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Estimation of the Mixing Ratio of a Foreign Oil in an Adulterated Sesame Oil. II. Rice Bran Oil or Rapeseed Oil

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A method for determining the mixing ratio of rice bran oil or rapeseed oil in an adulterated sesame oil was developed using ten sesame oils, six rice bran oils and fourteen rapeseed oils.

Adulterant oil content in sesame oil could be estimated as rice bran oil based on that of two unsaponifiable components with relative retention times (*RRT*) of 1.19 and 1.55, and as rapeseed oil based on the percentages of linolenic acid (18 : 3) and an unsaponifiable component (brassicasterol) with *RRT* of 0.69.

Fatty acid pattern similarity ($\cos \theta$) for sesame oil adulterated with rice bran oil or rapeseed oil and pure sesame oil was demonstrated. $\sqrt{(1-\cos \theta) 10^6}$, was expressed as $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$, a function proportional to the mixing ratio of rice bran oil or rapeseed oil. For a given adulterant oil the mixing ratio could be determined based on the fatty acid pattern similarity.

1 Introduction

Sesame oil has a characteristic aroma and has been widely used in the world. Therefore, sesame oil has been often mixed with other fats and oils for the commercial use. Hence, developments of methods for the identification and detection of a foreign oil are required. Physical and chemical tests such as iodine value, saponification value and refractive index or organoleptic tests on taste, characteristic odor and color are not useful for the identification and detection in the case that an oil was mixed with an oil of similar characteristics, for example, both an adulterated and an adulterant oils are included to the group of oleic-linoleic acid oil. Although a few methods using some instruments such as a differential thermal analyzer¹⁾ and a HPLC apparatus²⁾ have been studied, there are still some problems in the sensitivity or limits of detection.

The restriction in processed food becomes strict because consumers request for cheaper and better products for health. However, methods for evaluating the validity of display have not been developed satisfactorily. When an adulterated oil and an adulterant oil belong to the same group of oleic-linoleic acid oil, it is difficult to detect and identify each one. We have developed the method³⁾ for the identification and estimation of the mixing ratio of soybean oil as an adulterant oil mixed to sesame oil. In this study, we have investigated a method for the detection and estimation of mixing ratios of rice bran oil or rapeseed oil in sesame oil. These oils are categorized to a group of oleic-linoleic acid oil.

2 Experimental

Ten sesame oils, six rice bran oils and fourteen rapeseed oils were obtained in local markets and some inspection institutes. Mixtures of sesame and rice bran oils, and

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sesame and rapeseed oils were prepared in the same way as described in the previous report³⁾.

Fatty acid and unsaponifiable matter were analyzed by gas chromatography as described in the previous report³⁾.

Fatty acid pattern similarity was calculated according to Tamura and Oosawa's method⁴⁾ in the same way as described in the previous report³⁾.

3 Results and Discussion

3.1 Fatty acid compositions of sesame, rice bran and rapeseed oils

Fatty acid compositions of ten sesame oils are the same as the previous report³⁾. Major fatty acids are 16 : 0 (9.0 %), 18 : 0 (5.3 %), 18 : 1 (39.0 %) and 18 : 2 (44.8 %). **Table-1**

shows fatty acid compositions of six rice bran oils. Major fatty acids are 16 : 0, 18 : 1 and 18 : 2. These fatty acids occupied 95 % of total fatty acids. **Table-2** shows fatty acid compositions of fourteen rapeseed oils. Major fatty acids, 18 : 1, 18 : 2 and 18 : 3, amounted to 91 % of total fatty acids. Especially, a level of 18 : 1 accounted to 58.4 % of total fatty acids. A level of 18 : 3 (10.8 %) in rapeseed oil was as high as that in the soybean oil. An old type rapeseed oil showed a high percentage of 22 : 1 but its content in canola oils was very low (0.6 %). Standard deviation in the percentage of 18 : 2 was relatively large (1.52 %) and the difference between minimum (19.7 %) and maximum (25.7 %) was 6 %. The fatty acid pattern of rapeseed oil was similar to that of sesame

Table-1 Fatty acid composition (%) of rice bran oil.

