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A Comparison of Phenolic Components in Cinnamon Medicines

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Abstract – As a result of comparing the phenolic components of cinnamon medicines, the total phenolic component content of Cinnamomi Cortex in China was about 2.65 times higher than that of Cinnamomi Cortex in Vietnam. In addition, the total phenolic component content of Vietnamese Cinnamomi Cortex Spissus was about 1.80 times higher than that of Chinese Cinnamomi Cortex Spissus. Meanwhile, Vietnamese Cinnamomi Ramulus showed a content about 3.29 times higher than that of Chinese Cinnamomi Ramulus. Cinnamaldehyde, the main component of cinnamon medicines, showed the same tendency as the total phenolic component content. In terms of the average content of the total phenolic components, Cinnamomi Cortex showed the highest content at 23964 μg/g, followed by Cinnamomi Cortex Spissus at 17489 μg/g and Cinnamomi Ramulus at 5435.8 μg/g. These results showed that Cinnamomi Cortex and Cinnamomi Cortex Spissus with stem bark as usage sites had about 3.22 to 4.41 times higher content of phenolic components than Cinnamomi Ramulus with young branches as usage sites.

Keywords – Phenolic component content, Cinnamon medicines, Cinnamomi Cortex, Cinnamomi Cortex Spissus, Cinnamomi Ramulus, Cinnamaldehyde

Introduction

The origin plants of the cinnamon medicines include the *Cinnamomum cassia* in Lauraceae, the *Cinnamomum louriri* in Vietnam, and the *Cinnamomum zeylanicum* in Sri Lanka. The extraction method of essential oil is steam distillation. The obtained crude essential oil is purified in Korea and China, and essential oil containing more than 99% of the cinnamaldehyde is processed and used as food and pharmaceutical raw materials.[1] Cinnamomi Cortex is dried by peeling off the soft inner bark of the stem of the *C. cassia*. In addition, Cinnamomi Cortex Spissus is the stem bark of *C. cassia*. Cinnamomi Ramulus is a young branch of *C. cassia*. The main component of the phenolic component of Cinnamomi Cortex is cinnamaldehyde, and contains cinnamic acid, cinnamyl ethylacetate, phenyl propylacetate, cineol, 2-methoxy cinnamaldehyde, 2-methoxycinnamic acid.[1] The terpenoid components include cincassiol A, C1, C2, C3, D1, D2, D3, D4 and cinnamoids A-D, as well as coumarin.[1] Pharmaceutical effects include antipyretic, antiviral, anti-bacterial, anti-inflammatory, vascular expansion, platelet aggregation inhibition, bile secretion improvement, diabetic nephropathy improvement, sexual dysfunction improvement, sleep extension, stress ulcer inhibition, and anticancer.[1]

As an oriental medicine effect, the Cinnamomi Cortex has the effect of keeping the stomach warm and relieving abdominal pain. Cinnamomi Cortex Spissus has the effect of keeping the lower abdomen warm and promoting hormone metabolism. Cinnamomi Ramulus has the effect of antipyretic action and cold improvement action. Although the indications are clinically different, KP and KHP are currently managed as Cinnamomi Cortex by integrating Cinnamomi Cortex and Cinnamomi Cortex Spissus.[2]

A number of studies have been conducted on component separation and pharmacological efficacy[3-11] related to cinnamon medicines. Meanwhile, comparative analysis studies on cinnamon components were conducted on the essential oil components of Cinnamomi Ramulus[12] and *C. cassia* stems,[13] cinnamaldehyde, cinnamic acid, 2-methoxy

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cinnamaldehyde. However, comparative studies on the ingredients of cinnamon medicines such as Cinnamomi Cortex, Cinnamomi Cortex Spissus, and Cinnamomi Ramulus, which are used as other herbal medicines in clinical practice, have not been systematically conducted. Therefore, it is intended to compare and analyze phenolic components, which are the main components of cinnamon medicines, to confirm the component identity of cinnamon medicines, and to secure basic data for the development of functional materials using cinnamon medicines.

Experimental

Materials – Cinnamon medicines used in this study were purchased in May 2021 at Jecheon herbal medicine market in Korea and traditional Chinese medicine market in Nanchang, Jiangxi province, China. The experimental sample Cinnamomi Cortex [Vietnamese Cinnamomi Cortex CC(V)-1, CC(V)-2, CC(V)-3, CC(V)-4, Chinese Cinnamomi Cortex CC(C)-1], Cinnamomi Cortex Spissus [Chinese Cinnamomi Cortex Spissus CCS(C)-1, CCS(C)-2, CCS(C)-3, CCS(C)-4, Vietnamese Cinnamomi Cortex Spissus CCS(V)-1, CCS(V)-2, Indonesian Cinnamomi Cortex Spissus CCS(I)-1], Cinnamomi Ramulus [Chinese Cinnamomi Ramulus CR(C)-1, CR(C)-2, CR(C)-3, Vietnamese Cinnamomi Ramulus CR(V)-1, CR(V)-2] is stored in the laboratory for oriental medicine functional food materials at Semyung University (Fig. 1).

