

# Morphological Characteristics of Inflorescence, Flowering Bud, Fruit and Leaf of Korean Ginseng

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## 高麗人蔘의 花序, 花蕾, 果實 및 葉의 形態學的 特性

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### ABSTRACT

To clarify the morphological characteristics of Korean ginseng cultivated, the shapes and frequencies of inflorescence, flowering bud, fruit, and leaf were investigated. The shapes of inflorescence, flowering bud and fruit, and leaf were divided into 6, 3, and 7 groups, respectively. The frequencies of these shapes were not significantly different according to the planting positions.

### INTRODUCTION

Korean ginseng, *Panax ginseng* C.A. Meyer, which has been a mysterious cure-all medicine in Asia for several thousand years, belongs to the *Araliaceae* family<sup>1)</sup>.

In 1613, Huh Joon<sup>2)</sup> wrote "Dong-Eui-Bo-Gam" (Compendium of Oriental Medicine) and reported that ginseng plants have a single stem, bearing 3 palmately compound leaves with 5 leaflets each which faces toward sunshine in shadow so that they are found under the basswood trees in the deep mountain. In the ancient Korean literatures, it is very hard to find the literatures of ginseng morphology. On the other hand, we can find out more Chinese literatures about ginseng morphology.

In 1932, Immamura<sup>3)</sup> described the morphology of Korean ginseng in his book "人蔘史 (History of Ginseng)", but we can find out many insufficiencies in his describing. And ecotype of ginseng has been changed according to the environmental conditions, climate, soil characteristics, and so on, for several thousand years. We feel that it is significant to present in detail our data so far obtained in the field. In this work, the shapes of inflorescences, flowering buds, fruits and leaves were investigated.

### EXPERIMENTAL METHOD

Morphological characteristics of inflorescence, flowering bud, fruit and leaf of Korean ginseng cultivated were investigated at Jeungpyeong, central area, and Kanghwa, northern area in our country, and classified by the phenotypical morphology. The types of inflorescence and fruit were observed at the maturing stage of 4-year-old ginseng plants from which the peduncles were not cut for seed production. About 1,000 plants grown on the different planting positions were examined for the classification of the types of inflorescence and fruit. The types of flowering buds were classified during May, flowering stage of ginseng,

and about 500 plants grown on the different planting positions were examined. The shapes of ginseng leaves were investigated in the fields of 2- to 6-year-old ginseng. It is very difficult to classify the leaf shapes in the ginseng fields, directly. For the classification of ginseng leaf shapes, palmately compound leaves of 100 plants were cut at each age and compared with the standard shapes. And the frequencies of all of the shapes classified were compared according to the planting positions.

## RESULTS AND DISCUSSION

### 1. Morphological characteristics of inflorescence

Korean ginseng has the inflorescence of indeterminate umbel shape. A long flowering peduncle is, in general, produced at the center of whorled leaves, i.e., at the tip of stem and bears a simple umbel at the end of the peduncle<sup>3,4</sup>. The umbel shapes of ginseng cultivated were diversified and divided into 6 groups which named from I-shape to VI-shape in this paper. Their characteristics investigated were as follows.

1) I-shape: It is a model shape with simple umbel which have same length of pedicels that formed globular (Fig. 1).

2) II-shape: Some pedicels are longer than the other and are projected from simple umbel, and have some fruits or flowering buds (Fig. 2).

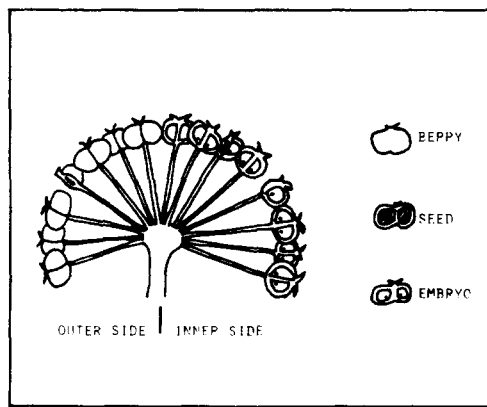


Fig. 1. Morphological shape I of inflorescence of Korean ginseng.