No.	14 : 0	16 : 0	16 : 1	18 : 0	18 : 1	18 : 2	18 : 3	20 : 0	20 : 1	Other	22 : 0
1	0.2	16.2	0.2	1.7	42.2	36.6	1.4	0.6	0.4	0.3	0.2
2	0.2	16.8	0.2	1.6	41.0	37.3	1.3	0.6	0.5	0.3	0.2
3	0.3	16.2	0.2	1.8	42.0	36.3	1.5	0.6	0.5	0.4	0.2
4	0.3	17.1	0.2	1.6	41.9	35.9	1.3	0.7	0.5	0.3	0.2
5	0.2	15.9	0.2	1.7	42.2	36.7	1.5	0.6	0.5	0.3	0.2
6	0.2	16.0	0.2	1.7	42.2	36.6	1.5	0.7	0.4	0.3	0.2
Mean	0.2	16.4	0.2	1.7	41.9	36.6	1.4	0.6	0.5	0.3	0.2
S. D.	0.06	0.67	0.00	0.08	0.51	0.39	0.10	0.06	0.06	0.04	0.04

Table-2 Fatty acid composition (%) of rapeseed oil.

No.	16 : 0	16 : 1	18 : 0	18 : 1	18 : 2	18 : 3	20 : 0	20 : 1	Other	22 : 0	22 : 1
1	4.0	0.2	1.6	59.5	20.9	10.9	0.5	1.5	0.1	0.3	0.5
2	4.0	0.2	1.7	57.8	22.3	10.9	0.4	1.6	0.2	0.3	0.6
3	4.0	0.2	1.7	58.4	22.1	10.6	0.5	1.5	0.2	0.3	0.5
4	3.7	0.2	1.5	58.8	21.1	11.5	0.5	1.6	0.1	0.3	0.7
5	4.3	0.2	1.8	56.9	23.1	10.8	0.4	1.5	0.2	0.3	0.5
6	4.3	0.2	1.8	56.1	23.9	10.6	0.5	1.6	0.1	0.3	0.6
7	3.8	0.2	1.7	59.7	20.9	10.6	0.5	1.5	0.2	0.3	0.6
8	4.0	0.2	1.6	58.5	21.8	10.9	0.5	1.5	0.1	0.3	0.6
9	4.6	0.2	1.9	54.0	25.8	10.6	0.5	1.4	0.1	0.3	0.6
10	3.8	0.2	1.6	59.1	20.9	11.3	0.5	1.5	0.1	0.3	0.7
11	3.8	0.2	1.6	59.7	20.8	10.7	0.5	1.7	0.1	0.3	0.6
12	3.5	0.2	1.5	58.7	21.0	11.8	0.5	1.6	0.1	0.3	0.8
13	3.7	0.2	1.7	62.1	19.7	9.1	0.5	1.6	0.2	0.3	0.9
14	3.8	0.2	1.6	58.5	21.6	11.3	0.5	1.5	0.1	0.3	0.6
Mean	4.0	0.2	1.7	58.5	21.8	10.8	0.5	1.5	0.1	0.3	0.6
S. D.	0.29	0.00	0.12	1.03	1.52	0.62	0.04	0.09	0.07	0.00	0.12

oil, even though the percentage of individual acids were different between these two oils.

3.2 Fatty acid compositions and unsaponifiable matter compositions of sesame oils adulterated with rice bran oil, or rapeseed oil

Table-3.1) shows fatty acid compositions of sesame oils adulterated with rice bran oil. Even if the mixing ratio of rice bran oil increased, the change of the fatty acid composition was small. The percentage of 16 : 0 increased slightly with the increase of the mixing ratio of rice bran oil.

Table-3.2) shows fatty acid compositions of the sesame oils adulterated with rapeseed oil. The percentage of 18 : 3 largely varied. When the mixing ratio of rapeseed increased to 5 %, 10 % and 20 %, the percentage of 18 : 3 increased by two, three and five times, respectively. The percentage of 22 : 1 and the other fatty acids scarcely varied.

Table-4.1) shows the unsaponifiable matter compositions of sesame oils adulterated

with rice bran oil. Two components with *RRT* 1.19 and *RRT* 1.55 were found in the adulterated sesame oils except for 5 % adulterated oil.

Table-4.2) shows the unsaponifiable matter compositions of sesame oils adulterated with rapeseed oil. A component with *RRT* 0.69 was brassicasterol, a characteristic component of rapeseed oil. The rate of this component was proportional to the mixing ratio of rapeseed oil. The rate of two components with *RRT* 0.90 and *RRT* 1.14 in 100 % sesame oil was significantly different between two results in **Table-4.1)** and **Table-4.2)**. The other components were not always proportional to the mixing ratio in **Table-4**. The quantitative analysis of unsaponifiable matter compositions was reliable.