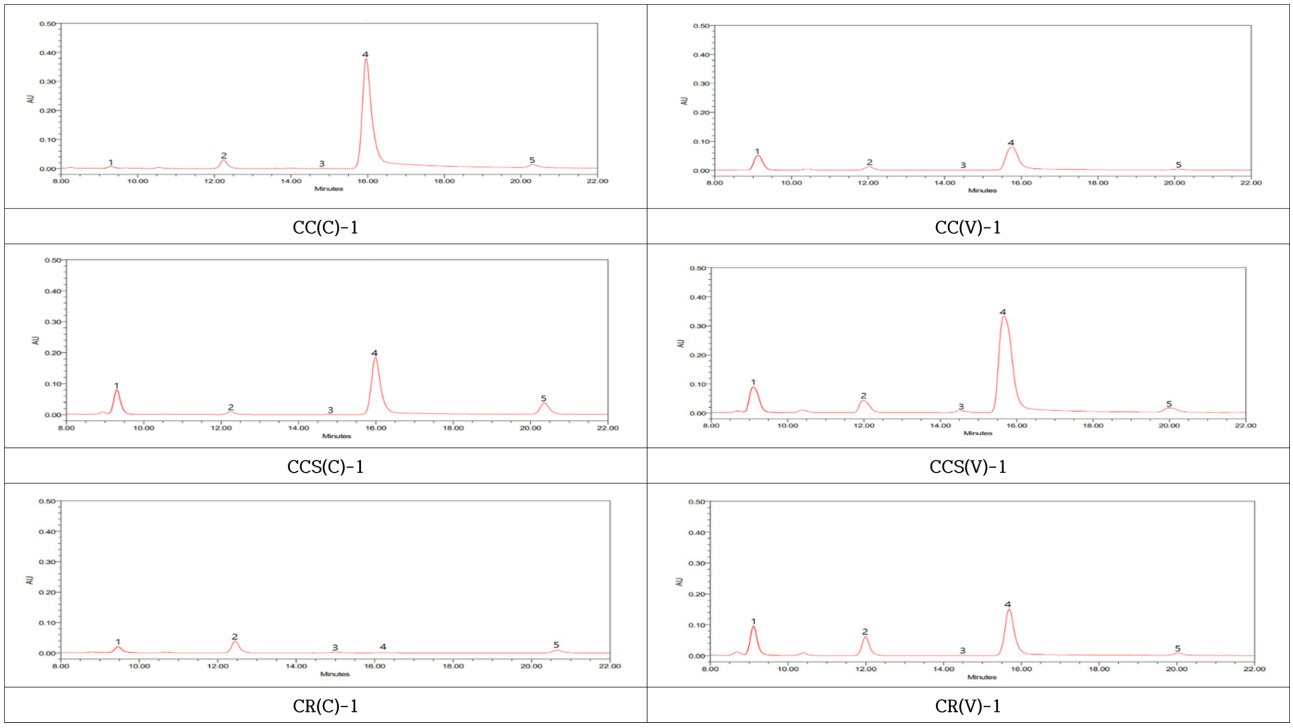
Preparation of extract – After grinding each sample of Cinnamon medicines, 250 ml of 70% ethyl alcohol (SAMCHUN, Seoul. Korea) was added to each 10 g, repeated reflux extraction twice for 2 hours, concentrated, and freeze-dried (FDU-1110, EYELA, Tokyo, Japan) to obtain extract.

HPLC analysis – The phenolic compounds of the extract was analyzed with HPLC according to the method of Zhao et al.[14] The phenolic compounds of each sample were analyzed three times. The pure phenolic compound standards (99% purity) used in this experiment were purchased from Chromadex (SantaAna, CA, USA). The HPLC instrument used was a Waters 1525 binary HPLC system (Waters, Milford, MA, USA) with a Eurospher Ⅱ C18 column (250 × 3 mm; Knauer, Berlin, Germany). The mobile phase was a mixture of acetonitrile (HPLC grade; Burdick & Jackson, 718 Cheoyong-ro Nam-gu Ulsan, Korea) and distilled water (0.1% formic Acid, HPLC grade; Burdick & Jackson, 718 Cheoyong-ro Nam-gu Ulsan, Korea). The acetonitrile content was sequentially increased from 25% to 25% (1 min), 25% to 38% (20 min), 38% to 40% (29 min), 40% to 48% (35 min) and finally adjusted from 48% to 25%. The operating temperature was set at room temperature, and the flow rate at 1 mL/min. An elution profile on a chromatogram was obtained by using a UV/VIS detector (Waters, Milford, MA, USA) at 265 nm (2487 dual absorbance detector, Waters).

