ORIGINAL

Structures and Hypotensive Effect of Flavonoid Glycosides in Young *Citrus unshiu* Peelings[†]

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As a series of our studies on physiologically active substances in citrus fruit peels, we report here the differences between flavonoid glycosides in *Citrus unshiu* peelings (the ripe fruit peels) and flavonoid glycosides in young *Citrus unshiu* peelings (the unripe fruit peels). Eleven flavonoid glycosides were isolated from young *Citrus unshiu* peels and their structures established by UV, MS, ¹H-NMR and ¹³C-NMR spectroscopy and also by chemical findings. They were limocitrin 3- β -D-glucoside (1), narirutin (4), rutin (5), narcissin (6), hesperidin (7), 3-hydroxy-5,6,7,8,3',4'-hexamethoxyflavone 3- β -D-glucoside (8), 6,8-di-C-glucosylapigenin (11), 3,8-di-C-glucosylapigenin (12), 3,7,4'-trihydroxy-5,6,8,3'-tetramethoxy flavone 3- β -D-glucoside (13), 3,7,4'-trihydroxy-5,6,8,3'-tetramethoxyflavone 3-O-[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside (14) and limocitrin 3-O-[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside (15).

Five flavonoid glycosides (11)~(15) were found not to be present in *Citrus unshiu* peelings (the ripe fruit peels), but could be isolated from young *Citrus unshiu* peelings (the unripe fruit peels).

Thus the kinds and quantity of flavonoid glycosides in ripe fruit peels and those in unripe fruit peels differ greatly. The relationship between their structures and hypotensive activity was determined by injecting the compounds intravenously in SHR-SP.

Of these compounds, (13), (14), and (15) were identified here for the first time as flavonoid glycosides.

Introduction

In previous papers, we reported ten flavonoid glycosides, limocitrin 3- β -D-glucoside (1), limocitrin 3- α -L-rhamnose (2), 3,6-di-C-glucosylapigenin (3), narirutin (4), rutin (5), narcissin (6), hesperidin (7), 3-hydroxy-5,6,7,8,3',4'-hexamethoxyflavone 3- β -D-glucoside (8), limocitrin 3-O-[5- α -glucosyl-3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 2)]- β -glucoside (9) and narirutin-4'-glucoside (10) isolated from *Citrus unshiu* peelings (see Fig.-1), and their depressive effect on blood pressure^{1),2)}. Among them, compounds (3), (5), (8) and (10) showed strong hypotensive effects.

In the present paper, we report the difference between the kinds and quantity of flavonoid glycosides in *Citrus unshiu* peelings (the ripe fruit peels) and those in young *Citrus unshiu* peelings (the unripe fruit peels) (see Table-1).

Results and Discussion

Crude flavonoids were obtained from the hot

water extract of young *Citrus unshiu* peel by the procedure illustrated in Fig.-2. Eleven flavonoid glycosides were purified by gel filtration on TSK gel HW-40 F, and column chromatography on silica gel. The UV and ¹H-NMR spectral data for each flavonoid glycoside are shown in Tables-2, 3 and 4, respectively.

The UV and ¹H-NMR spectral data for (1), (4), (5), (6), (7) and (8) agreed with those of the authentic samples isolated from *Citrus unshiu* peels (the ripe fruit peels) in our previous study^{1),2)}.

Compound (11) was identified with 6,8-di-C-glucosylapigenin by comparing its UV and ¹H-NMR spectra with those of the authentic sample isolated from lemon peel³⁾ as a strong blood pressure depressing compound.

Compound (12) was also identified with 3,8-di-C-glucosylapigenin by comparing its UV and ¹H-NMR spectra with those of the authentic sample obtained from sudachi peel⁴⁾.

Compound (13) was yellow needles, mp 186~200°C (decomposed). The molecular weight of (13) was found to be 552 by FAB-MS which showed characteristic peaks at *m/z* 391

[†]Studies on Physiologically Active Substances in Citrus Fruit Peel, Part XIV. For Part XIII, see ref. 8).

Fig.-1 Structures of isolated flavonoid glycosides.