3.3 Fatty acid pattern similarity ($\cos \theta$) of sesame oils adulterated with rice bran oil and with rapeseed oil

Table-5.1) shows $\cos \theta$ between pure sesame oil and the sesame oils adulterated

Table-3 Fatty acid composition (%) of sesame oils adulterated with rice bran oil and with rapeseed oil
1) Adulterant oil : Rice bran oil

No.	Ratio Sesame : Rice bran oil : oil											
		14 : 0	16 : 0	16 : 1	18 : 0	18 : 1	18 : 2	18 : 3	20 : 0	20 : 1	Other	22 : 0
1	100 : 0	0.0	8.8	0.2	5.5	39.3	44.5	0.5	0.7	0.1	0.2	0.2
2	95 : 5	0.0	9.2	0.2	5.3	39.6	44.3	0.5	0.5	0.1	0.2	0.1
3	90 : 10	0.0	9.7	0.2	5.1	39.5	43.8	0.5	0.6	0.2	0.2	0.2
4	85 : 15	0.0	9.9	0.2	4.9	39.7	43.4	0.6	0.7	0.2	0.2	0.2
5	80 : 20	0.1	10.2	0.2	4.7	39.9	43.0	0.7	0.7	0.2	0.2	0.1
6	70 : 30	0.1	10.9	0.2	4.3	40.2	42.0	1.0	0.8	0.2	0.2	0.1
7	0 : 100	0.3	15.9	0.3	1.7	42.4	36.5	1.3	0.6	0.5	0.3	0.2

2) Adulterant oil : Rapeseed oil

No.	Mixture ratio Sesame : Rapeseed oil : oil											
		16 : 0	16 : 1	18 : 0	18 : 1	18 : 2	18 : 3	20 : 0	20 : 1	Other	22 : 0	22 : 1
1	100 : 0	8.9	0.2	5.5	39.2	44.6	0.5	0.7	0.1	0.2	0.1	0.0
2	95 : 5	8.5	0.2	5.3	40.1	43.4	1.1	0.8	0.2	0.2	0.2	0.0
3	90 : 10	8.3	0.2	5.1	41.3	42.2	1.5	0.7	0.2	0.3	0.2	0.0
4	85 : 15	8.1	0.2	4.9	42.3	41.2	2.0	0.6	0.3	0.2	0.2	0.0
5	80 : 20	7.9	0.2	4.7	43.3	39.7	2.6	0.6	0.4	0.2	0.2	0.2
6	70 : 30	7.4	0.2	4.3	45.4	37.5	3.5	0.6	0.6	0.2	0.2	0.1
7	0 : 100	3.9	0.2	1.7	59.3	20.7	10.7	0.5	1.7	0.3	0.4	0.6

with rice bran oil. The value of $\cos \theta$ decreased as the mixing ratio of the rice bran oil increased. The difference between $\cos \theta$ values of adulterated oils and pure oil was expressed as the parameter, $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ given from the following equation, $\sqrt{2} \sin \frac{\theta}{2} \times 10^3 (= \sqrt{(1 - \cos \theta)} \cdot 10^6)$. Afterward, the parameter, $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ was expressed only as $\sqrt{2} \sin \frac{\theta}{2}$ with abridgement of ($\times 10^3$). The parameter, $\sqrt{2} \sin \frac{\theta}{2}$ increased gradually as the mixing ratio of the rice bran oil increased. Next, increase of $\sqrt{2} \sin \frac{\theta}{2}$ per 1 % mixing ratio of the rice bran oil

was shown as the parameter, $\sqrt{2} \sin \frac{\theta}{2} / \%$. The parameter, $\sqrt{2} \sin \frac{\theta}{2} / \%$ value was constant at around 1.4 among the adulterated sesame oil with various mixing ratio of rice bran oil.

Table-5-2) shows $\cos \theta$ between sesame oils adulterated with rapeseed oil and pure sesame oil. The parameter, $\sqrt{2} \sin \frac{\theta}{2}$ increased gradually as the mixing ratio of the rapeseed oil increased. The parameter, $\sqrt{2} \sin \frac{\theta}{2} / \%$ value was constant at around 4.0 among the adulterated sesame oil with various mixing ratios of rapeseed oil. The parameter, $\sqrt{2} \sin \frac{\theta}{2} / \%$ was smaller in

Table-4 Unsaponifiable matter compositions (%) of adulterated sesame oils.

