

Study on the Composition and Industrial Evaluation of Chinese Oil Seeds I. —— Rice Bran Oil and Teaseed Oil ——

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synopsis: Oil seeds in middle China were collected and investigated about oil quality and composition, chemically and industrially. Especially teaseed and rice bran were evaluated. Authors classified Chinese teaseed oil in two types and isolated the 22-C F-1 fatty acid newly as a component of Chinese teaseed lipid. Japanese teaseed and camellia have no such component of the lipid. However USM of them have only small differences in the pattern of GLC. Oil content of teaseed is about 30 %.

Rice bran oil content in ordinary bran was 14.5 %, and this value is nearly equal to international average value but less than 20 % in Japan or USA. The composition of fatty acids or USM is similar to Japanese rice bran lipid. The yield of crude rice bran oil by hydraulic or screw press is about 12%, and AV of crude oil is about 10. Corngerm and rice bran have a big potential as vegetable oil resource in China.

1. Introduction

Vegetable oils are important not only for human nutrition, but also as fuel energy source in future.

The fossil energy has a limited life of mining resource, however biomass energy from oilseeds is renewable. It has no limit after enlarging culturing field and absorbing more quantity of solar energy.

Because People's Republic of China has enormous area and population, and is rich in the kind of oil seed, studying on the developing of oil industry and technology is desirable.

One of the authors, Takeshita¹⁾ visited China by Columbo Plan, and Tian Renlin collaborated as the counterpart. They collected and investigated oilseeds and oils in middle China, and will report about the oil chemical property of main oilseeds and the potential of vegetable oil resources.

The annual production and distribution of oil seed in each region of China are shown in **Table 1**²⁾ and **Figure 1**³⁾. Chinese oilseed production is accerelated year by year, and production quantities of rapeseed and cottonseed are the tops in the world.

Rice bran and corn germ produce large quantities, but no official statistics as oil ingredient in China was published, and still seem the potential oil resources. Authors confirmed that they had common oil chemical components to foreign country's ones and will discuss

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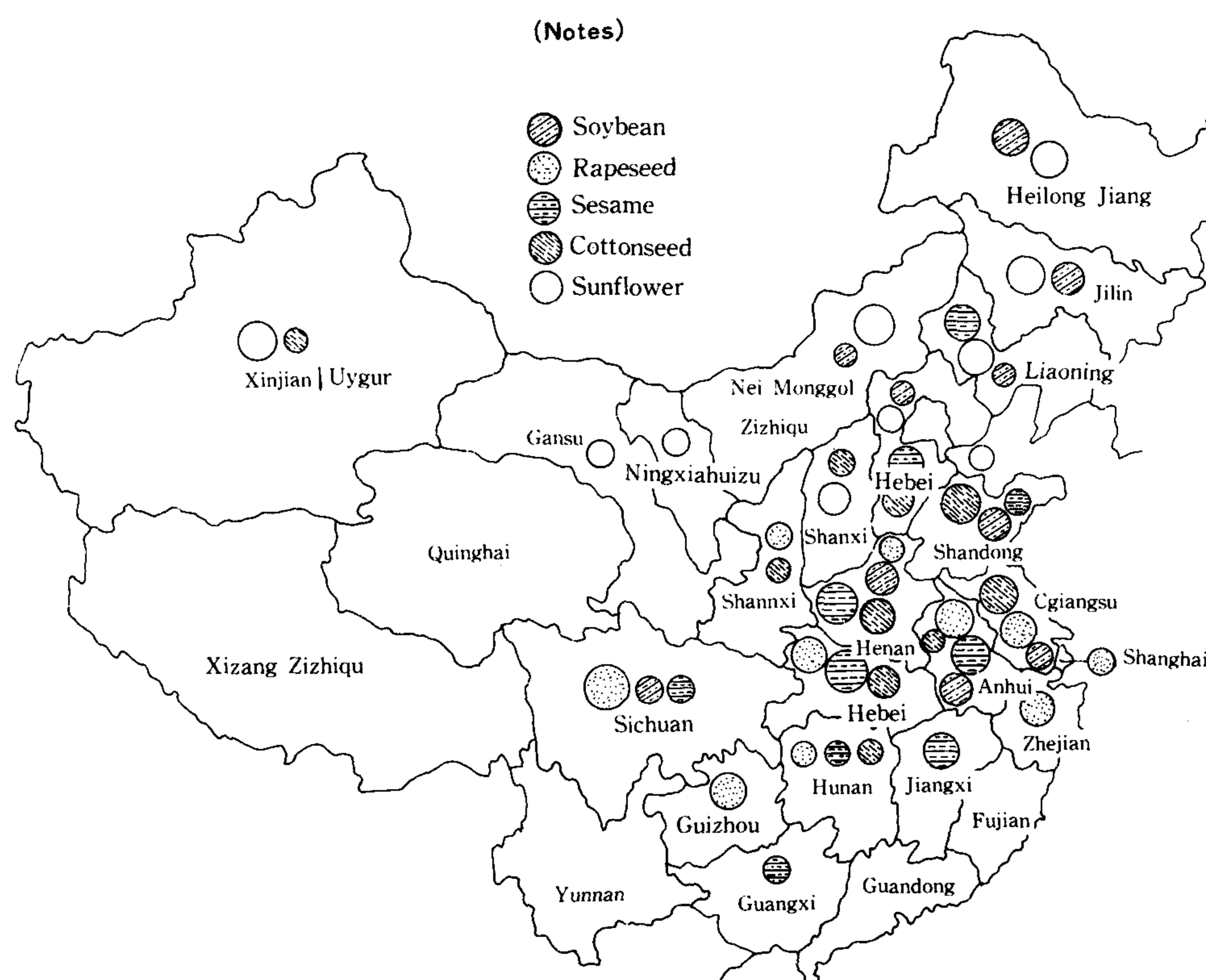
Table 1. Oil seeds production in China (unit:10,000M/T)

