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Pharmacognostical study of the folk medicine "Da-Rae-Jul-Ki"

Mi-Jeong Ahn,[a] Ji Young Bae,[b] Masayuki Mikage,[c] Jong Hee Park*[b]

[a]College of Life Science & Natural Resources, JinJu National University, JinJu 660-758, Korea. [b]College of Pharmacy, Pusan National University, Busan 609-735, Korea. [c]Graduate School of Natural Science and Technology of Kanazawa University, Kakuma-machi, Kanazawa 920-1192, Japan. *(Received June 14, 2010. Accepted October 5, 2010.)*

Abstract

The Korean folk medicine "Da-Rae-Jul-Ki" is used to treat various diseases including dysuria, stroke, intestinal catarrh, and stomach cancer. This crude drug is considered to originate from the branches of *Actinidia* species, but this has not been pharmacognostically confirmed. To clarify the botanical origin of "Da-Rae-Jul-Ki," we conducted a comparative anatomical study using branches of *Actinidia* species growing wild in South Korea and Japan. These included *A. arguta, A. arguta* var. *rufinervis, A. kolomikta, A. polygama,* and *A. rufa.* Our study revealed morphological criteria that distinguished each of these four species and one variety of *Actinidia* from the others. These criteria included the number of cell layers in the cork; the size of cork cells; the ratio of the width of the secondary cortex to that of the primary cortex; the presence of stone cells between fiber bundles; and the sizes of stone cells, vessels, and parenchyma cells in the pith. Using these criteria, we determined that "Da-Rae-Jul-Ki" is derived from the branches of *A. arguta.*

Key words *Actinidia arguta*, Da-Rae-Jul-Ki, Korean folk medicine, botanical origin, anatomical study.

Abbreviations c, cambium; ca, druses; co, collenchyma cell; cn, raphides; en, endodermis; f, fiber; fb, fiber bundle; i, intercellular space; k, cork cell; mph, phloem medullary ray; p, parenchyma cell; psc, passage cell; rxy, xylem medullary ray; s, sieve tube; seca, secretory canal; st, stone cell; v, vessels; wf, wood fiber; x, xylem.

Introduction

The Korean folk medicine "Da-Rae-Jul-Ki" is used as an oral medication for various conditions, including dysuria, stroke, intestinal catarrh, acute gastritis, and stomach cancer.[1,2] It is generally known that "Da-Rae-Jul-Ki" is produced in the branches of *Actinidia* species; and in China, antipyretic and diuretic medications are obtained from branches of *A. polygama* (Sieb. et Zucc.) Maxim.[3] However, the botanical origin of "Da-Rae-Jul-Ki" has not been pharmacognostically confirmed. Four species and one variety of *Actinidia* (Actinidiaceae) grow in South Korea, namely, *A. arguta, A. arguta* var. *rufinervis, A. kolomikta, A. polygama,* and *A. rufa.*[4] Since the dried branches of these plants are similar in shape, it is hard to distinguish one from another using only the morphological appearance. As a result, "Da-Rae-Jul-Ki" products in local Korean markets lack identifying information and standardization. We therefore studied the anatomical characteristics of the branches of the four *Actinidia* species and one variety growing in South Korea seeking to clarify the botanical origin of "Da-Rae-Jul-Ki." Branches of *A. arguta, A. kolomikta,* and *A. polygama* from Japan were also examined and compared with those from Korea.

*To whom correspondence should be addressed.
e-mail : abpark@pusan.ac.kr

Materials

The voucher specimens and all other experimental materials are kept in the herbarium of the College of Pharmacy, Pusan National University. All plant specimens were botanically identified by Jong Hee Park. Each of the five experimental materials was collected from a plant growing at one or more of the following locations as indicated:

1. *Actinidia arguta* (Siebold & Zucc.) Planch. ex Miq.: [Korea]: Mt. Jiri (No. 17500~17505), Mt. Cheonsung (No. 17506~17510), Mt. Deukyou (No. 17511~17515), Mt. Odae (No. 17516~17520), and Mt. Cheongok (No. 17521~17525). [Japan]: Mt. Iouzen (No. 17526~17530) and Mt. Gokayama (No. 17531~17535).