Table-1 Yield of each compound.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15) (mg)
<i>Citrus unshiu</i>	8	6	24	89	30	7	2100	28	5	3	—	—	—	—	—
<i>Young Citrus unshiu</i>	5	—	—	126	14	16	4800	6	—	—	38	20	8	32	400

[aglycone + H]⁺, m/z 553[M + H]⁺ and m/z 575[M + Na]⁺. The maximum absorptions of the UV spectrum of (13) were observed at 261, 279 and 355 nm in ethanol. These absorptions did not shift significantly upon addition of sodium acetate or aluminum chloride. These facts suggest the absence of such functional groups as 3-hydroxy-4-oxo-, 5-hydroxy-4-oxo- and *O*-dihydroxyl-systems⁵⁾ in (13). The ¹H-NMR spectrum of (13) indicated the presence of aromatic signals of an ABX type at δ 7.98 (J = 2 Hz), 7.70 (J = 2 and 8 Hz) and 6.93 (J = 8 Hz), respectively assignable to H₂, H₆ and H₅,

four methoxyl groups at δ 3.83, 3.87, 3.91 and 4.04, and an anomeric proton of a β -glucosyl moiety at δ 5.46 (J = 7 Hz). Sugar analysis of (13) gave D-glucose ($[\alpha]_D^{25} + 42.2$, c = 0.1, H₂O), which was identified by GLC of its acetyl derivative. Therefore, the structure of (13) was proved to be 3,7,4'-trihydroxy-5,6,8,3'-tetramethoxyflavone 3- β -D-glucoside.

Compound (14), yellow needles, showed mp 176 ~ 186°C (decomposed). The molecular weight of (14) was found to be 696 by FAB-MS which showed characteristic peaks at m/z 697 [M + H]⁺ and m/z 719[M + Na]⁺. The maximum

Fig.-2 Preparation of crude flavonoids from the hot water extract.

absorptions of the UV spectrum of (14) were observed at 261, 278 and 351 nm in ethanol. The 2nd band (240~285 nm) showed a bathochromic shift of 11 nm in an ethanol solution with sodium acetate, whereas the 1st band (300~400 nm) indicated a bathochromic shift of 19 nm in an ethanol solution with aluminium chloride. These facts show that a hydroxyl group was located at the C₇ position and that no hydroxyl group existed at the C₅ position⁶). The ¹H-NMR spectrum of (14) indicated the presence of methyl and methylene protons of 3-hydroxy-methylglutamate at δ 1.00 and δ 2.18~2.33, respectively. The rest of the signals of (14) closely resembled those of compound (13). The structure of a tetramethoxyflavonol glycoside was supported by the appearance of thirty-one signals in the ¹³C-

NMR spectrum (**Table-5**) including six carbon signals of β -glucosyl moiety, six carbon signals of 3-hydroxy-3-methylglutaric acid residue and four methoxy carbon signals. After the alkaline hydrolysis of (14), 3,7,4'-trihydroxy-5,6,8,3'-tetramethoxyflavone 3- β -D-glucoside (13) was also identified on the basis of spectral evidence. On the other hand, methylation⁷) of (14) followed by methanolysis, gave methyl 2,3,4-tri-O-methyl-D-glucopyranoside. Based on the above evidence, the structure of 3,7,4'-trihydroxy-5,6,8,3'-tetramethoxyflavone 3-O-[[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside] was assigned to (14).

Compound (15) was isolated as yellow needles (mp 210 ~ 220°C, decomposed). The molecular weight of (15) was found to be 652 by FAB-MS which showed characteristic peaks at m/z 653[M+H]⁺ and m/z 675[M+Na]⁺. The maximum absorptions of the UV spectrum of (15) were observed at 262, 277 and 364 nm in ethanol. The 2nd band showed a bathochromic shift of 5 nm in an ethanol solution with sodium acetate, and the 1st band indicated a bathochromic shift of 51 nm in an ethanol solution with aluminum chloride, suggesting the presence of hydroxyl groups at the C₇ and C₅ positions⁶). The ¹H-NMR spectrum of (15) indicated the presence of four aromatic signals at δ 6.37, 7.86 ($J=2$ Hz), 6.98 ($J=8$ Hz) and 7.62 ($J=2$ and 8 Hz), respectively assignable to H₆, H₂, H₅, and H₈, two methoxy groups at δ 3.82 and 3.86, an anomeric proton of a β -glucosyl moiety at δ 5.45 ($J=8$ Hz), and methyl and

Table-2 Characteristic UV spectral data ($\lambda_{\max}$ in nm) for the isolated flavonoids.

