



Fatty Acid Content in Perilla Cultivars and Commercial Oils Determined by GC Analysis

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Abstract – The content analysis of fatty acids in *Perilla* cultivars and commercial oils is conducted through gas chromatography with a flame ionization detector. Results show that *Perilla* cultivars, such as Deulsaem and Daesil, contain high amounts of α -linolenic acid (262.22 and 261.97 mg/g, respectively). Among commercial oils, *Perilla* oil contains a higher amount of α -linolenic acid (515.20 mg/g). Accordingly, α -linolenic acid is a major fatty acid of *Perilla* cultivars and oil. Therefore, *Perilla* cultivars could be used as a food supplement for nutritional and pharmaceutical purposes.

Keywords – *Perilla frutescens* var. *japonica*, α -Linolenic acid, Fatty acid, Gas chromatography

Introduction

Perilla (*Perilla frutescens*; Labiatae) is an annual herbaceous plant used for various purposes in Asia. In Korea, it has been used for food, medicinal, and industrial purposes. In China, *Perilla* is considered as a traditional medicinal herb used to treat various diseases, such as anxiety, tumor, intoxication, cough, allergy, bacteria, and fungal infections.¹⁻⁴ Previous studies have revealed that *Perilla* contains three major nutrients, namely lipid (44%), protein (17%), and carbohydrates (28%) and several fatty acids (FA). α -Linolenic acid (ALA) is more than 60% of the total FA in *Perilla* seeds.^{5,6} ALA prevents colon cancer,⁷ exhibits effects against Crohn's disease,⁸ and affects learning and memory skills.⁹ Linoleic acid shows antioxidant properties, prevents inflammation in the colon, and stimulates anti-tumorigenic proteins.¹⁰⁻¹² Oleic acid has anti-tumor activity,¹³ while palmitic acid is related to diabetes mellitus and cardiovascular diseases.¹⁴ Meanwhile, stearic acid exhibits antibacterial properties.¹⁵

In Asia, *Perilla* oil has been used as a garnish and food supplement. The oil is now being developed as a healthy functional food. Accordingly, *Perilla* oil has been the

topic of some previous bodies of research. The oil has been found to lower serum lipids and Ovalbumin-specific IgG1 levels,¹⁶ prevent brain damage by suppressing inflammation, and exert significant antidepressant-like effects.¹⁷

There are few reports on analysis of functional ingredients in *Perilla* cultivars. This study aims to determine the FA content in *Perilla* cultivars and commercial oils using gas chromatography (GC) with a flame ionization detector (FID).

Experimental

Plant materials – *Perilla* cultivars (i.e., Dami, Danjo, Deulsaem, Anyu, Yujin, Dayu, Yeupsil, Hyangim, and Hwahong) and oil (*P. frutescens* var. *japonica*) were contributed by the Southern Area Crop Science, Rural Development Administration, Miryang, Republic of Korea (2015). Commercial oils (i.e., nut, soybean, corn, olive, cooking, canola, and grape seed oils) were purchased from a local retailer in Anseong, Republic of Korea.

Sample preparation of *Perilla* cultivars for GC – Each *Perilla* cultivar seed (1 g) was ground and extracted with internal standard (1 mL).

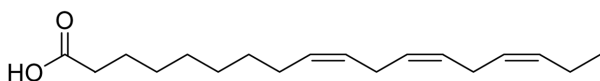
Apparatus and chemicals – The samples were analyzed by Agilent 7890A GC (Agilent, CA, USA) equipped with a FID and a DB-Wax column (Agilent, 30 mm \times 0.25 mm \times 0.25 μ m). The samples were stored in a FRS-300RWE

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Table 1. GC conditions for the ALA analysis

Instrument	GC model : Agilent 7890A (Agilent, CA, USA) Detector: FID (280 °C, H ₂ 35 mL/min; air 350 mL/min; He 35 mL/min)
Column	DB-Wax (Agilent, 30 mm × 0.25 mm × 0.25 μm)
Injector temperature	250 °C
Column temperature	50 °C (1 min) → 200 °C (5 min) → 230 °C (20 min)
Split ratio	1:20
Separator temperature	250 °C
Ion source temperature	200 °C