2. *Actinidia arguta* (Siebold & Zucc.) Planch. ex Miq. var. *rufinervis* Nakai: [Korea]: Gadeokdo (No. 17536~17540) and Mt. Ganwol (No. 17541~17545).

3. *Actinidia kolomikta* (Maxim. & Rupr.) Maxim.: [Korea]: Mt. Odae (No. 17546~17550) and Mt. Cheongok (No. 17551~17555). [Japan]: Yamaguchi-machi of Takayama City and Gifu prefecture (No. 17561~17565).

4. *Actinidia polygama* (Siebold & Zucc.) Maxim.: [Korea]: Mt. Jiri (No. 17566~17570), Mt. Cheonseong (No. 17571~17575), Mt. Jaeyak (No. 17576~17580), Mt. Cheongok (No. 17581~17585), and Mt. Deukyou (No. 17586~17590). [Japan]: Mt. Iouzen (No. 17591~17595) and Kamiichi-machi of Toyama (No. 17596~17600).

5. *Actinidia rufa* (Siebold & Zucc.) Planch.: [Korea]: Uloong-do (No. 17606~17610) and Gadeokdo (No. 17611~17615).

Commercial "Da-Rae-Jul-Ki" from Korea: Guseo and Gupo traditional markets (No. 986 and No. 987) in Pusan; Seobu traditional market (No. 988) in Jinju; Muju traditional market (No. 989) in Cheonbuk province; and a local market (No. 990) in Sokcho, Kangwon province.

Experiment

Branches 4~10 mm in diameter were taken from the collected plant materials, as the branches of the commercial "Da-Rae-Jul-Ki" were of a similar size (4~8 mm). Samples prepared using a Doska microslicer were observed under an Olympus A041 optical microscope or an Olympus SZH 10 microscope using methods previously described.[5-7)]

General characteristics

a. Macroscopic characteristics: The surfaces of the branches were brownish gray to brown, and several scattered white to reddish brown lenticels were present. The color of the surfaces and the lenticels are shown in Table 1.

b. Microscopic characteristics: The outermost layer of a branch consisted of cork layers, which contained thick and highly lignified stone cells. The cork cells were rectangular in shape. Differences in the number of cork cell layers and cell size were found among the five *Actinidia* plants. The lenticels were composed of round to oval complementary tissue containing a large amount of intercellular space. The ratio (B/A) of the width (B) of the secondary cortex to width (A) of the primary cortex differed among the species investigated. Collenchyma tissue composed of three to five cell layers was found under the cork layer together with a large amount of intercellular space. All five *Actinidia* plants had a clear long-circular or long-oval endodermis, which differed in size among the species. Pericyclic fibers were located beneath the endodermis.[8)] The primary cell walls of the fibers were obviously lignified. The fibers ranged in length from 350 to 800 μm, and differed in diameter among the samples. From two to five stone cells separated the fiber bundles in *Actinidia arguta, A. arguta* var. *rufinervis, A. polygama,* and *A. rufa.* As a result, fiber bundles and stone cells in tranverse section appeared in annular arrangement. In contrast, *A. kolomikta* showed a broken ring of fiber bundles through lack of stone cells. One of two cell layers of phloem medullary rays was clearly observed. Schizogenous secretory canals were found in the phloem.[9)] The canals were

Table 1 Morphological and anatomical characteristics of the branches of *Actinidia* species from Korea and Japan.