Compound	in EtOH	in AcONa-EtOH	in AlCl ₃ -EtOH
(1)	258, 275, 360	283, 328, 372	276, 284, 306 ^s , 370, 419
(4)	228, 284, 330	228, 285, 331	226, 310, 387
(5)	259, 266 ^s , 307 ^s , 360	274, 329, 415	277, 302 ^s , 337, 439
(6)	254, 265 ^s , 306 ^s , 358	271, 330, 414	267, 300 ^s , 368 ^s , 401
(7)	273, 333	283, 370	283, 299 ^s , 370, 390
(8)	254, 269 ^s , 343	256, 270 ^s , 345	256, 270 ^s , 343
(11)	216, 273, 335	283, 390	283, 307, 350, 383
(12)	273, 333	283, 302 ^s , 380	283, 309, 358, 380 ^s
(13)	261, 279, 355	262, 278, 358	274, 286, 377
(14)	261, 278, 351	263, 289, 360	277, 289, 370
(15)	262, 277, 364	282, 330, 379	268, 286, 309, 366, 415

s, shoulder

Table-3 ^1H -NMR data for each flavonoid at 200 MHz [δ ppm (J Hz)].

Compound	H ₂	H ₃	H ₆	H ₈	H _{2'}	H _{3'}	H _{5'}	H _{6'}	OCH ₃	H _{1''}
(1)*	—	—	6.07 s	—	7.95 d ($J=2$)	—	6.86 d ($J=8$)	7.72 dd ($J=8, 2$)	3.84 s, 3.94 s	5.20 d ($J=7, 5$)
(4)**	5.29 dd ($J=12, 3$)	2.68 dd ($J=17, 3$) 3.09 dd ($J=17, 12$)	6.14 d ($J=1$)	6.14 d ($J=1$)	7.27 d ($J=8$)	6.81 d ($J=8$)	6.81 d ($J=8$)	7.27 d ($J=8$)	—	5.01 d ($J=7$) 4.69 d ($J=1$)
(5)*	—	—	6.21 d ($J=2$)	6.40 d ($J=2$)	7.62 d ($J=2$)	—	6.88 d ($J=8$)	7.62 dd ($J=8, 2$)	—	5.11 d ($J=8$) 4.53 d ($J=2$)
(6)*	—	—	6.20 d ($J=2$)	6.40 d ($J=2$)	7.93 d ($J=2$)	—	6.90 d ($J=8$)	7.62 d ($J=8, 2$)	3.94 s	5.22 d ($J=8$) 4.52 d ($J=2$)
(7)**	5.42 dd ($J=12, 3$)	2.76 dd obscured ($J=17, 3$)	6.07 s	6.07 s	6.87 d ($J=2$)	—	6.82	6.82	3.73 s	4.91 d ($J=7$) 4.50 d ($J=1$)
(8)*	—	—	—	—	7.87 d ($J=2$)	—	6.96 d ($J=9$)	7.85 dd ($J=9, 2$)	3.89 s, 3.90 s 3.92 s $\times$ 2, 3.97 s 4.08 s	4.88 d ($J=7$)
(11)**	—	6.70 s	—	—	7.96 d ($J=8$)	6.90 d ($J=8$)	6.90 d ($J=8$)	7.96 d ($J=8$)	—	4.85 d ($J=10$) 4.76 d ($J=10$)
(12)**	—	—	6.22 s	—	7.74 d ($J=8$)	6.76 d ($J=8$)	6.76 d ($J=8$)	7.74 d ($J=8$)	—	4.77 d ($J=10$) 4.52 d ($J=10$)
(13)*	—	—	—	—	7.98 d ($J=2$)	—	6.93 d ($J=8$)	7.70 dd ($J=8, 2$)	3.83 s, 3.87 s 3.91 s, 4.04 s	5.46 d ($J=7$)

s, singlet ; d, doublet ; dd, double doublet. Solvent ; *CD₃OD, **DMSO- d_6 **Table-4** ^1H -NMR data for (14) and (15) at 200 MHz [δ ppm (J Hz)].