**Fig. 1.** ALA structure.

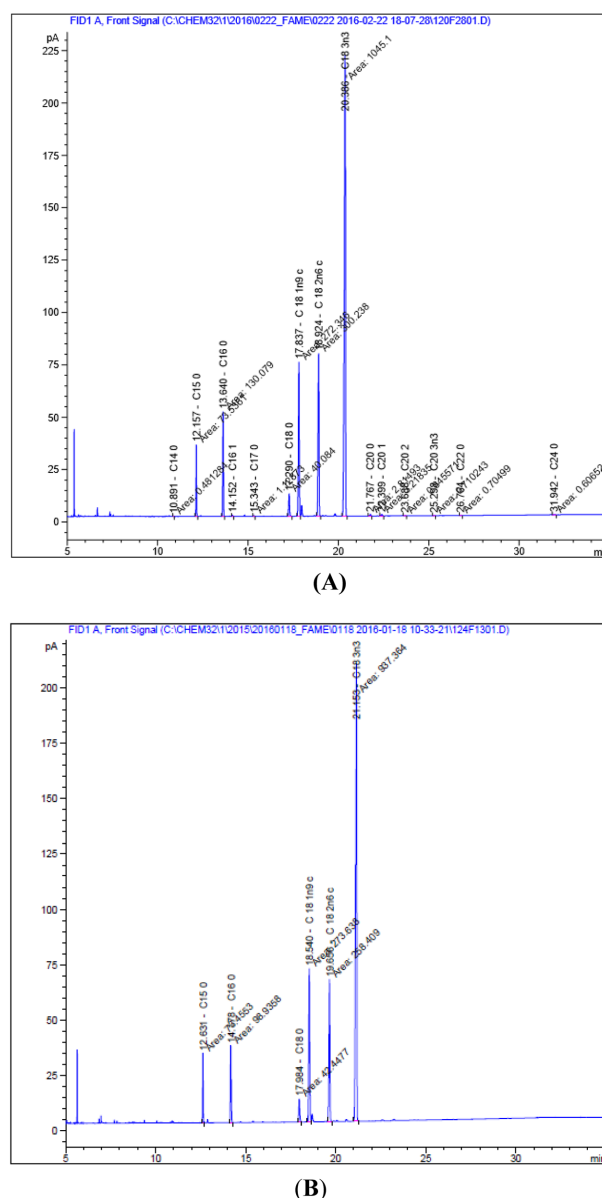
refrigerator (Dongbu Daewoo Electronics, Seoul, Republic of Korea) until use. The GC-FID methylation was conducted with sodium hydroxide and iodomethane purchased from DaeJung Chemicals and Metals Co., Ltd. (Siheung, Republic of Korea). Dimethyl sulfoxide (DMSO) was purchased from Wako Pure Chemicals Industries, Ltd. (Osaka, Japan).

GC-FID methylation – Ground sodium hydroxide (20 mg) and iodomethane (0.1 mL) were added into DMSO (0.5 mL) with the samples, and then sonicated for 30 min at room temperature. CH₂Cl₂ and distilled water were added. Subsequently, the non-polar phase was obtained. The collected CH₂Cl₂ layer was evaporated by nitrogen gas.¹⁸ The FA methyl ester was then prepared.

GC conditions – Accordingly, 1 μL (split ratio: 1:20) of FA methyl ester was injected into an Agilent 7890A autosampler (Agilent, CA, USA) at 250 °C. The column was a DB-Wax (Agilent, 30 mm × 0.25 mm × 0.25 μm) in Agilent 7890A (Agilent, CA, USA) by FID. The column temperature was set to 50 °C for 1 min. The analysis was started at 200 °C. The temperature was increased at 25 °C/min for 5 min. The column was set re-initiated at 230 °C, then, increased at a rate of 3 °C/min for 20 min. The injector and ion source temperatures were set at 250 °C and 200 °C, respectively. Table 1 shows the detailed conditions.

Result and Discussion

ALA (Fig. 1) is an essential fatty acid, with a structure of long chains that is a precursor of the eicosapentaenoic and docosahexaenoic acids. ALA is known as an omega-3 fatty acid.¹⁹ The ALA analysis in ten *Perilla* cultivars was conducted using GC-FID. Table 2 shows the data. Among the *Perilla* cultivars, Deulsaem and Daesil contained higher contents of total FA, that is, 449.7 and 451.18 mg/g, respectively, as well as ALA contents of 262.22 and

**Fig. 2.** GC chromatograms of Daesil (A) and Perilla oil (B).

261.97 mg/g, respectively. Fig. 2 shows the Deulsaem chromatogram. Shin and Kim (1994) revealed the composition of the total lipid and the major lipids in the

Table 2. FA contents from *Perilla* cultivars

Sample	FA (mg/g)					
	α -Linolenic acid	Linoleic acid	Oleic acid	Stearic acid	Palmitic acid	Total
Dami	188.07 \pm 6.97	35.97 \pm 2.41	51.83 \pm 2.18	8.77 \pm 0.38	22.44 \pm 0.91	308.08 \pm 12.85
Danjo	237.77 \pm 5.16	64.99 \pm 1.42	70.14 \pm 1.80	12.06 \pm 0.32	29.29 \pm .68	415.25 \pm 9.38
Deulsaem	262.22 \pm 0.44	75.88 \pm 1.50	72.22 \pm 0.59	10.89 \pm 0.15	28.49 \pm 0.23	449.7 \pm 2.91
Daesil	261.97 \pm 3.70	76.69 \pm 0.96	69.17 \pm 0.67	10.09 \pm 0.12	33.26 \pm 0.20	451.18 \pm 5.65
Anyu	242.38 \pm 3.07	56.70 \pm 1.88	69.99 \pm 1.10	9.01 \pm 0.09	28.11 \pm 0.82	362.19 \pm 6.96
Yujin	248.54 \pm 4.26	62.71 \pm 1.41	69.89 \pm 1.41	8.81 \pm 0.13	29.87 \pm 0.57	419.82 \pm 7.78
Dayu	249.06 \pm 15.26	56.57 \pm 3.29	57.94 \pm 3.70	11.01 \pm 0.69	29.29 \pm 0.68	403.87 \pm 23.62
Yupseol	244.51 \pm 8.77	55.56 \pm 1.65	54.12 \pm 2.05	11.50 \pm 0.40	30.76 \pm 1.04	396.45 \pm 3.91
Hyangim	208.84 \pm 6.86	48.70 \pm 1.59	53.28 \pm 1.89	8.33 \pm 0.31	24.30 \pm 0.85	343.45 \pm 11.5
Hwahong	189.08 \pm 14.13	34.48 \pm 2.28	42.99 \pm 2.99	5.85 \pm 0.39	21.29 \pm 1.46	293.69 \pm 21.25