Elements \ Materials	*A.arguta* and Da-Rae-Jul-Ki	*A.arguta* var. *rufinervis*	*A.kolomikta*	*A.polygama*	*A.rufa*
Macroscopic characteristics					
Surface color	light brown~ brown	light gray~ brownish gray	brownish gray~ dark brown	brownish gray~ light brown	light brown~ brown
Lenticel color	white	reddish brown	white	reddish brown	white
Microscopic characteristics					
Number of cork cell layers	5~10	17~22	15~20	6~15	18~27
Cork cell diameter					
Tangential (μm)	20~70	30~80	15~35	20~70	30~80
Radial (μm)	20~70	20~60	5~15	20~50	25~60
Diameter of stone cells in cork layer	25~35	15~35	10~20	10~20	10~50
Width of primary cortex (μm, A)	130~170	140~180	220~270	150~180	180~230
Width of secondary cortex (μm, B)	80~120	180~230	260~310	110~150	120~160
B/A	0.61~0.70	1.12~1.25	1.14~1.21	0.73~0.83	0.68~0.76
Diameter of endodermal cell (μm)	40~110	40~100	50~90	40~90	40~80
Diameter of fiber (μm)	15~35	10~40	10~20	10~25	20~45
Diameter of stone cells between fiber bundles (μm)	30~70	20~50	-	20~50	15~40
Diameter of secretory canal (μm)	60~90	40~60	30~50	30~50	30~50
Diameter of vessel (μm)	40~100	20~80	30~110	40~90	40~120
Diameter of xylem fiber (μm)	10~35	10~20	10~25	10~20	10~30
Diameter of parenchyma cell in pith (μm)	30~90	30~100	20~60	30~80	40~180
Raphides	+	+	-	+	+
Druses	-	-	+	-	-

surrounded by 6-15 thin-walled secretory cells in one or two layers. Interestingly, whereas raphides were found in the canals of *A. arguta, A. arguta* var. *rufinervis, A. polygama,* and *A. rufa,* druses were present in those of *A. kolomikta.* The clear cambium consisted of two to four cell layers.

The xylem was composed of vessels, xylem fibers, and xylem parenchyma cells with lignified cell walls. The vessels of the secondary xylem were pitted vessels with simple perforations or reticulate vessels. The diameters of the vessels differed among the five plants studied. The xylem fibers were well developed in all species, but differed in their diameters. The xylem medullary rays consisted of one to three layers of cells with thick, lignified cell walls. When the ray was tangentially and axially sectioned, it looked like a thin lens

with an upright ray cell at both ends. The pith was composed of small lignified circular or oval parenchyma cells. The diameters of the parenchyma cells differed among the five plants studied.

Microscopic characteristics of the branches of the five *Actinidia* plants

1. ***Actinidia arguta*** (Fig. 1)**:** The cork layer consisted of 5~10 cork cell layers. The ratio (B/A) of the width (B, 80~120 μm) of the secondary cortex to width (A, 130~170 μm) of the primary cortex ranged from 0.61 to 0.70. The diameter (40~110 μm) of the endodermis of this species was the largest among those of the five *Actinidia* plants examined. In addition, this species had the largest stone cells (30~70 μm in diameter) and the largest secretory canals (60~90 μm in diameter). The diameters of its vessels ranged from 40 to 100 μm.

