

Research Article



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유채꽃 가공유형별 플라보노이드 조성 및 함량 변화

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2

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Changes in Composition and Content of Flavonoids by Processing Type in Rapeseed (*Brassica napus*) Flowers

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Abstract

BACKGROUND: Increased value added by rapeseed (*Brassica napus*) by-product and the development of a usable rapeseed functional tea.

METHODS AND RESULTS: To develop a usable rapeseed functional tea, the total flavonoid content in the varieties Youngsan, Tammi, Tamra, Naehan, Hanra, Mokpo No. 68, and Mokpo No. 111 was investigated. Effect of three treatments, i.e., drying, leaching, and roasting, on flavonoid contents of flower was tested using multiple processing methods per treatment. Total flavonoid content decreased under the various drying methods, confirming that flavonoid content is heat-dependent. This finding was more pronounced for freezing and oven-drying (15.3 and 13.8 mg/g DW, respectively), with a 10% difference in the total flavonoid content between the two methods. Under leaching conditions, the flavonoid content decreased with increasing treatment time. Notably, roasting

methods did not result in loss of flavonoid content. The total flavonoid content in the rapeseed varieties decreased in the following order: Youngsan, Tammi, Tamra, Naehan, Hanra, Mokpo No. 68, and Mokpo No. 111.

CONCLUSION: The flavonoid content in rapeseed flower was higher in Youngsan than in the other varieties, under processing conditions such as freeze-drying, leaching at 90°C for 5 min, and roasting.

Key words: Flavonoids, HPLC, Rapeseed Flower Tea, UPLC-Q-TOF/MS

서론

(*Brassica napus* L.)

(Brassicaceae)

(Downey, 1983).

BC 2300

1960

(Prakash, 1980; Jung *et al.*, 2007).

(Lee *et al.*, 2014).

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40% 25~35% 5
 (, , , ,) ,
 (Kim *et al.*, 1988; Lee *et al.*, 1994).
 가 ,
 가 (Kim, 2009;
 Trethewey, 2012). 가
 (Kim *et al.*, 2007).

(Roger and Frank, 1980; Danielsen *et al.*,
 1994).
 (Yang *et al.*, 2014).

(Kim *et al.*, 2010), LED
 (Cho *et al.*, 2008),
 (Lee *et al.*, 2010)
 (Amarowicz, 2000),
 (Mariassyova *et al.*, 2006)
 isorhamnetin , quercetin
 , kaempferol (Shao *et al.*, 2014)
 (茶)

(Jo *et al.*, 2006).
 가
 , ,
 (Jae, 2008).

500 (Jo *et al.*, 2002).

가 가 ,
 (Rice-Evans, 1999).

가 ,
 가 가
 가 .
 , 8,000 가 2
 (Harborne and Williams, 2000).
 (flavone) C6-C3-C6

(Fig. 1)
 (Hetog *et al.*, 1993; Zeng *et al.*, 1997).
 phenylpropanoid

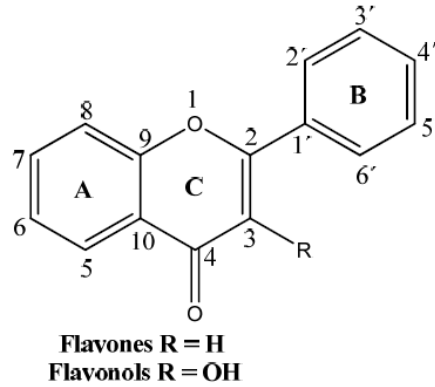


Fig. 1. Basic chemical structure of flavonoids.

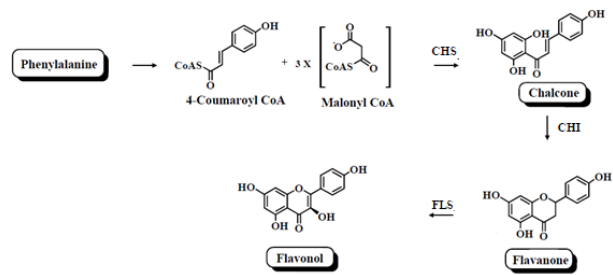


Fig. 2. The proposed flavonoid biosynthesis pathway. CHS, chalcone synthase; CHI, Chalcone isomerase; FLS, Flavone synthase.