kind of oilseed	peak year	before war quantity	1978	1980	1983	1984	world trend 1984-5
soybean	1936	1,130	757	794	976	1,000	9,025
peanuts	1933	317	237	360	395	448	1,957
rapeseed	1934	191	187	238	429	406	1,617
sesame	1933	99	32	26	35	30	200
sunflower	—	—	28	91	135	140	1,965
cotton-seed	1936	170	433	541	927	1,100	3,316
Total Trend	1985					3,120	

Source:China goverment statistics & USDA²⁾

them merely qualitatively.^{4),5)}

The teaseed oil is familiar edible oil in Hunan province. The authors researched the fatty acid and USM compositions of it by GLC, and compared with Japanese teaseed or camellia oil. They discovered some differences between both oils in spite of the similarity of USM composition, and isolated 22-C-F-1 fatty acid as a new constituent.

Fig 1. Oil Seed Production in China (1982) (Source: Yushi 38, (2) 22 (1985))¹⁾

2. Experimentals

2.1 The quality of Chinese oilseeds

The oil seeds, collected in the producing area, and brought to Tokyo, were analysed and

Rice Bran Oil and Teaseed Oil

evaluated the quality. The results are shown in **Table 2 ~ 4**.

Those samples were solvent extracted with diethylether, and the high acidity of extracted cereals lipid might be caused by storing condition of bran or germ.

Oil content of China planted soybean is usually 18–19 %, however in this sample, oil content is ca 1 % more than upper value. The oil content 40 % of rapeseed is ordinary.