Compound	H _{1''}	H ₆	H _{2'}	H _{5'}	H _{6'}	OCH ₃	CH ₃ (6'')	H _{2''} , H _{4''}
(14)	5.45 d ($J=8$)	—	7.84 d ($J=2$)	6.97 d ($J=8$)	7.64 dd ($J=8, 2$)	3.83 s 3.87 s 3.91 s 4.02 s	1.00 [3 H, s]	2.18~2.33 [4 H, m]
(15)	5.45 d ($J=8$)	6.37 s	7.86 d ($J=2$)	6.98 d ($J=8$)	7.62 dd ($J=8, 2$)	3.82 s 3.86 s	1.01 [3 H, s]	2.16~2.40 [4 H, m]

s, singlet ; d, doublet ; dd, double doublet. solvent ; DMOS- d_6

methylene protons of 3-hydroxy-3-methylglutamate at δ 1.01 and δ 2.16–2.40, respectively. The structure of a flavonoid glycoside was supported by the appearance of twenty-nine signals in the ^{13}C -NMR spectrum (**Table-5**) including six carbon signals of β -glucosyl moiety, six carbon signals of 3-hydroxy-3-methylglutaric acid residue and two methoxy carbon signals. The alkaline hydrolysis of (15) yielded limocitrin 3- β -D-glucoside (1) which was identified on the basis of spectral evidence. On the other hand, methylation of (15), followed by methanolysis, gave methyl 2,3,4-tri-O-methyl-D-

glucopyranoside. Based on the above evidence, the structure of limocitrin 3-O-[[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside] was established for compound (15).

The depressive effects on blood pressure were examined for these ten glycosides (1), (4), (5), (6), (8), (11), (12), (13), (14) and (15), and the results are shown as average values of triplicates (**Table-6**). However, (7) has not been determined, because of its poor solubility in water. As a result, we have found that the kinds and the position of the substituents and the sugar moieties strongly effect the

Table-5 ^{13}C -NMR data for (14) and (15).

Carbon No.	(14)	(15)
2	156.8	157.0
3	135.5	133.2
4	170.1	170.1
5	147.1	156.0
6	133.0	99.1
7	150.1	156.2
8	131.3	127.7
9	144.3	148.6
10	106.5	104.0
1'	120.6	121.3
2'	113.0	113.4
3'	152.4	149.7
4'	148.2	147.1
5'	115.5	115.5
6'	122.5	122.3
OCH_3	55.6, 60.5 61.4, 61.7	55.8, 60.5
Glc-1"	100.9	101.2
Glc-2"	74.2	74.3
Glc-3"	76.2	76.4
Glc-4"	70.0	70.3
Glc-5"	74.2	74.3
Glc-6"	63.0	63.2
1'', 5''	173.7*, 177.6*	172.3*, 177.6*
2'', 4''	45.3*, 45.6*	45.2*, 45.3*
3''	68.6	68.8
6''	27.0	27.1

Solvent : $\text{DMSO}-d_6$

* The assignments may be interchangeable.

physiological activity. In particular, components having fully substituted A-ring tend to show strong activity.

Five flavonoid glycosides (11)~(15) did not exist in *Citrus unshiu* peelings (the ripe fruit peels), but were isolated from young *Citrus unshiu* peelings (the unripe fruit peels). Accordingly, we confirmed the significant difference between the kinds and quantity of flavonoid glycosides in the ripe fruit peels and those in the unripe fruit peels.

Among these compounds, (13), (14) and (15) were found to be new flavonoid glycosides.

Experimental

Materials

The young *Citrus unshiu* fruit was collected at

Table-6 Hypotensive effect.

Compound	Maximal decrease of blood pressure (mmHg) [Time after administration (h)]
(1)	-12 ^b [0.5]
(4)	0
(5)	-45 ^d [0.5]
(6)	-8 ^a [0.5]
(7)	-
(8)	-12 ^c [0.5]
(11)	-78 ^b [0.5]
(12)	-10 ^a [1.0]
(13)	-28 ^a [1.0]
(14)	-15 ^a [0.5]
(15)	-20 ^a [0.5]

^a Dose : 1.0 mg/100 g body weight, i.v.^b Dose : 0.5 mg/100 g body weight, i.v.^c Dose : 0.3 mg/100 g body weight, i. v.^d Dose : 0.015 mg/100 g body weight, i.v.

Arita city, Wakayama prefecture, in June 1986.

Hot water extraction

The peels (11.0 kg) of 1979 young *Citrus unshiu* fruits soaked in hot water was chopped by a commercial mixer and homogenized after addition of 3 L of hot water in an earthen mortar. The mixture was kept at 96°C for 30 min and then filtered. This operation was repeated four times and the collected filtrate was concentrated to 900 mL under reduced pressure. Cold ethanol (2.1 L) was added to the concentrated solution and the mixture was allowed to stand overnight at 5°C to complete the precipitation before being filtered. The filtrate was concentrated to about 300 mL *in vacuo*, and then freeze-dried, giving 426 g of a strongly hygroscopic brick.