(C6-C-C-C)가 (Fig. 2),
 (Zhao and Dixon, 2010).

(Kawaguchi *et al.*, 1997; Cha *et al.*, 1999a).
 (-OH)

가
 (Lu and Foo, 2000; Cha *et al.*, 1999b).
 가
 가
 (Camellia
 sinensis)

재료 및 방법

시약

HPLC-grade methanol (CH₃OH) ethanol (C₂H₅OH)
 Fisher Scientific Korea Ltd. (Seoul, Korea)

. Phosphoric acid (H₃PO₄) Wako Pure Chemical Industries, Ltd. (Osaka, Japan) . Formic acid (HCOOH) SAMCHUN Pure Chemical (Pyeongtaek, Korea) . Acetic-acid (CH₃COOH) Junsei Chemical Co., Ltd. (Tokyo, Japan) . kaempferol Wako Pure Chemical Industries, Ltd. (Osaka, Japan) , quercetin Extrasynthese (Genay, France) , isorhamnetin Biopurify Phytochemicals Ltd (Chengdu, Sichuan, China)

재료 및 품종 선별

2014 4 18 (,) ' , ' 68 ' , ' 111 ' , ' ' , ' ' , ' ' 7 가 ' .

[실험 I] 유채꽃 건조

1% (w/v) 1~2 가 . (, ,), (40°C, 60°C oven dry), 5가

[실험 II] 차 침출

1 g 3가 (70, 80, 90°C) (1, 3, 5) 100 mL (1 g/100 mL). (SFDSF 12, Samwon frezing engineering Co., Busan, Korea)

[실험 III] 덩음 처리

hot plate 130°C 5 . 1 g 70°C 3 100 mL . (SFDSF 12, Samwon frezing engineering Co., Busan, Korea)

플라보노이드 추출

, (modified from Perez-Gregorio *et al.*, 2010).

유채꽃 내 플라보노이드 추출

2.0 mL eppendorf tube (10 mg) 10% phosphoric acid MeOH(1.0 mL) . 37°C 3 (12,000 rpm, 10 min, 4°C)

0.45 µm PTFE hydrophilic syringe filter (13 mm) , HPLC vial .

유채꽃 침출물 내 플라보노이드 추출

(50 mL) 45°C . (5% formic acid, v/v) 2.0 mL 0.45 µm PTFE hydrophilic syringe filter(13 mm) HPLC vial .

HPLC 분석

1200 series HPLC system (Agilent Technologies, Santa Clara, CA, USA) Capcell PAK C18 (4.6×250 mm, particle size 5 µm) (GL Science, Tokyo, Japan) , 40°C, (detection wavelength) 350 nm, (flow rate) 1.0 mL/min . (automatic injector) 10.0 µL A methanol: water: acetic acid, 5: 92.5: 2.5 (v/v/v) B methanol: water: acetic acid, 95: 2.5: 2.5 (v/v/v) . 0-27 min, 10-36% B; 27-32 min, 36-60% B; 35-35.1 min, 60-10% B; 35.1-40 min, 10% B 3 isorhamnetin, kaempferol, quercetin HPLC (mg/g DW) .

플라보노이드 Ultraperformance Liquid Chromatography with Q-TOF Mass Spectrometry 분석

Acquty Ultra Performance Liquid Chromatographic System (Waters Co., Milford, MA, USA) , Xevo G2-S Q-TOF Mass Spectrometer (Waters Co.) positive ion mode ([M+H]⁺) . Kinetex 1.7 µ XB-C18 100A (2.1×150 mm, Phenomenex, Torrance, CA, USA) . 30°C, (detection wavelength) 350 nm, (flow rate) 0.3 mL/min . (automatic injector) 10.0 µL A water: formic acid, 99.5: 0.5 (v/v) B acetonitrile: formic acid, 99.5: 0.5 (v/v) . 0-10 min, 5-10% B; 10-25 min, 10-25% B; 25-30 , 25-50% B; 30-35 min, 50-90% B; 35-37 min, 90% B; 37-40 min, 90-5% B; 40-45 min, 5% B . (capillary voltage) 3.5 kV, 가 (cone gas) 50 L/h , 가 (curtain gas) N₂ 1050 L/h, (desolvation temperature) 500°C, (source temperature) 120°C, (scan spectra) *m/z* 200-1,600 , (scan time) 1.0s .