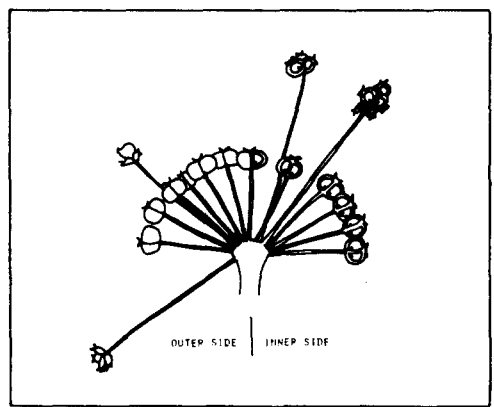


Fig. 2. Morphological shape II of inflorescence of Korean ginseng.

3) III-shape: Several branched pedicel are projected under simple umbel and have 2 to 8 flower buds or fruits at the tip of pedicel (Fig. 3).

4) IV-shape: It is a mixture of II and III-shapes (Fig. 4).

5) V-shape: Two simple umbels exist together and 2-stair umbel is formed (Fig. 5).

6) VI-shape: One wide and thick pedicel is projected from the middle part of simple umbel and has some flower buds or fruits at the tip (Fig. 6).

In general, environmental condition such as light intensity, temperature and soil water content are significantly different according to the planting position. Inflorescences of ginseng growing on different planting positions were investigated in order to clarify the variations of inflorescence shapes. Table 1 shows the frequency distribution of inflorescence shape classified. The frequencies of I-, II-, III-, IV-, V-, and VI-shape were 67.3%, 24.22%, 3.75%, 0.98%, 0.81% and 2.90%, respectively. Therefore, I-shape was observed at the highest frequency. And the variation of inflorescence shape according to the planting positions was

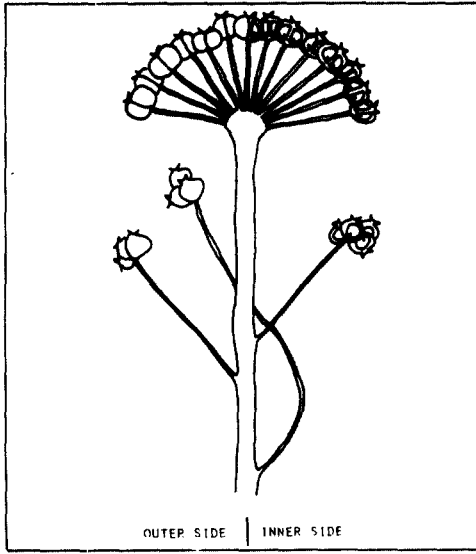


Fig. 3. Morphological shape III of inflorescence of Korean ginseng.

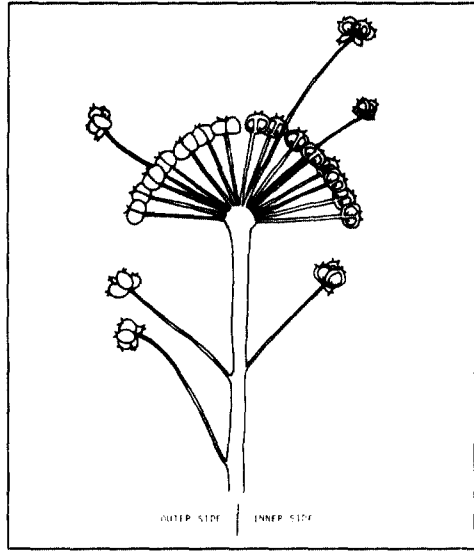


Fig. 4. Morphological shape IV of inflorescence of Korean ginseng.

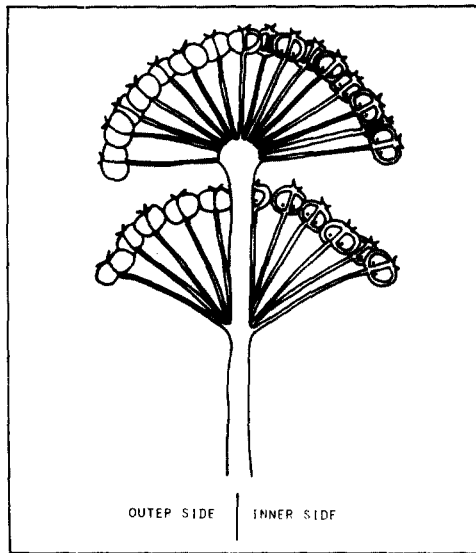


Fig. 5. Morphological shape V of inflorescence of Korean ginseng.