Separation by solvent extraction

The brick dissolved in 800 mL of water was extracted five times with 800 mL of *n*-hexane and then extracted five times with 800 mL of *n*-butanol. After removing the solvents, the two organic layers afforded 38 g and 151 g of the extracts, respectively.

Concentration of flavonoid glycosides with lead subacetate

To a solution of 151 g of the *n*-butanol extract in 750 mL of water was added a saturated aqueous solution of 170 g of lead subacetate, and the mixture was kept in a refrigerator overnight. The yellowish precipitates were filtered

off and treated with a saturated aqueous solution of 80 g of sodium carbonate. After stirring for 1 h, the white precipitate of lead carbonate was removed by filtration, and the filtrate adjusted to pH 5.3 with 6 N HCl was extracted five times with *n*-butanol to afford 53 g of a mixture of crude flavonoid glycosides from the butanol solution.

Gel filtration

Gel filtration was carried out on a packed column (5 cm dia. $\times$ 1 m) of TSK gel HW-40 F (Toyosoda Mfg. Co., Ltd.) under medium pressure, the eluate by measuring the absorption at 280 nm with a UVICON-540 M instrument (Toyo Kagaku Sangyo Co., Ltd.). Drops of the eluate from one minimum to the next minimum on the absorption curve were collected as one fraction. The column was eluted with 30 L of carbonated water (pH 5), 20 L of distilled water and 30 L of aqueous ammonia (pH 9), successively.

Column chromatography on silica gel

Each fraction obtained from the gel filtration was chromatographed on silica gel (Wako gel C-300, Wako Pure Chemical Industries, Ltd.) with chloroform-methanol-acetic acid-water (70 : 15 : 12 : 3 or 60 : 20 : 15 : 5) as an eluents.

Measurement of the blood depressive effect

Each substance was intravenously injected [1.0 mg dose/100 g of body weight (200 ~ 250 g)] into SHR-SP, whose blood pressure was measured chronologically using the tail pulse pickup method without anesthesia.

Analytical instruments

UV spectra were taken with a Hitachi 323 visible-ultraviolet autoanalyzer. MS spectra were obtained with JEOL JMS-HX 100 and JMA-DA 5000 instruments under Xe bombardment (6.0 keV). NMR spectra were measured with JEOL JNM-FX 200 in dimethylsulfoxide- d_6 or methanol- d_4 with TMS as an internal standard (200 MHz for ^1H and 50 MHz for ^{13}C).

Methylation of (14) and (15) followed by methanolysis

To a solution of the sample (10 mg) in DMSO (1 mL) was added the methylsulfinyl carbanion solution (1 mL) (prepared from 2 g of NaH and 35 mL of DMSO)⁷⁾. The solution was kept stirring under N_2 atmosphere for 1 h, treated with CH_3I (1 mL), and kept stirring for another 1 h.

The mixture was subjected to gel filtration using TSK gel HW-40 F under medium pressure. A solution of the sample in 10 % HCl/MeOH (1 mL) was refluxed for 1 h, diluted with distilled water, and then extracted with *n*-hexane. The hexane extract was analyzed by GLC (YANACO-G 180 gas chromatograph equipped with FID; column : 10 % PEG-20 M, ϕ 3.0 mm $\times$ 1.5 m, column temperature : 215°C, carrier gas : nitrogen at 28 mL/min) and was identified as methyl 2,3,4-tri-*O*-methyl-D-glucopyranosides; t_R (min) : 7.03, 8.85.

Alkaline hydrolysis of (14) and (15)

A mixture of the sample (10 mg) and 0.5 N KOH-EtOH (10 mL) was refluxed for 1 h, and then neutralized with 0.5 N HCl. The mixture was dried, and subjected to gel filtration to isolate the products.

Sugar analysis

A mixture of the sample (3 mg) and 0.5 N HCl (2 mL) was heated at 96°C for 1 h, and concentrated *in vacuo*. Ethyl acetate and water were added to the residue. The aqueous layer was evaporated *in vacuo* to give a sugar, which was acetylated with acetic anhydride-pyridine (1 : 1, vol/vol) at 90°C for 1 h. The retention times of the acetyl derivatives obtained by extracting the above reaction mixture with chloroform were compared with those of authentic samples by GLC (YANACO-G 180 gas chromatograph equipped with FID; column : Dexil 400, ϕ 3.0 mm $\times$ 3 m, column temperature : 150 ~ 300°C (5°C/min), carrier gas : nitrogen at 26 mL/min).