Table 2. Flavonoid contents (mg/g DW) in seven varieties of rapeseed flowers (n=3)

No. ^{a)}	Flavonoids	Cultivars							Average of sum (%)
		Hanra	Mokpo no.68	Mokpo no.111	Naehan	Tammi	Tamra	Young san	
1	Quercetin-3-Osophoroside-7-OD-glucoside	0.07±0.04ab ⁹⁾	0.02±0.00bc	0.01±0.01c	0.03±0.00bc	0.03±0.00bc	0.05±0.01abc	0.10±0.01a	0.04 (0)
2	Kaempferol-3,7,4'-OD-triglucoside	0.15±0.01ab	0.10±0.01b	0.07±0.02b	0.12±0.00b	0.10±0.01b	0.09±0.03b	0.26±0.10a	0.13 (1)
3	Kaempferol-3-Osophoroside-7-OD-glucoside	0.22±0.02a	0.16±0.01ab	0.08±0.04bc	0.13±0.03abc	0.15±0.03abc	0.06±0.01c	0.22±0.06a	0.15 (1)
4	Isorhamnetin-3,7,4'-OD-triglucoside	0.25±0.01bc	0.26±0.02bc	0.19±0.02c	0.33±0.01b	0.28±0.01bc	0.32±0.05b	0.58±0.09a	0.31 (2)
5	Isorhamnetin-3-Osophoroside-7-OD-glucoside	0.29±0.01b	0.22±0.03bc	0.13±0.01c	0.23±0.02bc	0.25±0.02b	0.21±0.04bc	0.63±0.09a	0.28 (2)
6	Quercetin-3-OD-glucoside-7-OD-glucoside	0.37±0.02d	0.83±0.11ab	0.44±0.02d	0.64±0.05c	0.66±0.02bc	1.00±0.09a	0.89±0.09a	0.69 (5)
7	Quercetin-3-Osinapoyl-sophoroside-7-OD-glucoside	0.08±0.01b	0.03±0.00c	ND ^{b)}	0.03±0.00c	0.02±0.00cd	0.01±0.01cd	0.12±0.02a	0.04 (0)
8	Kaempferol-3-OD-glucoside-7-OD-glucoside	1.35±0.03b	1.75±0.19a	0.65±0.03c	0.81±0.04c	1.12±0.02b	1.34±0.15b	1.96±0.11a	1.28 (9)
9	Isorhamnetin-3-OD-glucoside-7-OD-glucoside	4.43±0.02c	6.36±0.71b	4.69±0.13c	6.95±0.61ab	6.75±0.15b	6.70±0.67b	8.02±0.06a	6.27 (42)
10	Isorhamnetin-3-Ogentiobioside-7-OD-glucoside	0.02±0.00b	0.01±0.01bc	ND	ND	0.02±0.00b	ND	0.05±0.02a	0.02 (0)
11	Quercetin-3-Osophoroside	0.33±0.00a	0.12±0.01d	0.14±0.00d	0.21±0.00c	0.19±0.00c	0.10±0.01e	0.28±0.02b	0.20 (1)
12	Isorhamnetin-3-Ogentiobioside	0.30±0.01b	0.17±0.01e	0.23±0.01cd	0.26±0.01c	0.23±0.00c	0.20±0.02de	0.36±0.02a	0.25 (2)
13	Kaempferol-3-Osophoroside	1.06±0.04a	0.40±0.01e	0.30±0.01f	0.69±0.03b	0.54±0.02cd	0.49±0.03d	0.57±0.02c	0.58 (4)
14	Isorhamnetin-3-Osophoroside	0.36±0.01c	0.38±0.05c	0.51±0.02b	0.49±0.01b	0.53±0.02b	0.71±0.08a	0.46±0.02bc	0.49 (3)
15	Quercetin-3-OD-glucoside	0.10±0.00ab	0.13±0.00ab	0.05±0.01b	0.07±0.00b	0.10±0.02b	0.09±0.02b	0.20±0.09a	0.11 (1)
16	Quercetin-3-Disinapoyl-triglucoside-7-OD-glucoside	0.28±0.01b	0.08±0.03e	0.09±0.01e	0.25±0.1bc	0.20±0.01d	0.23±0.00cd	0.39±0.02a	0.22 (1)
17	Kaempferol-7-OD-glucoside	0.28±0.05b	0.09±0.00c	0.11±0.05c	0.58±0.04a	0.36±0.01b	0.38±0.05b	0.56±0.1a	0.34 (2)
18	Kaempferol-3-OD-glucoside	1.10±0.07a	0.50±0.05c	0.47±0.03c	0.32±0.01d	0.54±0.02c	0.54±0.06c	0.76±0.01b	0.60 (4)
19	Isorhamnetin-3-OD-glucoside	2.57±0.08c	1.68±0.22d	3.32±0.15ab	3.20±0.13ab	3.56±0.05a	3.02±0.33bc	3.02±0.02bc	2.91 (19)
	Total	13.62±0.25bc	13.30±1.41bc	11.48±0.43d	15.33±0.90b	15.65±0.36b	15.53±1.37b	19.41±0.60a	14.90