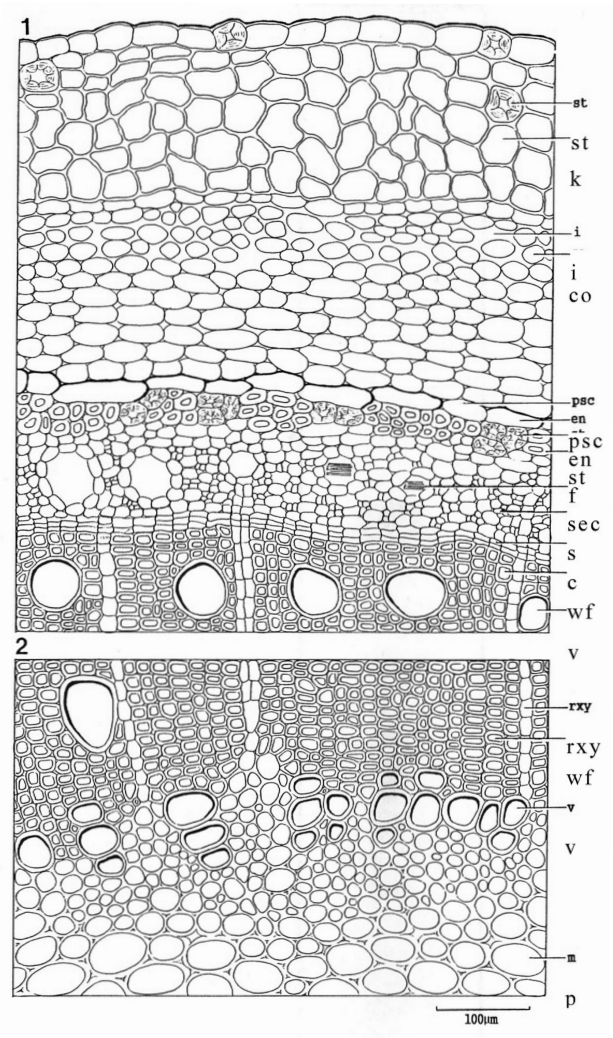

Figure 1 Detailed drawings of transverse sections of a branch (No. 17515) of *Actinidia arguta* showing the cortex and phloem (1), and the xylem and pith (2).

2. ***Actinidia arguta*** **var.** ***rufinervis*** (Fig. 2-A)**:** The cork layer consisted of 17~22 layers of cork cells. The ratio (B/A) of the width (B, 180~230 μm) of the secondary cortex to that (A, 140~180 μm) of the primary cortex ranged from 1.12 to 1.25. The stone cells filling the spaces between fiber bundles were 20~50 μm in diameter. The secretory canals were 40~60 μm in diameter. Among the five plants examined, this one showed the smallest vessel diameters, which ranged from 20 to 80 μm.

3. ***Actinidia kolomikta*** (Fig. 2-B)**:** The cork layer consisted of 15~20 layers of cork cells. *A. kolomikta* had the widest primary and secondary cortices with values of 220 to 270 μm (A) and 260~310 μm (B), respectively. Its B/A ratio (1.14~1.21) was similar to that of *A. arguta* var. *rufinervis.* Specifically, there were no stone cells between fiber bundles. The secretory canals and vessels were 30~50 μm and 30~110 μm in diameter, respectively. The parenchyma cells in the pith were 20-60 μm in diameter, and were significantly smaller than those of the other plants.

4. ***Actinidia polygama*** (Fig. 2-C)**:** The cork layer consisted of 6~15 layers of cork cells. The ratio (B/A) of the width (B, 110~150 μm) of the secondary cortex to the width (A, 150~180 μm) of the primary cortex ranged from 0.73 to 0.83. The stone cells, secretory canals, and vessels were 20~50, 30~50, and 40~90 μm in diameter, respectively.

5. ***Actinidia rufa*** (Fig. 2-D)**:** The cork layer consisted of 18 to 27 layers of cells, and was the thickest of those among the five plants examined. The ratio (B/A) of the width (B, 80~120 μm) of the secondary cortex to that (A, 130~170 μm) of the primary cortex ranged from 0.68 to 0.76. In addition, this species had the smallest endodermal cells (40~80 μm in diameter) and stone cells (15~40 μm in diameter). On the contrary, vessels and parenchyma cells of the pith were 40~120 and 40~180 μm in diameter, respectively, and were the largest of those among the five plants examined.