3,7,4'-Trihydroxy-5,6,8,3'-tetramethoxyflavone 3-*O*-[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside (14)

HR-FAB/MS found : m/z 697. 1948, calcd. for $\text{C}_{31}\text{H}_{37}\text{O}_{18}$: $M+H$, 697. 1980.

3-*O*-[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside (14)

HR-FAB/MS found : m/z 697. 1948, calcd. for $\text{C}_{31}\text{H}_{37}\text{O}_{18}$: $M+H$, 697. 1980.

Limocitrin 3-*O*-[3-hydroxy-3-methylglutaryl (1 $\rightarrow$ 6)]- β -D-glucoside (15)

HR-FAB/MS found : m/z 653.1741, calcd. for $\text{C}_{29}\text{H}_{33}\text{O}_{17}$: $M+H$, 653.1718.

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著者らはかんきつ(柑橘)類果皮中の生理活性物質に関する研究の一環として、温州みかん成熟果皮と未熟果皮のフラボノイド配糖体の差異を検討する目的で本研究を行った。その結果、摘果温州みかん果皮中から11種のフラボノイド配糖体の分離に成功した。各成分の構造は各種スペクトルの測定結果からリモシトリン 3- β -D-グルコシド(1), ナリルチン(4), ルチン(5), ナルシシン(6), ヘスペリジン(7), 3-ヒドロキシ-5,6,7,8,3',4'-ヘキサメトキシフラボン 3- β -D-グルコシド(8), 6,8-ジ-C-グルコシルアピゲニン(11), 3,8-ジ-グルコシルアピゲニン(12), 3,7,4'-トリヒドロキシ-5,6,8,3'-テトラメトキシフラボン 3- β -D-グルコシド(13), 3,7,4'-トリヒドロキシ-5,6,8,3'-テトラメトキシフラボン 3-O-[3-ヒドロキシ-3-メチルグルタリル(1 $\rightarrow$ 6)]- β -D-グルコシド(14)及びリモシトリン 3-O-[3-ヒドロキシ-3-メチルグルタリル(1 $\rightarrow$ 6)]- β -D-グルコシド(15)と決定した。また、温州みかん成熟果皮には存在しなかった(11)~(15)の5種の成分を分離し、成熟果皮と未熟果皮に大きな差異があることを確認した。さらに SHR-SP に対する静脈内投与で生理活性の検討を行い、構造と生理活性について考察を加えた。

なお、今回分離した成分のうち(13), (14)及び(15)は新規フラボノイド配糖体である。

摘果温州みかん(Young *Citrus unshiu*)果皮中のフラボノイド配糖体の構造と血圧降下作用

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本書はすでに月刊誌『油脂』に「卵の科学」というテーマで連載されたもので、これに加筆して出版されたものである。内容は、鶏卵の生産、流通、栄養、鮮度判定、加工、利用、食中毒など多岐にわたっているが、内容は平易で誰にでも分かりやすく書かれている。本書は鶏卵加工を長年経験された方の著によるもので、学問的というよりは、生産方式、生産量、流通様式、価格、加工方法利用法など、鶏卵を実務的に扱う方々に役に立つように配慮されている。

従って、これから鶏卵を実務的に扱う業種に携わる方の格好の入門書といえよう。また、一般消費者にとって、日常の食生活に欠くことのできない卵について、鮮度の選定、見分け方、加工食品への利用、微生物による汚染や食中毒など参考になる点が多い。ゆで卵と生卵の見分け方、卵の強度は長軸方向では6~7kgもあり、10個の卵の上に平均的に重力をかければ大人でも卵を割らずに乗ることができるなど、卵にまつわる種々のはなしを折り込んであるのも興味深く読める。

惜しむらくは、本書では卵の食品としての栄養性、有益性に関する記述が淡白である点である。本の標題から受ける印象では、本書の内容の中心は卵の食品としての有益性に関する記述として受け取れた。一般の読者は、食品としての卵の栄養、その摂取の有益性など卵の本質についての記述を予想するのではないだろうか。この点もう少し突っ込んでほしいと思う。また、消費者の購入の対象の一つとなっているヨード卵などの健康食的な卵の是非などについても触れて欲しかったように思う。

(菊川清見：東京薬科大学)