^{a)}No., the elution order of flavonoids, ^{b)}ND, not detected, ^{c)}Within each column, values follow by the same letters are not significantly different at *P*<0.05, using Tukey's multiple-range test (*n*=3).

Table 3. Flavonoid group contents (mg/g DW) in seven varieties of rapeseed flowers (n=3) (recalculated from Table 2.)

Flavonoid group	Cultivars							Average of sum (%)
	Hanra	Mokpo no.68	Mokpo no.111	Naehan	Tammi	Tamra	Young san	
Isorhamnetin	8.23	9.08	9.07	11.45	11.64	11.16	13.12	10.53 (70)
Quercetin	1.23	1.22	0.73	1.23	1.19	1.48	1.97	1.30 (9)
Kaempferol	4.16	3.00	1.68	2.65	2.82	2.90	4.32	3.08 (21)
Total	13.62	13.30	11.48	15.33	15.65	15.53	19.41	14.90

isorhamnetin-3-Ogentiobioside-7-OD-glucoside (19.4), isorhamnetin-3-Osophoroside-7-OD-glucoside (42), isorhamnetin-3-OD-glucoside (19), kaempferol-3-OD-glucoside-7-OD-glucoside (9%) (Table 3.), isorhamnetin (10.5), kaempferol (3.1), quercetin (1.3 mg/g DW) isorhamnetin 가 Isorhamnetin quercetin 3'-O-methylated metabolite (Won *et al.*, 2016). isorhamnetin 7 isorhamnetin-3-Osophoroside-7-OD-glucoside 4.4~

8.0, isorhamnetin-3-OD-glucoside 1.7~3.6, kaempferol-3-OD-glucoside-7-OD-glucoside 0.7~2.0 mg/g DW isorhamnetin-3-Osophoroside-7-OD-glucoside, kaempferol-3-OD-glucoside-7-OD-glucoside 가 Isorhamnetin-3-OD-glucoside 가 isorhamnetin-3-OD-glucoside (1.7) kaempferol-3-OD-glucoside-7-OD-glucoside (1.8 mg/g DW) 건조조건별 플라보노이드 함량 5가 flavonoid 15.3 mg/g DW 가 40°C (14.4)> (13.9)>60°C (13.8 mg/g DW) (Table 4). (' ') 19.4 mg/g