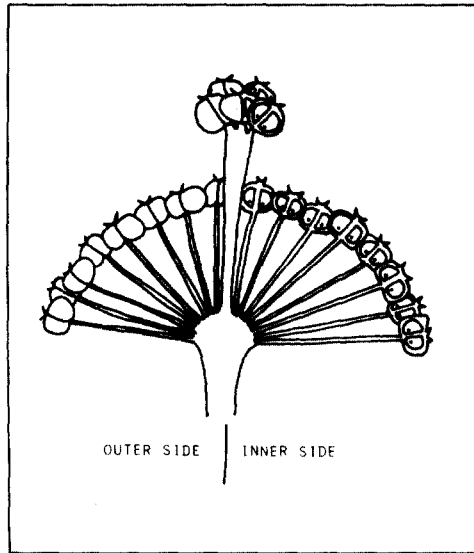


Fig. 6. Morphological shape VI of inflorescence of Korean ginseng.

not significant. These may have been caused by the influence of genetic factors.

Hu<sup>4,5)</sup> described *Panax japonicus* var. *angustifolius* showing a branched peduncle with a cluster of umbel, and branched inflorescences were reported in *Panax pseudoginseng*<sup>5)</sup>. In this experiment, a branched peduncle with a cluster of umbel was not found out, but a branched pedicel with some flowering buds were observed.

**Table 1.** Frequency distribution of inflorescence shapes according to the planting position.

Planting position (line)	Inflorescence shape						No. of plants investigated
	I	II	III	IV	V	VI	
1	148( 74.37)	43( 21.61)	6( 3.02)	0(0.00)	0(0.00)	2( 1.00)	199(100.0)
2	142( 54.62)	85( 32.69)	16( 6.15)	2(0.77)	3(1.15)	12( 4.62)	260(100.0)
3	166( 66.67)	51( 20.48)	10( 4.02)	6(2.41)	4(1.61)	12( 4.81)	249(100.0)
4	237( 67.24)	95( 26.91)	9( 2.55)	6(1.70)	2(0.57)	4( 1.31)	353(100.0)
5	99( 73.88)	26( 19.40)	4( 2.99)	0(0.00)	1(0.75)	4( 2.98)	134(100.0)
Total	792( 67.34)	300( 24.22)	45( 3.75)	14(0.98)	10(0.81)	34( 2.90)	1195(100.0)

( ): Per cent.

## 2. Morphological characteristics of flowering bud and fruit

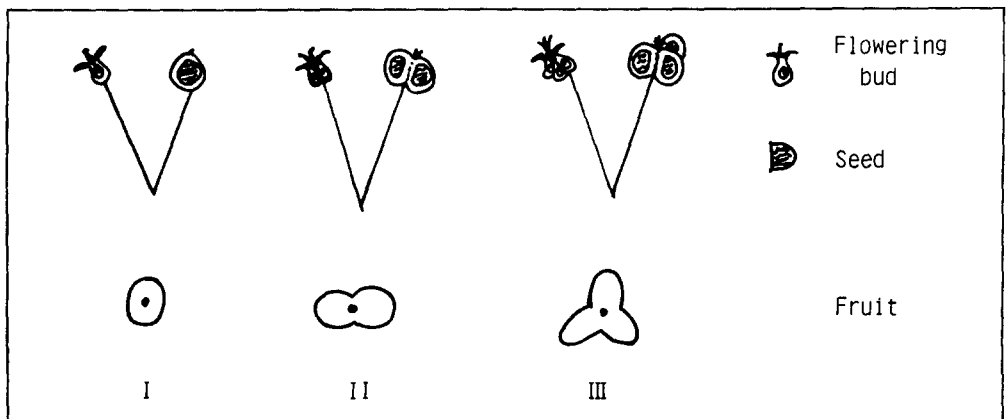
The type of flowering bud and fruit are important factor to classify plant. The number of carpels and the arrangement of seeds are varied with the plant species<sup>5,6,7,8,9,10</sup>. Usually, we have been known that Korean ginseng fruits have two seeds<sup>3,10</sup>, which is called a drups having thin exocarp, thick and fleshy mesocarp and hard endocarp. The flowering bud and fruit of ginseng grown on the different planting positions were investigated in the regions of Kanghwa and Jeungpyeong in order to classify their types.