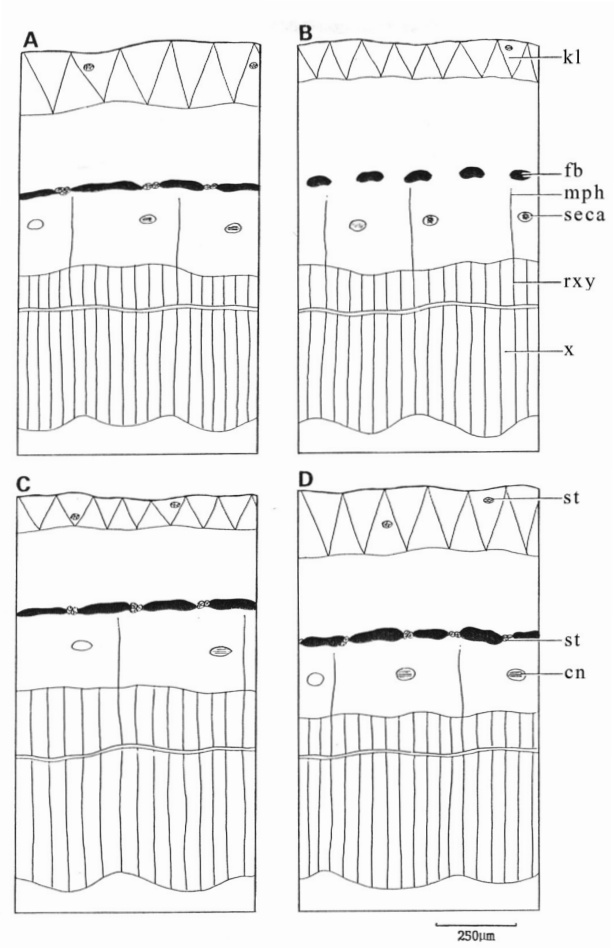

Figure 2 Diagrams illustrating transverse sections of the branches of *Actinidia* species. A, *A. arguta* var. *rufinervis* (No. 17536); B, *A. kolomikta* (No. 17552); C, *A. polygama* (No. 17580); D, *A. rufa* (No. 17611).

"Da-Rae-Jul-Ki" from Korean markets

a. Macroscopic characteristics (Photo. 1)**:** The commercial "Da-Rae-Jul-Ki" was composed of dried and cut branches 4~8 cm in diameter and 10~20 cm in length.

Photograph 1 "Da-Rae-Jul-Ki" from Gupo traditional market in Pusan, Korea (No. 987).

The surfaces of the branches were light brown to brown in color with several scattered white or reddish brown lenticels and leaf scars. The branches were hard and easily broken, and tasted a little bitter.

b. Microscopic characteristics: The anatomical characteristics of the "Da-Rae-Jul-Ki" from Korea were closely matched to those of *Actinidia arguta* (Table 1).

Results and Discussion

The words of "Da-Rae" and "Jul-Ki" mean *"Actinidia* species" and "a branch," respectively, in Korean. In our previous ethnopharmacological study on Korean folk medicine,[2)] we discovered that this plant preparation has been used to treat painful or difficult urination, and stroke. Here we present results from our current anatomical study on the branches of *Actinidia* species, conducted to clarify the botanical origin of "Da-Rae-Jul-Ki."

1. The anatomical characteristics of the branches of four species and one variety of *Actinidia* plants growing wild in Korea and Japan (i.e., *Actinidia arguta, A. arguta* var. *rufinervis, A. kolomikta, A. polygama,* and *A. rufa*) are shown in Table 1. The anatomical characteristics of the *A. arguta, A. kolomikta,* and *A. polygama* samples collected from Korea were similar to those of samples of the same species collected from Japan.

2. Each of the five species was characterized anatomically as follows: *A. arguta* had the largest endodermal cells and stone cells; *A. arguta* var. *rufinervis* had the smallest secretory canals and vessels; *A. polygama* had the widest cork cell layers; *A. rufa* had the largest vessels and pith parenchyma cells; and *A. kolomikta* lacked stone cells in the spaces between fiber bundles.

3. Through comparisons with samples from *Actinidia* species growing in Korea and Japan, we found that the "Da-Rae-Jul-Ki" sold in Korea was derived from the small branches of *A. arguta.* Our samples of medicinal "Da-Rae-Jul-Ki" were collected from three local markets, in Pusan, Jinju, and Sokcho.

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