Table 4. Flavonoid contents (mg/g DW) in rapeseed flowers with dry conditions ($n=3$)

No. ^{a)}	Flavonoids	40°C Oven dry	60°C Oven dry	Lab dry	Green house dry	Freeze dry
1	Quercetin-3- <i>O</i> sophoroside-7- <i>O</i> D-glucoside	0.08±0.01a ^{c)}	0.06±0.00b	0.08±0.01a	0.07±0.00ab	0.08±0.01ab
2	Kaempferol-3,7,4'- <i>O</i> D-triglucoside	0.17±0.02bc	0.16±0.00c	0.19±0.01ab	0.15±0.01c	0.20±0.01a
3	Kaempferol-3- <i>O</i> sophoroside-7- <i>O</i> D-glucoside	0.20±0.01a	0.15±0.00bc	0.18±0.02ab	0.14±0.01c	0.21±0.01±
4	Isorhamnetin-3,7,4'- <i>O</i> D-triglucoside	0.41±0.01b	0.35±0.00c	0.42±0.02ab	0.37±0.02c	0.45±0.01a
5	Isorhamnetin-3- <i>O</i> sophoroside-7- <i>O</i> D-glucoside	0.44±0.01ab	0.38±0.00c	0.42±0.02b	0.37±0.01c	0.47±0.01a
6	Quercetin-3- <i>O</i> D-glucoside-7- <i>O</i> D-glucoside	0.61±0.01b	0.50±0.01d	0.54±0.01c	0.48±0.01d	0.66±0.01a
7	Quercetin-3- <i>O</i> sinapoyl-sophoroside-7- <i>O</i> D-glucoside	0.10±0.00a	0.08±0.00b	0.08±0.00b	0.08±0.00b	0.09±0.00a
8	Kaempferol-3- <i>O</i> glucoside-7- <i>O</i> D-glucoside	1.40±0.01a	1.19±0.01c	1.30±0.01b	1.14±0.03c	1.48±0.06a
9	Isorhamnetin-3- <i>O</i> D-glucoside-7- <i>O</i> D-glucoside	6.09±0.09b	5.68±0.06c	5.91±0.12bc	5.77±0.17bc	6.50±0.14a
10	Isorhamnetin-3- <i>O</i> gentiobioside-7- <i>O</i> D-glucoside	TR ^{b)}	TR	TR	TR	TR
11	Quercetin-3- <i>O</i> sophoroside	0.18±0.00a	0.18±0.01a	0.17±0.00a	0.17±0.01a	0.18±0.00a
12	Isorhamnetin-3- <i>O</i> gentiobioside	0.29±0.01ab	0.28±0.00b	0.31±0.01a	0.30±0.01ab	0.29±0.01ab
13	Kaempferol-3- <i>O</i> sophoroside	0.38±0.01b	0.36±0.00bc	0.35±0.00c	0.38±0.01b	0.42±0.01a
14	Isorhamnetin-3- <i>O</i> sophoroside	0.36±0.01a	0.36±0.01a	0.37±0.01a	0.37±0.01a	0.35±0.02a
15	Quercetin-3- <i>O</i> D-glucoside	0.15±0.01a	0.10±0.01bc	0.12±0.01b	0.09±0.00c	0.17±0.01a
16	Quercetin-3- <i>O</i> disinapoyl-triglucoside-7- <i>O</i> D-glucoside	0.29±0.01a	0.21±0.01b	0.20±0.01b	0.16±0.01c	0.32±0.01a
17	Kaempferol-7- <i>O</i> D-glucoside	0.45±0.01a	0.31±0.01b	0.30±0.02b	0.30±0.01b	0.46±0.01a
18	Kaempferol-3- <i>O</i> D-glucoside	0.63±0.02a	0.65±0.02a	0.68±0.02a	0.67±0.02a	0.55±0.03b
19	Isorhamnetin-3- <i>O</i> D-glucoside	2.63±0.11bc	2.74±0.03ab	2.80±0.08ab	2.93±0.11a	2.41±0.10c
	Total	14.86±0.34ab	13.75±0.13c	14.42±0.26bc	13.94±0.35c	15.28±0.36a

^{a)}No., the elution order of flavonoids, ^{b)}TR, trace, ^{c)}Within each column, values follow by the same letters are not significantly different at $P<0.05$, using Tukey's multiple-range test ($n=3$).