Flowering bud and fruit types are divided into 3 types named I-type, II-type and III-type (Fig. 7). Characteristics of 3 types of flowering bud and fruit are as follows.

- 1) I-type: It has single pistil and 1-celled ovary. This fruit is round-ovarate and elliptic shape.
- 2) II-type: It has compound pistil with 2 free styles and 2-celled ovary. This fruit is combined two round-elliptic and ovarate shapes.
- 3) III-type: It has compound pistil with 3 free styles and 3-celled ovary. This fruit is combined 3-round-ovarate and elliptic shapes toward center.

The frequencies of the number of celled-ovary according to planting positions and regions are shown in Table 2.

In Kanghwa area, the frequency of 1-celled ovary was higher than that of 3-celled ovary, but the result obtained in Jeungpyeong area was conversely. 2-celled ovary was observed at the highest frequency in both Kanghwa and Jeungpyeong. And the variation of flowering bud and fruit types according to the planting

**Fig. 7.** Morphological types of flowering buds and fruits of Korean ginseng.

position was not significant by statistical analysis.

**Table 2.** Frequency distribution of the number of celled-ovary per flowering bud or fruit according to planting positions and areas

Area	No. of celled-ovary per bud or fruit	Planting position (line)					Average
		1	2	3	4	5	
Kanghwa	1	17.29	10.66	7.51	8.51	12.80	11.35
	2	80.37	87.43	91.42	90.29	86.57	87.22
	3	2.34	1.91	1.07	1.20	0.63	1.43
Jeungpyeong	1	1.87	0.53	1.10	1.40	2.11	1.40
	2	86.98	91.77	85.56	93.53	97.08	91.00
	3	12.63	7.70	13.24	5.07	0.80	7.88

Banerjee (1968)<sup>11)</sup> described Indian *Panax* Linn has 5-celled ovary and 2-3 styles, and *Panax sikkimensis* Ban. spec. nov. has 2-celled ovary and 2-3 styles. Also, Hu<sup>13)</sup> described the genus *Panax* have 1-pistil, inferior ovary, 2-locular, 2-3 styles and united at base, and it contains 2 or 3 white seeds. Besides these reports, some species of the genus *Panax* were divided by the number of styles and the nature of ovary<sup>11)</sup>.

Especially, it is the peculiarity that, in Korean ginseng, 2 kinds or 3 kinds of types of flowering bud and fruit exist in one plant. This point may have been solved by the influence of environmental, physiological and soil factors. This problem will be solved by progeny test and genetic analysis.

### 3. Morphological characteristics of leaf

The nature of leaves is important points of taxonomy<sup>5,6,7,8,9,10,11)</sup>. Banerjee (1968)<sup>11)</sup> insisted taxonomic importance of the nature of leaves to classify the *Panax* genus. Bae<sup>2)</sup>, Hu<sup>4,5,12,13)</sup> and Banerjee<sup>11)</sup> described *Panax* has palmately compound leaf, though the nature and the number of leaves and leaflets vary with the species.

Leaves of Korean ginseng plants are palmately compound with 5-leaflets except yearlings having 3-leaflets. The shapes of palmately compound leaf of Korean ginseng were divided into 7 groups named from A-type to G-type. The characteristics of each type to ginseng leaves are as follows:

1) A-type: 3 leaflets of middle part are oblong-ovate, serrate, and having acute tip. The length of leaflets is longer than the other types. The basal two leaflets are small, serrate and elliptic (Fig. 8).

2) B-type: 3 leaflets are round-ovate, serrate and having dull tip. The width of leaflets is wider than the other types. The basal two leaflets are serrate, small, and round ovate (Fig. 9).

3) C-type: 3 leaflets are dull spear-type-ovate, serrate, having acute tip and rough margin. The basal two leaflets are small, elliptic and serrate (Fig. 10).

