smaller and contains bunch of small roots for absorbing water and nutrient. Inner part of roots is light yellow or violet (Fig. 2). Total root length is 3.2-26.5 cm and diameter is 1.2-3.3 cm.

Aerial stem dies in winter and new stem starts from root head in spring. This creates scars in roots (Fig. 2). Aerial stem is 20-60 cm height and 0.3-0.8 cm diameter. It is green and/or light violet without hairs (Fig. 3). Each aerial stem contains 1-4 main leaves and each main leaf contains 4-6 sub-leaves (Fig. 3). There are tiny hairs covering both sides of sub-leaves (Fig. 3).

Each aerial stem contains an inflorescence on top (Fig. 4), which is 15-25 cm length and contains 40-120 flowers. The inflorescence is 3-4.5 cm in diameter. When ripen, fruits become red. Seeds are white with a triangle shape. Flower season is May-July and season of ripen fruits is October-December.

3.3 Anatomy and Saponin

Aerial stem and root of a 6-year old plant of Tuyen Quang ginseng were collected for anatomy and saponin analysis. Results indicates aerial stem of Tuyen Quang Ginseng includes main parts as cutin layer in outermost, epidermis, xylem, phloem, and xylem ray (Fig. 5). While, transverse section of root indicates main layer of epidermis, oxalate, phloem, xylem, and xylem ray (Fig. 6).

Total saponin content of Tuyen Quang ginseng (*Panax* sp.) is 13.7%, which is much higher than that of *P. stipuleanatus* and *P. bipinnatifidus* (Table 2). However, it is lower than *P. vietnamensis* var. *fuscidiscus* (21.9%) and *P. vietnamensis* (22.3%), two well-known ginsengs in Vietnam.

4. DISCUSSION

Forest herbs like ginseng can only survive and grow well under shades of other vegetation [10-12]. Therefore, Tuyen Quang ginseng can only be found in evergreen broadleaved with forest canopy cover of >50%, and lower vegetation cover of >80% in the present study. Forest structure including more than two layers of trees, and lower vegetation [13] is an important indicator for the existence of Tuyen Quang ginseng. Low cover of tree layer will allow direct sunlight to forest floor, reducing soil moisture, litter layers, soil organic carbon *etc.*, which is not a favor condition for existence of Tuyen Quang ginseng [14].

Soil with high ratio of sandy particles and high humus content (Table 1) indicates low compact soil, which supports growth of roots in the soil. If soil is compact with low humus content, the soil is high water holding capacity with low soil air. Such kind of soil will never well support growth of plants which have roots as main part of their body. Therefore, selecting suitable soil is important for growing Tuyen Quang ginseng. It must be high humus content and drainage soil.

Comparing morphology among five ginsengs in Vietnam indicates several differences of Tuyen Quang ginseng with others (Table 3). The most different characteristic is number of leaves per aerial stem, which contains 1-4 leaves per stem in Tuyen Quang ginseng compared to 3-5 in others. While, no. flowers were also most numerous of up to 120 flower per inflorescence. It seems that Tuyen Quang ginseng most look like *P. vietnamensis*. However, there is a possibility of a new sub-species found in Tuyen Quang province. Therefore, further study such as DNA analysis is required to identify where the Tuyen Quang ginseng (*Panax* sp.) is a new sub-species of ginseng in Vietnam.

Anatomy of Tuyen Quang ginseng is similar to that of other ginseng and plants [9, 15], which have been widely used as traditional medicines. Root shows clusters of oxalate, which is known as containing high saponin; the main active chemical component of ginseng.

The saponin content of Tuyen Quang ginseng is much higher than that of *P. stipulealatus* and *P. bipinnatifidus* (Table 2), which have been widely grown and marketed for poverty reduction in mountainous areas of Vietnam. In addition, current price of Tuyen Quang ginseng ranges 1,000-2,600 US$/ 1 kg, depending on size and age of roots [16]. Therefore, growing Tuyen Quang ginseng could also contribute to poverty reduction in Tuyen Quang province. However, before practical application researches on planting Tuyen Quang ginseng should be conducted extensively to issue the applicable growing guideline, ensuring the quality/saponin content of planted ginseng compared to natural ones.

5. CONCLUSION AND RECOMMENDATION

Tuyen Quang ginseng –*Panax sp.* has natural distribution in Thuong Lam commune Lam Binh district and Sinh Long commune, Na Hang district of Tuyen Quang province, North Vietnam. The species distributes in evergreen broadleaved forests on the elevation of 980–1,200 m above sea level. The species only distributes in forests with canopy cover >50% and cover of low vegetation layer of >80%. The soil must be acidic with pH of 4.5-5.0 and high ratio of sandy particles, indicating drainage soil.

There is a possibility that Tuyen Quang ginseng is a new sub-species of ginseng because of some differences of its morphological characteristics compared to other ginsengs in Vietnam. However, detail analysis such as DNA application should be conducted for better conclusion.

Tuyen Quang ginseng has high saponin content (13.7%) and is a potential forest herb for poverty reduction to ethnic communities in the province. Study on growing techniques must be conducted, which is valuable for local communities. Selecting vegetation types for growing Tuyen Quang ginseng is important, which must have high canopy cover of > 50% and high cover of low vegetation layer of >80%.