DW (2.8)>60°C (2.7)>40°C (2.6)> (2.4 mg/DW)

가

(Kim *et al.*, 2011).

(*Isodon japonicus*)

1.6 (Kim *et al.*, 2009),

가 1.2

(Chung *et al.*, 2013). 40°C (14.9)

(15.3 mg/g DW)

(,)

14.2 mg/g DW

(40, 60°C) 14.3 mg/g DW 가

(246.4), (239.0 mg/

kg DW) 가 .

isorhamnetin-3-*O*sophoroside-7-*O*D-glucoside 5.7~6.5, isorhamnetin-3-*O*D-glucoside 2.4~2.9, kaempferol-3-*O*D-glucoside-7-*O*D-glucoside 1.1~1.5 mg/g DW

isorhamnetin-3-*O*sophoroside-7-*O*D-glucoside, kaempferol-3-*O*D-glucoside-7-*O*D-glucoside isorhamnetin-3-*O*D-glucoside (2.9)>

침출조건별 플라보노이드 함량

3가 (1, 3, 5) (70, 80, 90°C)

(Table 5).

3.8~13.2

9 mg/g DW ,

0°C/5 (13.2)>80°C/5 (11.5)>90°C/3 (11.0)>80°C/3

(8.8)>70°C/5 (7.4)>90°C/1 (7.0)>70°C/3 (6.3)>80°C

/1 (5.5)>70°C/1 (3.8 mg/g DW)

(70, 80, 90°C

) 5 (10.7)>3 (8.7)>1 (5.4

mg/g DW)

(1, 3, 5) 9

0°C(10.4)>80°C(8.6)>70°C(5.8 mg/g DW)

가

(Jang *et*

al., 2006) 100°C

/4.5 (8.1)>80°C/8.5 (8.0)>90°C/6.5 (7.9)>80°C/4.5

(7.1)>80°C/4.5 (6.9)>70°C/6.5 (6.1)>90°C/2.5

(6.0)>60°C/4.5 (4.4)>70°C/2.5 (2.7)>80°C/0.5 (1.4

mg/g DW)

Table 5. Flavonoid contents (mg/g DW) according to leaching temperature and time in the flower tea of rapeseed (n=3)