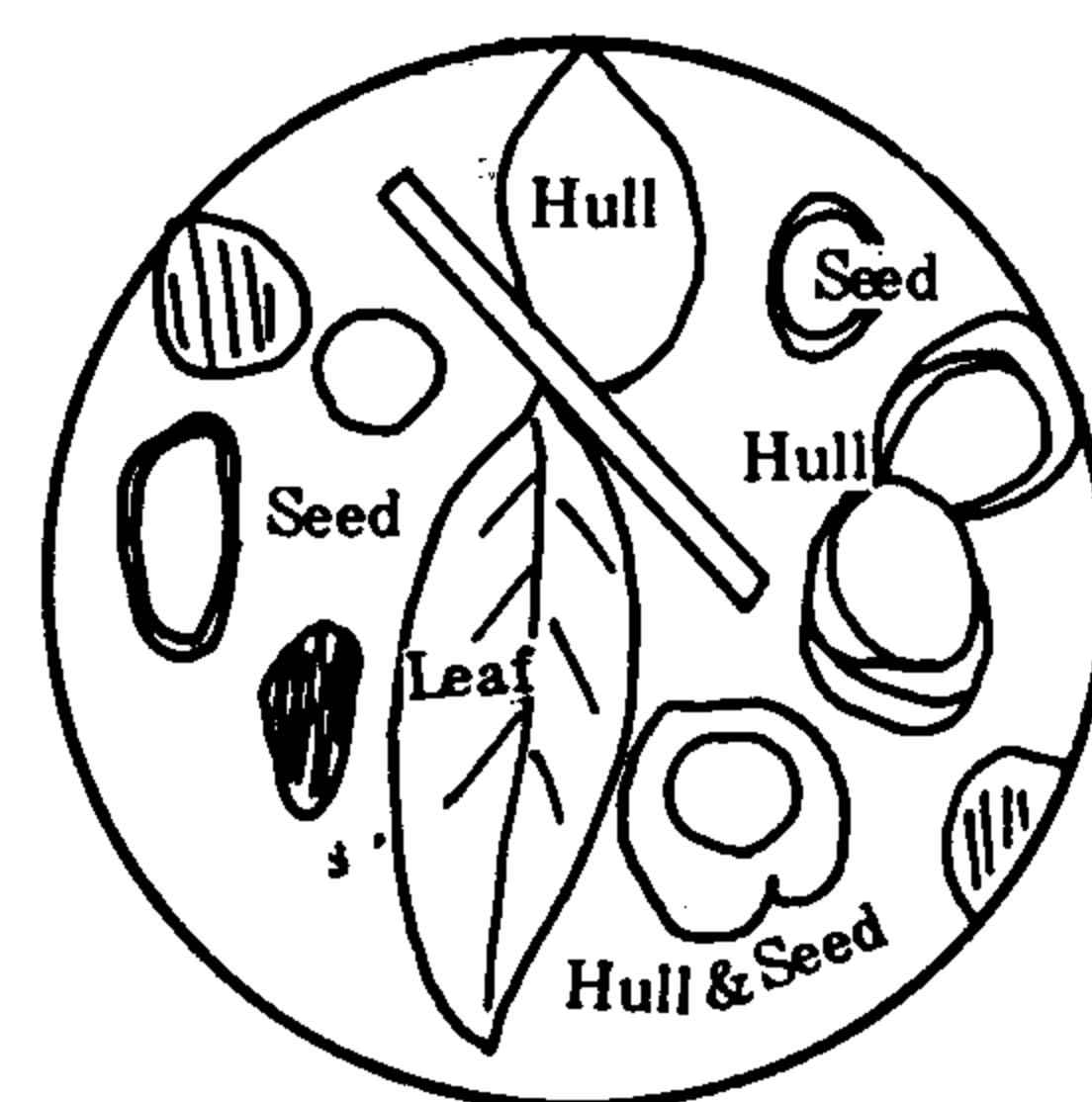
Table 2. Analytical data of Chinese oil seeds

kind of seed	oil cont. %	moist. %	AV of oil	crude ash %	grain size
soybean	19.6	7.6	2.2	—	—
rapeseed	40.0	6.8	2.4	—	—
ricebran	14.5	11.0	109	6.6	60 mesh under:80%
ricebran cake	7.0	8.0	—	—	hard block
teaseed	30	27	2.6	—	—

The color of rapeseed is red and yellow like Canadian seed, but it is high erucic (**Table 4**). The rice bran was sampled at Changsha, and its oil content is nearly equal to so called ordinary bran of south east Asia, but is less than the bran of Japan or USA.^{4),5)}

The teaseed (*Thea sinensis* L.) was sampled at the suburb of Yueyan, located near Donting Hu. The other seeds were sampled at each field, and compared with Japanese tea (*Thea japonica* Nois.) and camellia (*Camellia japonica* L.), seeds.

(**Figure 2.** Teaseed of Yueyan, China)



(Scale 1/3)

2.2 Crude and refined oils analyses (Table 3)

Fig 2. Tea seed (Yueyan, China)

Table 3. Analytical data of chinese oil and wax

<div>Items</div> <div>Samples</div>	AV		Phosphatide (%)	USM (%)	IV	n _D ²⁵	PV meq/kg
	AB.6B.	PP.					
Ricebran crude oil							
Yueyan	—	10	1.4	5.0	—	—	—
Changsha	—	12	1.1	5.3	—	—	—
Refined ricebran oil							
Yueyen	1.2	1.8	—	—	103	1.472	17
Changsha	1.8	2.8	—	—	102	1.472	9
Veg. blended oil							
Changsha	1.8	2.5	—	3.4	105	1.472	15
Teaseed oil (refined)	—	0.03	—	(SV:188)	88	1.468	4.5
Changsha	—	2.6	0.3	(SV:191)	85	1.468	—
Rice wax (Changsha)	—	—	—	(SV:71)	35	(mp:68°C)	—