4) D-type: 3 leaflets are spear-type-ovate, elliptic, serrate, and having acute tip. The basal two leaflets, also, are wider and taking acute tip (Fig. 11).

5) E-type: All leaflets are stream-lined ovate, and petiole and petiolule are slender (Fig. 12).

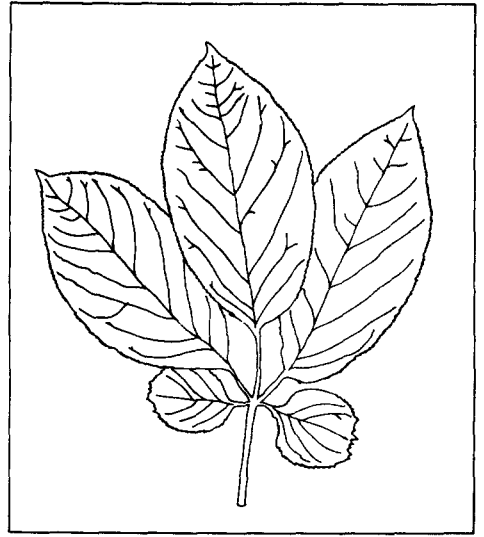
6) F-type: The basal two leaflets are so large that the leaf with 5-leaflets, on the whole, form the pentagonal palmately compound leaf (Fig. 13).

7) G-type: All leaflets are mild-oblong-ovate and having tip. The basal two leaflets are also small (Fig. 14).

Leaf types classified above were investigated in 2- to 6-year-old ginseng grown on the different planting positions. Frequencies of A, B, C, D, E, F, and G type are 22.5%, 23.7%, 21.6%, 8.5%, 10.0%, 9.0%, and



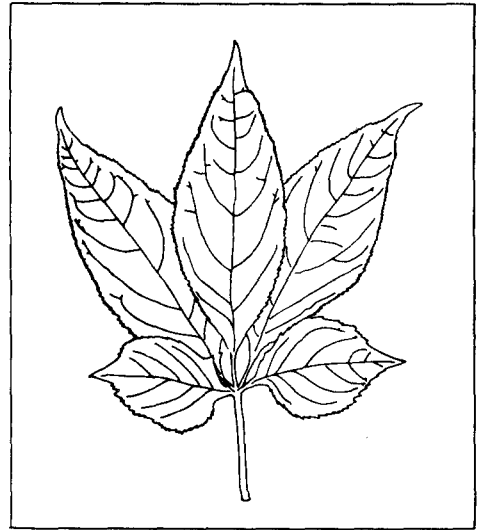
**Fig. 8.** Morphological type A of Korean ginseng leaf.



**Fig. 9.** Morphological type B of Korean ginseng leaf.



**Fig. 10.** Morphological type C of Korean ginseng leaf.



**Fig. 11.** Morphological type D of Korean ginseng leaf.

4.7%, respectively (Table 3). A, B and C types are observed at higher frequencies in each year-old plant. And the variations of the leaf types according to planting positions and plant ages were not significantly different (Tables 3 and 4). Therefore, when the progeny tests to the leaf types will be carried out, the genetic relations will be cleared.

In conclusion, we must develop many pure lines with various types of inflorescence, flowering bud, fruit, and leaf for genetic studies on their types.

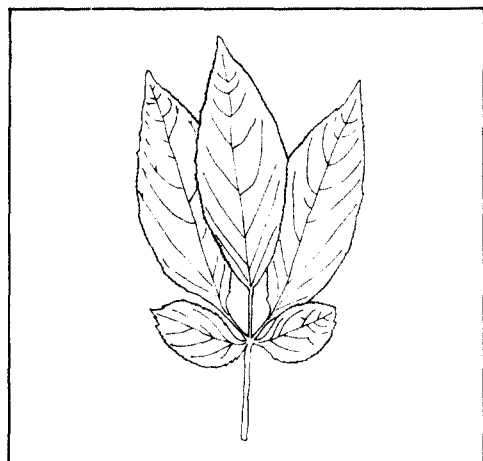


Fig. 12. Morphological type E of Korean ginseng leaf.