No. ^{a)}	Flavonoids	70°C			80°C			90°C		
		1 min	3 min	5 min	1 min	3 min	5 min	1 min	3 min	5 min
1	Quercetin-3-Osophorosite-7-OD-glucoside	0.02±0.00f ^{b)}	0.05±0.00de	0.06±0.01cd	0.04±0.00ef	0.07±0.01c	0.11±0.01b	0.05±0.01de	0.11±0.01b	0.16±0.01a
2	Kaempferol-3,7,4'-OD-triglucoside	0.09±0.00f	0.16±0.01de	0.19±0.02cd	0.13±0.01e	0.22±0.02c	0.29±0.02b	0.17±0.02de	0.28±0.01b	0.34±0.00a
3	Kaempferol-3-Osophorosite-7-OD-glucoside	0.11±0.01e	0.20±0.01d	0.23±0.03d	0.18±0.02d	0.30±0.03c	0.37±0.02ab	0.23±0.02d	0.36±0.00b	0.43±0.01a
4	Isorhamnetin-3,7,4'-OD-triglucoside	0.14±0.01f	0.26±0.01de	0.30±0.03d	0.23±0.02e	0.37±0.04c	0.50±0.02b	0.29±0.03de	0.48±0.01b	0.58±0.01a
5	Isorhamnetin-3-Osophorosite-7-OD-glucoside	0.04±0.00e	0.09±0.00de	0.13±0.02cd	0.08±0.01de	0.13±0.03cd	0.22±0.01ab	0.10±0.01cd	0.17±0.06bc	0.28±0.01a
6	Quercetin-3-OD-glucoside-7-OD-glucoside	0.12±0.01e	0.24±0.01d	0.29±0.05d	0.22±0.02d	0.39±0.06c	0.53±0.04b	0.30±0.03cd	0.53±0.01b	0.71±0.02a
7	Quercetin-3-Osinapoyl-sophorosite-7-OD-glucoside	0.04±0.00f	0.06±0.00cd	0.07±0.01c	0.04±0.00ef	0.07±0.01c	0.11±0.01b	0.05±0.00de	0.10±0.00b	0.13±0.01a
8	Kaempferol-3-Oglucoside-7-OD-glucoside	0.31±0.03d	0.61±0.03c	0.69±0.11c	0.59±0.06c	1.00±0.12c	1.25±0.09a	0.79±0.08bc	1.25±0.01a	1.44±0.06a
9	Isorhamnetin-3-OD-glucoside-7-OD-glucoside	0.77±0.04e	1.47±0.05d	1.73±0.26d	1.29±0.14d	2.29±0.30c	3.09±0.22b	1.71±0.18d	3.02±0.07b	3.73±0.04a
10	Isorhamnetin-3-Ogentiobioside-7-OD-glucoside	0.36±0.02c	0.51±0.01ab	0.54±0.04ab	0.35±0.02c	0.48±0.06d	0.58±0.01a	0.38±0.02c	0.51±0.01ab	0.57±0.01a
11	Quercetin-3-Osophorosite	0.09±0.01f	0.11±0.00de	0.14±0.01cd	0.10±0.01ef	0.15±0.01c	0.19±0.01b	0.13±0.00cd	0.19±0.01b	0.22±0.01a
12	Isorhamnetin-3-Ogentiobioside	0.07±0.01e	0.12±0.00d	0.16±0.01c	0.10±0.01d	0.17±0.01c	0.23±0.01ab	0.12±0.01d	0.21±0.00b	0.25±0.00a
13	Kaempferol-3-Osophorosite	0.45±0.05d	0.49±0.02cd	0.53±0.03cd	0.46±0.02d	0.58±0.02bc	0.66±0.05ab	0.55±0.02bc	0.65±0.04ab	0.71±0.09a
14	Isorhamnetin-3-Osophorosite	0.10±0.01g	0.18±0.00ef	0.24±0.02cd	0.15±0.01f	0.26±0.02c	0.35±0.01b	0.20±0.02de	0.33±0.01b	0.39±0.01a
15	Quercetin-3-OD-glucoside	0.01±0.00de	0.02±0.00cd	0.03±0.00c	0.00±0.00e	0.03±0.00c	0.07±0.00b	0.02±0.00cd	0.07±0.00b	0.09±0.01a
16	Quercetin-3-Odisnapoyl-triglucoside-7-OD-glucoside	0.03±0.01f	0.06±0.01de	0.08±0.01dc	0.05±0.00ef	0.09±0.01c	0.13±0.01ab	0.06±0.01de	0.13±0.00b	0.15±0.01a
17	Kaempferol-7-OD-glucoside	0.13±0.02b	0.18±0.04b	0.11±0.01b	0.20±0.01b	0.15±0.01b	0.32±0.10a	0.09±0.01b	0.33±0.01a	0.39±0.04a
18	Kaempferol-3-OD-glucoside	0.27±0.03e	0.43±0.02cd	0.55±0.04b	0.36±0.02d	0.56±0.03b	0.68±0.03a	0.45±0.04c	0.61±0.02ab	0.66±0.01a
19	Isorhamnetin-3-OD-glucoside	0.63±0.08f	1.02±0.06de	1.32±0.14c	0.94±0.07e	1.51±0.14bc	1.79±0.08a	1.25±0.13cd	1.69±0.07ab	1.96±0.02a
	Total	3.79±0.31f	6.29±0.23de	7.38±0.82cd	5.53±0.39e	8.82±0.79c	11.47±0.57b	6.95±0.59de	11.00±0.17b	13.19±0.06a

^{a)}No., the elution order of flavonoids, ^{b)}Within each column, values follow by the same letters are not significantly different at P<0.05, using Tukey's multiple-range test (n=3).