1) Adulterant oil : Rice bran oil

No.	Ratio Sesame oil : Rice bran oil	<i>RRT</i> ^a									
		0.80	0.86	0.90	1.00	1.04	1.14	1.19	1.29	1.34	1.55
1	100 : 0	9.2	3.6	2.7	73.3	8.6	1.4	—	0.5	0.7	—
2	95 : 5	9.3	3.7	2.5	71.0	8.4	3.1	—	0.8	1.2	—
3	90 : 10	9.9	4.4	2.8	66.1	8.6	4.6	0.4	1.1	1.6	0.5
4	85 : 15	10.0	4.9	2.9	62.8	8.5	5.5	0.5	2.2	2.0	0.7
5	80 : 20	9.5	5.0	3.0	57.6	9.4	6.1	1.5	4.7	2.7	0.5
6	70 : 30	9.9	5.2	3.4	53.0	9.5	7.3	2.1	6.1	3.3	0.2
7	0 : 100	11.2	7.8	5.1	31.8	11.6	10.9	3.0	11.6	5.7	1.3

2) Adulterant oil : Rapeseed oil

No.	Ratio Sesame oil : Rapeseed oil	<i>RRT</i> ^a								
		0.69	0.80	0.86	0.90	1.00	1.04	1.14	1.29	1.34
1	100 : 0	—	9.3	3.4	0.9	70.1	7.5	7.8	0.3	0.7
2	95 : 5	0.2	10.3	3.1	1.0	69.4	7.2	7.8	0.3	0.7
3	90 : 10	0.5	11.5	2.2	0.1	70.9	6.4	7.4	0.3	0.7
4	85 : 15	0.9	12.9	2.7	—	70.9	6.4	5.3	0.2	0.7
5	80 : 20	1.1	13.2	3.3	—	66.6	6.9	7.9	0.4	0.6
6	70 : 30	1.8	15.1	3.2	1.0	64.4	7.3	6.2	0.4	0.6
7	0 : 100	9.2	36.1	—	0.9	49.0	4.0	0.8	—	—

a : Relative retention time

RRT for like β -sitosterol taken as 1.00

RRT 0.69, brassicasterol ; 0.80, campesterol ; 0.86, stigmasterol ; 1.04, fucosterol ; 1.14, Δ^5 -avenasterol+ β -amyrin+gramisterol ; 1.18, Δ^7 -stigmasterol ; 1.34, Δ^7 -avenasterol ; 1.55, citrostadienol

Table-5 The value of $\cos \theta$ (fatty acid pattern similarity) between pure sesame oil and adulterated sesame oils.

1) Adulterant oil : Rice bran oil

No.	Mixture ratio Sesame oil : Rice bran oil	$\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ ^a	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3 / \%$ ^b
1	100 : 0	1.000000		
2	95 : 5	0.999941	7.7	(1.5)
3	90 : 10	0.999787	14.6	(1.4)
4	85 : 15	0.999615	19.6	(1.3)
5	80 : 20	0.999310	26.3	(1.3)
6	70 : 30	0.998420	39.7	(1.3)
7	0 : 100	0.980693	138.9	(1.4)

2) Adulterant oil : Rapeseed oil

No.	Mixture ratio Sesame oil : Rapeseed oil	$\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ ^a	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3 / \%$ ^b
1	100 : 0	1.000000		
2	95 : 5	0.999625	19.4	(3.9)
3	90 : 10	0.998407	39.9	(4.0)
4	85 : 15	0.996464	59.5	(4.0)
5	80 : 20	0.993551	80.3	(4.0)
6	70 : 30	0.985853	118.9	(4.0)
7	0 : 100	0.856284	379.1	(3.8)

$$a : \sqrt{(1 - \cos \theta)} 10^6 = \sqrt{2} \sin \frac{\theta}{2} \times 10^3$$

$$b : \sqrt{2} \sin \frac{\theta}{2} \times 10^3 / \text{percent of an adulterant oil}$$

the value between pure sesame oil and an adulterated sesame oil mixed with rice bran oil than in that between pure sesame oil and an adulterated sesame oil mixed with rapeseed oil. This indicates that rice bran oil has high similarity with sesame oil in fatty acid composition as compared with rapeseed oil.