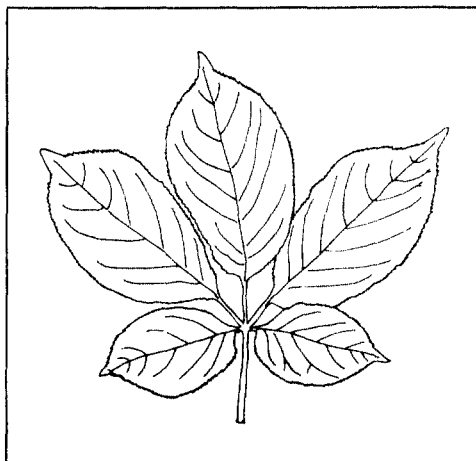


Fig. 13. Morphological type F of Korean ginseng leaf.

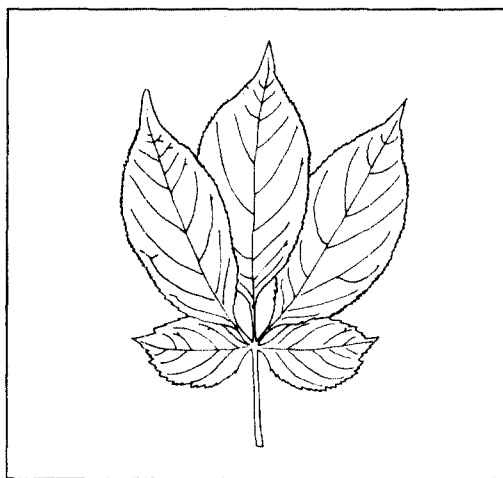


Fig. 14. Morphological type G of Korean ginseng leaf.

Table 3. Frequency distribution of leaf shape according to the plant age

Age	No. of plants investigated	Leaf shape						
		A	B	C	D	E	F	G
2	89	27	25	22	4	5	3	3
3	95	16	21	27	6	12	10	3
4	86	17	23	15	9	6	10	6
5	83	18	17	19	8	12	6	3
6	69	17	14	8	9	7	9	5
Total	422	95	100	91	36	42	38	20
Per cent (%)	100.0	22.5	23.7	21.6	8.5	10.0	9.0	4.7

Table 4. Frequency distribution of leaf shape according to planting positions

Leaf shape	Planting position (line)					Total
	1	2	3	4	5	
A	6( 6.3)	22(23.1)	23(24.2)	28(29.5)	16(16.8)	95(100)
B	7( 7.0)	23(23.0)	29(29.0)	27(27.0)	14(14.0)	100(100)
C	24(26.4)	18(19.8)	15(16.5)	16(17.6)	18(19.8)	91(100)
D	12(33.3)	9(25.0)	3( 8.3)	3( 8.3)	9(25.0)	36(100)
E	17(40.5)	6(14.3)	7(16.7)	7( 6.7)	5(11.9)	42(100)
F	7(18.4)	7(18.4)	10(26.3)	6(15.8)	8(21.1)	38(100)
G	5(26.3)	6(31.6)	2(21.1)	4(21.1)	3(15.8)	19(100)

( ): Per cent.

## 要 約

高麗人蔘(*Panax ginseng* C. A. Meyer)의 花序形態, 花蕾構造, 果實形態 및 葉形態를 分類하고 各 形態의 年生別, 栽植位置別, 地域別 分布를 調査하였던바 그 結果는 다음과 같다.

1. 花序形態는 6 種으로 分類되었으며, 이 중 I-型(Simple Umbel)이 67.34%로 가장 높은 빈도를 나타내었으며 栽植位置間 花序形態分布變異差異는 없었다.

2. 花蕾 및 果實形態는 암술이 한개이고 1室子房이며 種子가 하나인 I-型和 암술이 2개이며 2室子房이고 種子가 두개생기는 II-型和 암술이 3개이고 3室子房이어서 種子가 3개생기는 III-型으로 分類되었으며 이 중 II-型이 91.83%로 가장 높은 頻度를 나타내었고 栽植位置間의 分布差異는 인정할 수 없었으나 地域間의 差異는 있었다.

3. 葉型은 7 種으로 分類되었으며 이 중 A, B, C型이 67.8%로 가장 높은 頻度를 나타 내었고 年生間 栽植位置間 分布差異는 認定되지 않았다.

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