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241 **Table 1.** Physical and chemical characteristics (±SE) of soil samples

Research site	Density (g/cm^3)	Silt (< 0.002 mm; %)	Lam (0.002-0.02 mm; %)	Sand (2-0.02 mm; %)	pH	Humus content (%)	N (%)	K_2O (%)
Thuong Lam, Lam Binh	1,135.8 ±27.0	12.7 ±0.9	33.0 ±1.9	54.3 ±2.7	4.5 ±0.3	6.7 ±0.9	0.5 ±0.1	2.5 ±0.3
Sinh Long, Na Hang	1,156.5 ±8.5	4.3 ±0.0	34.9 ±1.4	60.8 ±1.4	4.9 ±0.3	8.9 ±1.1	0.6 ±0.0	3.2 ±0.3

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244 **Table 2.** Saponin content of ginsengs in Vietnam

Species	Root source	Saponin content (%)
Panax sp. - Tuyen Quang ginseng (study species)	Natural, Tuyen Quang province	13.7
Panax stipulealatus Tsai & K.m. Feng	Growing in garden of local people in Laichau Province, five years old	7.1*
Panax bipinnatifidus Seem.,	Growing in garden of local people in Laichau Province, five years old	7.5*
Panax vietnamensis var *fuscidicus* K. Komatsu, S. Zhu & S.Q. Cai.	Growing in garden of local people in Laichau Province, five years old	21.9*
Panax vietnamensis Ha et Grushv	Natural, central Vietnam	22.3*

245 *cited from Pham et al. [16].

246 **Table 3.** Morphological characteristics of five ginsengs in Vietnam.

	Species				
	P. stipuleanatus	***P. vietnamensis***	***P. vietnamensis* var. *fuscidiscus***	***P. notogingseng***	***Panax sp. (Tuyen Quang ginseng)***
Root distribution	Horizontal	Horizontal	Horizontal	Vertical	Horizontal
Root scar	In line	Alternate	Alternate	Random	Alternate
Color of inner part of root	White green	Yellow or light violet	Yellow or light violet	Yellow or light violet	Yellow or light violet
Aerial stem	Violet or green	Violet	Violet	Violet	Green or light violet
Leaves per stem	3	3-5	3-5	4	1-4
No. flowers	60-80	50-120	40-120	40-120	40-120
Flower color	White green	White green	White green	White green	White green
Stamen	1	1-2	1-2	2-3	1-2
Pistil	1-2	1-2	1-3	2-3	1-2
Color of ripen fruit	Red	Red with black dots on top	Red with black dots on top	Red	Red
Shape of fruit	Kidney shape	Kidney shape	Kidney shape	Half global or triangle	Kidney shape or half global
Seeds per fruit	1-2	1-2	1-3	2-3	1-2
Shape of seed	Kidney shape	Kidney shape	Kidney shape	Triangle	Triangle

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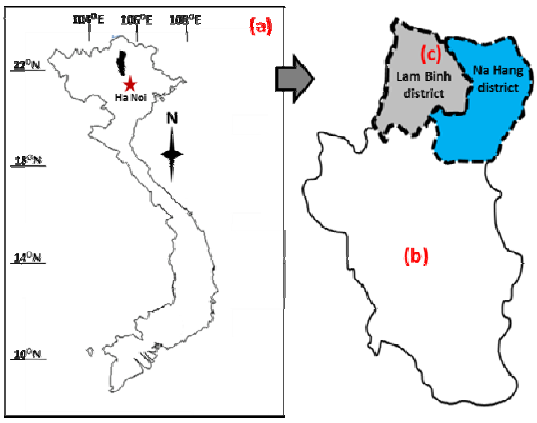

Fig. 1.(a) Map of Vietnam, (b) Tuyen Quang province, (c) Lam Binh and Na Hang districts – field survey sites.

Fig. 2. Full plant of Tuyen Quang ginseng (above left), root (above right), and root transverse sections (below; light yellow in left and violet in right).

Fig. 3. Aerial stem (1), sub-leaves (2) back side of leaf (3), front side of leaf (4), and bract (5).

Fig. 4. Inflorescence (1), bract (2), palea (3), sepal (4), petal (5), stamen (6), pistil (7), stigma splits (8), sruit lengthwise (9), fruit (10).

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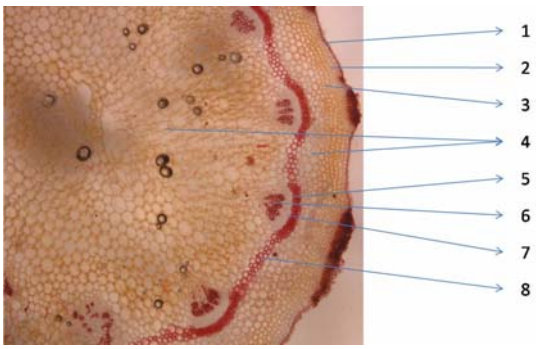

Fig. 5. Transverse section of aerial stem. Cutin (1), epidermis (2), collenchyma (3), axialparenchym (4), sclerenchyma (5), xylem (6), phloem (7), xylem ray (8).

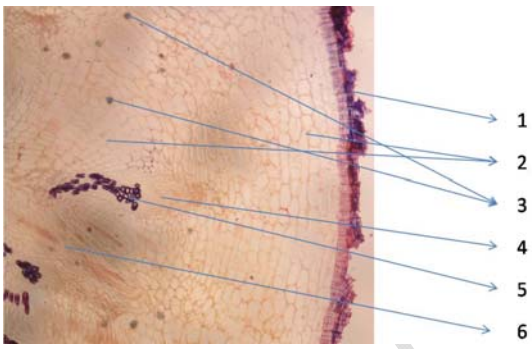

Fig. 6. Transverse section of root. Epidermis (1), axialparenchym (2), clusters of calcium oxalate (3), phloem (4), xylem (5), xylem rays (6).

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