Fig. 1. Figure of cinnamon medicines.

Results and Discussion

This study aims to confirm the identity of natural chemical components through comparison of phenolic components in cinnamon medicines. The phenolic component of Cinnamomi Cortex was analyzed by HPLC method (Fig. 2) for Vietnamese and Chinese Cinnamomi Cortex. As shown in Table 1, the total phenolic com-



* 1 : Coumarin, 2 : Cinnamic acid, 3 : 2-methoxycinnamic acid, 4 : Cinnamaldehyde, 5 : 2-methoxycinnamaldehyde

Fig. 2. The HPLC chromatogram of cinnamon medicines.

Table 1. The comparison of phenolic components content of Cinnamomi Cortex

(μg/g)

Phenolic compounds	Retention time (min)	Calibration curves[1)]	R^2	CC(V)-1	CC(V)-2	CC(V)-3	CC(V)-4	CC(C)-1
Coumarin	9.300	y = 35394x – 23370	0.9999	2040 ± 0.000	4120 ± 0.000	1820 ± 0.000	660 ± 0.000	270 ± 0.000
Cinnamic acid	12.252	y = 61439x – 7634.1	0.9999	230 ± 0.000	470 ± 0.000	370 ± 0.000	310 ± 0.000	760 ± 0.000
2-methoxycinnamic acid	14.803	y = 10705x – 6155.3	1.0000	-	10 ± 0.000	-	-	20 ± 0.000
Cinnamaldehyde	15.991	y = 23445x – 23914	0.9993	5450 ± 0.000	6490 ± 0.000	6760 ± 0.000	22960 ± 0.001	33030 ± 0.002
2-methoxycinnamaldehyde	20.409	y = 345910x – 398.42	1.0000	140 ± 0.000	520 ± 0.000	70 ± 0.000	20 ± 0.000	730 ± 0.000
Total	-	-	-	7860	11610	9020	23950	34810

[1)]y : area units, x : concentration in standard solutions (ppm), * CC(V) : Vietnamese Cinnamomi Cortex, CC(C) : Chinese Cinnamomi Cortex

ponent, which is the sum of the analyzed phenolic components, showed the highest content of CC(C)-1 at 34810 μg/g, followed by CC(V)-4 (23950 μg/g) and CC(V)-2 (11610 μg/g). In addition, cinnamaldehyde, an indicator component of Cinnamomi Cortex, a main component, and a phenylpropanoid phenolic component, also showed the highest content of CC(C)-1 at 33030 μg/g, followed by CC(V)-4 (22960 μg/g), and CC(V)-3 (6760 μg/g). However, coumarin, a coumarin-based component, showed the highest content of CC(V)-2 at 4120 μg/g, followed by CC(V)-1 (2040 μg/g) and CC(V)-3 (1820 μg/g).

As shown in Table 2, the ingredients of Cinnamomi Cortex Spissus were reviewed for Vietnamese, Chinese, and Indonesian Cinnamomi Cortex Spissus. The total phenolic component showed the highest content of CCS(V)-1 at 31040 μg/g, followed by CCS(V)-2 (20010 μg/g) and CCS(C)-2 (18490 μg/g). In addition, cinnamaldehyde, the main component of Cinnamomi Cortex Spissus, also showed the highest content of CCS(V)-1 at 25080 μg/g, and CCS(C)-2 (14940 μg/g), and CCS(V)-2(13800 μg/g) in order. However, coumarin, a coumarin-based component, showed the highest content of CCS(V)-2 at 4610 μg/g, followed by CCS(V)-1 (3870 μg/g) and CCS(I)-1 (2960 μg/g).

Table 2. The comparison of phenolic components content of Cinnamomi Cortex Spissus

(μg/g)

	CCS(C)-1	CCS(C)-2	CCS(C)-3	CCS(C)-4	CCS(V)-1	CCS(V)-2	CCS(I)-1
coumarin	2700 ± 0.000	920 ± 0.000	470 ± 0.000	100 ± 0.000	3870 ± 0.000	4610 ± 0.000	2960 ± 0.000
cinnamic acid	170 ± 0.000	650 ± 0.000	480 ± 0.000	900 ± 0.000	970 ± 0.000	580 ± 0.000	510 ± 0.000
2-methoxycinnamic acid	10 ± 0.000	30 ± 0.000	20 ± 0.000	-	300 ± 0.000	10 ± 0.000	10 ± 0.000
cinnamaldehyde	9840 ± 0.000	14940 ± 0.001	11420 ± 0.001	9250 ± 0.005	25080 ± 0.001	13800 ± 0.000	9280 ± 0.000
2-methoxycinnamaldehyde	1590 ± 0.001	1950 ± 0.000	1060 ± 0.000	210 ± 0.001	820 ± 0.000	1010 ± 0.000	-
Total	14310	18490	13450	10460	31040	20010	12760