3.4 Estimation of mixing ratio in the sesame oil adulterated with rice bran oil or with rapeseed oil

Table-5 shows a relationship between the mixing ratios of a foreign oil in the sesame oil and the parameter, $\sqrt{2} \sin \frac{\theta}{2}$. A similar relation was also observed in sesame oils adulterated with soybean oil as described in the previous report³⁾. It should be noted that this linear relationship could be valid for mixtures of a specified sesame

oil and a specified adulterant oil. Variation of fatty acid composition among different lots of oil was not involved in this relation.

Table-6 shows $\cos \theta$ between one of six pure rice bran oils and one sesame oil. Only minimum and maximum $\cos \theta$, and corresponding $\sqrt{2} \sin \frac{\theta}{2}$ are shown in this table.

Therefore, the maximum value in $\sqrt{2} \sin \frac{\theta}{2}$ of sixty values was 162.0 and the minimum value was 127.2. The difference between maximum and minimum values, which was caused by variation of fatty acid compositions, was 34.8. Also, as mentioned in the previous report³⁾, the maximum value

$\left(\sqrt{2} \sin \frac{\theta}{2} \right)$ calculated from the similarity between an average fatty acid composition of ten sesame oils and that of each

Table-6 The value of $\cos \theta$ between six rice bran oils and one sesame oil.

Sesame oil No.	Min. and Max. $\cos \theta$ of rice bran oils			
	Min. $\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$	Max. $\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$
1	0.975019	158.1	0.979549	143.0
2	0.976101	154.6	0.980569	139.4
3	0.973743	162.0**	0.978909	145.2
4	0.980035	141.3	0.983815	127.2*
5	0.979033	144.8	0.983048	130.2
6	0.978450	146.8	0.982515	132.2
7	0.974858	158.6	0.979196	144.2
8	0.975995	154.9	0.980443	139.8
9	0.977879	148.7	0.981830	134.8
10	0.976638	152.8	0.980849	138.4
S ^a	0.976968	152.1	0.981207	137.8

a : Sesame oil with the average fatty acid composition, ** Maximam, * Minimum

Fig.-1 Relationship between $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ and an adulterant oil (%)

sesame oil was 30.4. Therefore, the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ in all sesame oils ranges from -30.4 to 30.4. Based on this value and the result shown in **Table-6**, the relationship between $\sqrt{2} \sin \frac{\theta}{2}$ and the mixing ratio of rice bran oil in sesame oil was shown in **Fig.-1**. The lines, ①~④, in **Fig.-1**, indicate the equations shown as follows.

- ① $C=1.217 F+30.4$
- ② $C=1.521 F$
- ③ $C=1.373 F$
- ④ $C=1.677 F-30.4$

C and F in the equation are $\sqrt{2} \sin \frac{\theta}{2}$ and the mixing ratio of rice bran oil, respectively. The lines, ① and ④ show the relationship in the case that both fatty acid compositions of sesame oil and rice bran oil are unknown,

Fig.-2 Relationship between $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ and an adulterant oil (%)

meanwhile the range between two lines, ② and ③ shows the relationship in the case that the average fatty acid composition of sesame oils can be used. If fatty acid composition of sesame oil is specified or nearly equal to an average fatty acid composition of sesame oils, a relationship between $\sqrt{2} \sin \frac{\theta}{2}$ and a mixing ratio of rice bran oil is situated in a triangle area shown in **Fig.-1**. When the mixing ratio of rice bran oil is 5 %, 10 % and 30 %, the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ is in the range of 6.9~7.6, 13.7~15.2 and 41.2~45.6, respectively. Conversely, when the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ is 50, the mixing ratio can be estimated to be 34.7 ± 1.7 %. On the other hand, if fatty acid composition of sesame oil can not be specified, a relationship of $\sqrt{2} \sin \frac{\theta}{2}$ and a mixing ratio is sit-

Table-7 The value of $\cos \theta$ between fourteen rapeseed oils and one sesame oil.