Table 3. FA contents from commercial oils

Sample	FA (mg/g)					
	α -Linolenic acid	Linoleic acid	Oleic acid	Stearic acid	Palmitic acid	Total
Nut oil	33.19 \pm 0.62	276.31 \pm 5.40	456.32 \pm 7.74	31.21 \pm 0.53	78.10 \pm 1.36	875.14 \pm 15.65
Perilla oil	515.20 \pm 1.92	141.16 \pm 0.76	147.05 \pm 1.34	23.08 \pm 0.35	52.12 \pm 0.45	878.61 \pm 4.81
Soybean oil	55.27 \pm 0.15	480.78 \pm 1.45	205.03 \pm 0.77	40.84 \pm 0.21	102.48 \pm 0.47	884.40 \pm 3.06
Corn oil	8.45 \pm 0.12	474.88 \pm 3.09	294.09 \pm 1.14	19.08 \pm 0.12	105.93 \pm 0.46	902.42 \pm 4.93
Olive oil	5.03 \pm 0.15	63.24 \pm 0.69	693.67 \pm 7.24	30.80 \pm 0.36	127.45 \pm 1.50	920.19 \pm 9.94
Cooking oil	56.32 \pm 1.72	260.31 \pm 8.29	439.08 \pm 14.75	22.19 \pm 0.84	55.57 \pm 2.05	833.47 \pm 27.66
Canola oil	61.61 \pm 1.70	165.86 \pm 4.16	563.37 \pm 13.94	17.76 \pm 0.39	38.51 \pm 0.95	847.11 \pm 21.14
Grape seed oil	2.57 \pm 0.07	592.96 \pm 13.43	176.83 \pm 2.45	38.98 \pm 0.91	67.23 \pm 1.14	878.57 \pm 18.00

seeds of *Perilla* cultivars. Their conclusion was almost similar to ours. The major FAs were linolenic (61.1 – 64.0%), linoleic (14.3 – 17.0%), and oleic (13.2 – 14.9%) acids.²⁰ Lee *et al.* (1986) determined FA from seven *Perilla* cultivars. The FA content of oil from *Perilla* cultivars used ranged from 10% to 20% in linoleic acid and from 50% to 70% in linolenic acid content.²¹ Choung (2005) also analyzed the seed and vegetables of *Perilla* varieties. They compared the characteristics of seed *Perilla* and vegetables *Perilla* varieties. The seed *Perilla* varieties had more total FA than the vegetables varieties. However, the difference in FA compositions was not observed.²²

Additional analysis was conducted, wherein we compared the FA contents of *Perilla* and commercial oils. The content analysis of FAs from commercial oils was conducted using GC-FID. Table 3 shows the data. Among the commercial oils, olive and corn oils contain high amounts of total FAs (920.19 and 902.42 mg/g, respectively). However, the highest ALA amount was in *Perilla* oil (515.20 mg/g). Fig. 2 shows the chromatogram of *Perilla* oil. Sinclair and Gibson (1992) analyzed various oils, including *Perilla*, olive, fish, and safflower oils. They

showed that *Perilla* oil contained 57% ALA and 13% linoleic acid,²³ which were almost similar to our results. According to Sargi *et al.* (2013), Chia and white *Perilla* seeds contained high ALA amounts (544.85 and 539.07 mg/g, respectively).²⁴ Kostik *et al.* (2013) investigated the FA compositions of coconut, corn, cottonseed, linseed, palm kernel, olive, soybean, sunflower, peanut, safflower, and canola varieties. Their results showed that the oleic acid composition in olive oil was 78.4%.²⁵ Ten *Perilla* cultivars were analyzed in this study. Among them, three *Perilla* cultivars (Dami, Hwahong, and Deulsaem) were analyzed for the first time.

In conclusion, our results revealed that *Perilla* oil and Deulsaem contained higher ALA amounts. These results could be used as a guideline in choosing *Perilla* cultivars and oils to be used as food supplement for nutritional and pharmaceutical purposes.

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