* CCS(C) : Chinese Cinnamomi Cortex Spissus, CCS(V) : Vietnamese Cinnamomi Cortex Spissus, CCS(I) : Indonesian Cinnamomi Cortex Spissus

Table 3. The comparison of phenolic components content of Cinnamomi Ramulus

(μg/g)

	CR(C)-1	CR(C)-2	CR(C)-3	CR(V)-1	CR(V)-2
coumarin	550 ± 0.000	880 ± 0.000	1490 ± 0.000	1900 ± 0.000	4300 ± 0.000
cinnamic acid	530 ± 0.000	690 ± 0.000	600 ± 0.000	630 ± 0.000	1150 ± 0.000
2-methoxycinnamic acid	70 ± 0.000	70 ± 0.000	10 ± 0.000	10 ± 0.000	60 ± 0.000
cinnamaldehyde	40 ± 0.000	760 ± 0.000	440 ± 0.000	4680 ± 0.000	2800 ± 0.000
2-methoxycinnamaldehyde	320 ± 0.000	1010 ± 0.000	150 ± 0.000	190 ± 0.000	950 ± 0.000
Total	1510	3410	2690	7410	9260

* CR(C) : Chinese Cinnamomi Ramulus, CR(V) : Vietnamese Cinnamomi Ramulus

Table 4. Comparison of the average content of phenolic components in cinnamon medicines

(μg/g)

	Cinnamomi Cortex		Cinnamomi Cortex Spissus			Cinnamomi Ramulus	
	China	Vietnam	China	Vietnam	Indonesia	China	Vietnam
coumarin	270	2160	1047.5	4240	2960	973.3	3100
cinnamic acid	760	345	550	775	510	606.7	890
2-methoxycinnamic acid	20	10	20	155	10	50	35
cinnamaldehyde	33030	10415	11362.5	19440	9280	413.3	3740
2-methoxycinnamaldehyde	730	188	1202.5	915	-	493.3	570
Total	34810	13118	14182.5	25525	12760	2536.6	8335
	23964			17489		5435.8	

The ingredients of Cinnamomi Ramulus were compared and reviewed for Chinese and Vietnamese Cinnamomi Ramulus. As shown in Table 3, the total phenolic component showed the highest content of CR(V)-2 (9260 μg/g), followed by CR(V)-1 (7410 μg/g) and CR(C)-2 (3410 μg/g). In addition, cinnamaldehyde, the main component of Cinnamomi Ramulus, also showed the highest content of CR(V)-1 at 4680 μg/g, followed by CR(V)-2 (2800 μg/g) and CR(C)-2 (760 μg/g). However, coumarin showed the highest content of CR(V)-2 at 4300 μg/g, followed by CR(V)-1 (1900 μg/g) and CR(C)-3 (1490 μg/g).

On the other hand, as a result of comparing and reviewing the average content of the phenolic component of cinnamon medicines, as shown in Table 4, the total phenolic component of Cinnamomi Cortex in China was 34810 μg/g, about 2.65 times higher than that of Cinnamomi Cortex in Vietnam (13118 μg/g). In addition, in the case of cinnamaldehyde, the main ingredient, Chinese Cinnamomi Cortex was 33030 μg/g, about 3.17 times higher than Vietnamese Cinnamomi Cortex (10415 μg/g). In the case of Cinnamomi Cortex Spissus, Vietnam's Cinnamomi Cortex Spissus showed the highest content of 25525 μg/g, about 1.80 times higher than that of China's Cinnamomi Cortex Spissus (14182.5 μg/g). In addition, in the case of cinnamaldehyde, Vietnamese Cinnamomi Cortex Spissus was 19440 μg/g, which was about 1.40

times higher than that of Chinese Cinnamomi Cortex Spissus (11362.5 μg/g). For Cinnamomi Ramulus, Vietnamese Cinnamomi Ramulus was 8335 μg/g, which was about 3.29 times higher than Chinese Cinnamomi Ramulus (2536.6 μg/g). In addition, in the case of cinnamaldehyde, Vietnamese Cinnamomi Ramulus was 3740 μg/g, which was about 9.05 times higher than that of Chinese Cinnamomi Ramulus (413.3 μg/g).

Meanwhile, in terms of the average content of phenolic components of cinnamon medicines, Cinnamomi Cortex was the highest at 23964 μg/g, followed by Cinnamomi Cortex Spissus at 17489 μg/g and Cinnamomi Ramulus at 5435.8 μg/g. These results showed that Cinnamomi Cortex and Cinnamomi Cortex Spissus with stem bark as usage sites had about 3.22 to 4.41 times higher content of phenolic components than Cinnamomi Ramulus with young branches as usage sites.

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