Sesame oil	Min. and Max. $\cos \theta$ of rapeseed oils			
No.	Min. $\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$	Max. $\cos \theta$	$\sqrt{2} \sin \frac{\theta}{2} \times 10^3$
1	0.837910	402.6	0.898035	319.3
2	0.837447	403.2	0.880167	346.2
3	0.823309	420.3*	0.887299	335.7
4	0.852076	384.6	0.908716	302.1
5	0.857955	376.9	0.913107	294.8*
6	0.846171	392.2	0.904600	308.9
7	0.845427	393.1	0.903931	309.9
8	0.838497	401.9	0.898523	318.6
9	0.847626	390.4	0.905362	307.6
10	0.843540	395.6	0.902444	312.3
S ^a	0.843171	401.4	0.902138	315.4

a : Sesame oil with the average fatty acid composition

uated in a range between a line ① and a line ④ shown in Fig.-1. When the mixing ratio of rice bran oil is 20 %, 30 % and 50 %, the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ is situated in the range of 1.0~56.8, 16.8~70.0 and 48.4~96.3, respectively. And if the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ is 50, a mixing ratio is estimated to be in the larger range of 32.9 ± 18.1 % than mixing ratio estimated above.

Table-7 shows $\cos \theta$ between fourteen pure rapeseed oils and one sesame oil. Only minimum and maximum $\cos \theta$, and their corresponding $\sqrt{2} \sin \frac{\theta}{2}$ are shown in a similar way to **Table-6**. Therefore, the maximum value in $\sqrt{2} \sin \frac{\theta}{2}$ was 420.3 and the minimum value was 294.8. The difference between maximum and minimum values was 126.0. In a similar way to **Fig.-1**, **Fig.-2** shows the relationship between $\sqrt{2} \sin \frac{\theta}{2}$ and the mixing ratio of rapeseed oil in sesame oil. If fatty acid composition of sesame oil is specified or nearly equal to an average fatty acid composition of sesame oils, and the parameter, $\sqrt{2} \sin \frac{\theta}{2}$ is 60, a mixing ratio of rapeseed oil in an adulterated sesame oil could be estimated to be 17.0 ± 2.0 %. On the other hand, if fatty acid

composition of sesame oil can not be specified, a mixing ratio could be estimated to be 18.0 ± 10.5 %.

In conclusion, the adulteration of rice bran oil can be found by detecting two components with *RRT* 1.19 and *RRT* 1.55 in unsaponifiable matter. However, when a mixing ratio was less than 5 %, it's difficult to detect them. The adulteration of rapeseed oil to sesame oil can be found by measuring a percentage of 18 : 3 or by detecting *RRT* 0.69 (brassicasterol). Though the method using the fatty acid pattern similarity ($\cos \theta$) is not always effective for the identification of a foreign oil in an adulterated sesame oil, it could be useful in evaluating whether a foreign oil is mixed or not. Once an adulterant oil is specified, a mixing ratio could be quantitatively evaluated on the basis of fatty acid pattern similarity.

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References

- 1) S. Niiya, T. Maruyama, M. Imamura, and T. Matsumoto, *Yukagaku*, **19**, 228 (1970).
- 2) L. Han. and J. M. Adams, *J. Assoc. Off. Anal. Chem.*, **67**, 916 (1984).
- 3) M. Yamazaki, A. Nagao, and H. Yamamoto, *J. Jpn. Oil Chem. Soc. (YUKAGAKU)*, **42**, 605 (1993)
- 4) S. Tamura and H. Oosawa, *J. Jpn. Soc. Nutr. Food Sci.*, **22**, 494 (1969).

ごま油中の異種油脂の 混入比の推定(第2報)

米ぬか油あるいはなたね油

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ごま油 10 点, 米ぬか油 6 点そしてなたね油 14 点を供
試し, ごま油中の米ぬか油, あるいはなたね油の鑑定法
と混入比の推定法について検討した。混入米ぬか油の鑑

定は不けん化物 (*RRT* 1.19 及び 1.55) を検出すること
により, 一方, 混入なたね油の鑑定はリノレン酸の含有
比の分析や不けん化物-ブラシカステロール (*RRT*
0.69) を検出することにより可能であった。

米ぬか油あるいはなたね油混入ごま油と純粋なごま油
の脂肪酸パターン類似率 ($\cos \theta$) を求め, $\sqrt{(\cos \theta) 10^6}$

($=\sqrt{2} \sin \frac{\theta}{2} \times 10^3$) を算出した。 $\sqrt{2} \sin \frac{\theta}{2} \times 10^3$ は,

米ぬか油あるいはなたね油の混入比と比例関係にあっ
た。混入油が特定できた場合には, 脂肪酸パターン類似
率に基づき混入比の推定が可能である。

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