Table 6. Flavonoid contents (mg/g DW) in the flower tea of rapeseed roasted at 130 for 5 min and leached out at 70 for 3 min (n=3)

No. ^{a)}	Flavonoids	No roasted	Roasted
1	Quercetin-3-Osophorosite-7-OD-glucoside	0.05±0.00	0.21±0.01
2	Kaempferol-3,7,4'-OD-triglucoside	0.15±0.01	0.37±0.02
3	Kaempferol-3-Osophorosite-7-OD-glucoside	0.20±0.01	0.41±0.02
4	Isorhamnetin-3,7,4'-OD-triglucoside	0.27±0.01	0.54±0.03
5	Isorhamnetin-3-Osophorosite-7-OD-glucoside	0.09±0.02	0.27±0.01
6	Quercetin-3-OD-glucoside-7-OD-glucoside	0.26±0.02	0.59±0.03
7	Quercetin-3-Osinapoyl-sophorosite-7-OD-glucoside	0.06±0.01	0.16±0.01
8	Kaempferol-3-Oglucoside-7-OD-glucoside	0.59±0.04	1.30±0.07
9	Isorhamnetin-3-OD-glucoside-7-OD-glucoside	1.50±0.11	3.28±0.20
10	Isorhamnetin-3-Ogentiobioside-7-OD-glucoside	0.45±0.03	0.63±0.02
11	Quercetin-3-Osophorosite	0.11±0.01	0.22±0.01
12	Isorhamnetin-3-Ogentiobioside	0.12±0.01	0.25±0.01
13	Kaempferol-3-Osophorosite	0.46±0.03	0.81±0.06
14	Isorhamnetin-3-Osophorosite	0.13±0.01	0.30±0.06
15	Quercetin-3-OD-glucoside	0.02±0.00	0.11±0.01
16	Quercetin-3-Odisnapoyl-triglucoside-7-OD-glucoside	0.04±0.00	0.14±0.04
17	Kaempferol-7-OD-glucoside	0.17±0.01	0.68±0.15
18	Kaempferol-3-OD-glucoside	0.34±0.03	0.55±0.03
19	Isorhamnetin-3-OD-glucoside	0.87±0.09	1.44±0.05
	Total	5.89±0.42	12.29±0.34

^{a)}No., the elution order of flavonoids.

100°C) 57가 (0.5, 2.5, 4.5, 6.5, 8.5) , 57가 (60, 70, 80, 90,)

가 .

덕음 유무별 플라보노이드 함량

98.48°C 6.03 (Jang et al., 2006). 90°C,

() 130°C/5

(Table 6).

(Lee et al., 2009; Choi et al., 2007).

5.0 mg/g 9.8 mg/g 2 가
(Yu et al., 2008). flavonoid
12.3 mg/g DW
(5.9 mg/g DW) 2.1 .

가 .

결 론

가

‘5가 , ‘9가 , ‘ , ‘
flavonoid .

HPLC UPLC-Q-TOF/MS

19 가 flavonoids 3가
(isorhamnetin 7 ; quercetin 6 ;
kaempferol 6) ,

isorhamnetin 가 . 7가
flavonoid ‘ (19.4 mg/g DW) 가

11.5~19.4 mg/g DW . 5

가 flavonoid (15.3)

가 , 40°C (14.9), (14.4),

(13.9), 60°C (13.8 mg/g DW) .

9가 flavonoid 90°C /5

(13.2)>80°C /5 (11.5)>90°C /3 (11.0)>80°C /3

(8.8)>70°C /5 (7.4)>90°C /1 (7.0)>70°C /3 (6.3)>80°C

/1 (5.5)>70°C /1 (3.8 mg/g DW) ,

가 , .
flavonoid (12.3)가

(5.9 mg/g DW) 2.1 .

‘ , , 90°C /5 ,

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