2.3 Fatty acid composition of Chinese and Japanese Oils by GLC

Table 4. GLC data of fatty acid composition (%) of chinese oils*

oil kind \ C No.	14C-0	16C-0	18C-0, -1, -2, -3	20C-0, -1	22C-0, -1
Soybean oil	0.2	7.5	5.0 25 48 8	0 0	0 0
Rapeseed oil	0.1	3.1	0.1 14.2 13 8.8	0 9.5	0.1 45.6
Ricebran oil	0.5	17	1.0 40 38 1	0 0.5	0 0
Teaseed oil-A	0.1	10.2	0.1 72 13 ; 0.9	0.1 1.4	0 2.7
(seed) -B	3.0	21.5	0 49 19 1.7	(2.2)	0.5 0.2
(refined) -C	0.6	18.9	0 50 28 0.6	0.9 0.1	0.1 0.2
Jpn. Teaseed oil	0.1	15.7	0 45 37 0.7	0 0.3	0 0.3
Jpn. Camellia oil	0.1	8.6	0 85.3 4.0 0.2	0 0.7	0 0.1

*EGA column 190°C (injection 240°C)

2.4 USM composition of teaseed and camellia oils by GLC

The USM compositions of rice bran or teaseed oils were checked by GLC.

Japanese teaseed oil and camellia oil were compared with Chinese teaseed oil in the point of USM composition. **Figure 3 and Table 5** show the patterns and data of them.

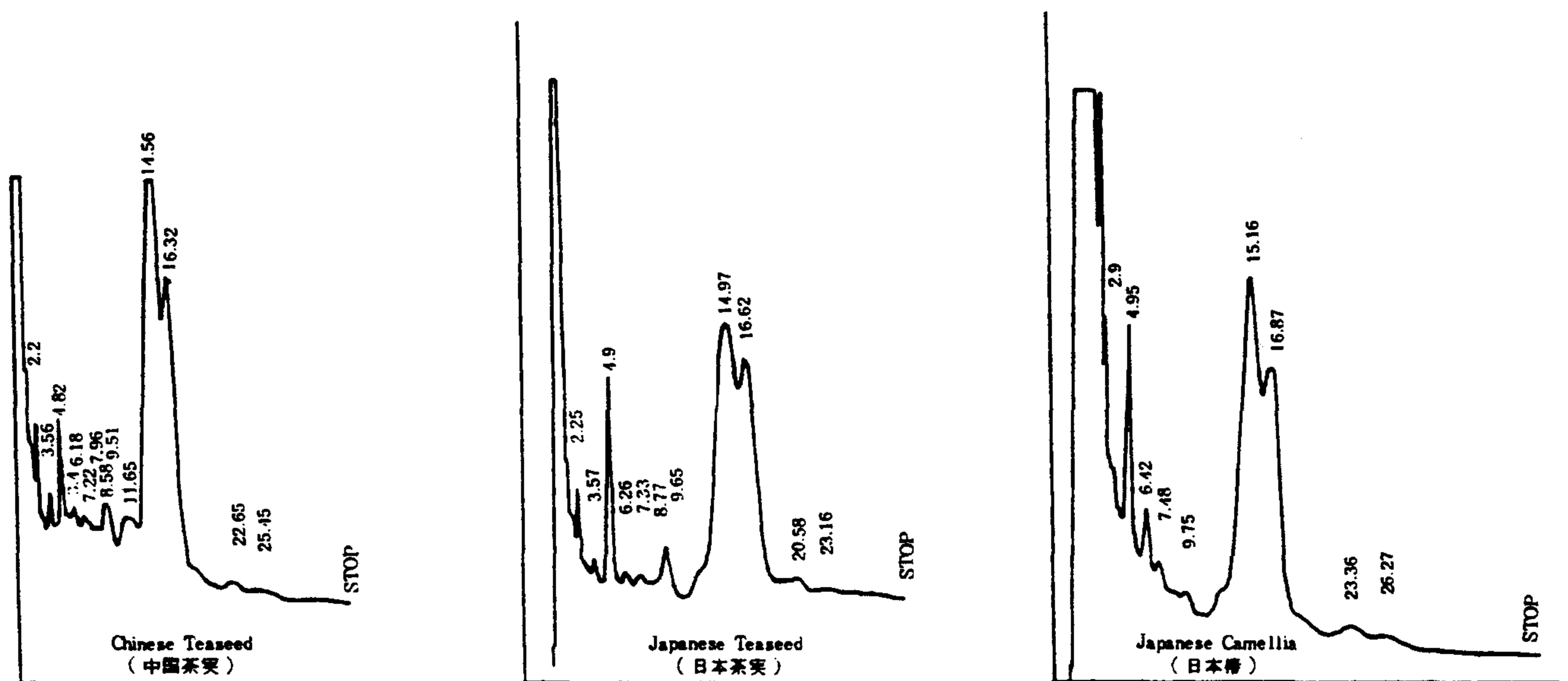


Fig 3. GLC patterns of USM in Chinese or Japanese Teaseed and Camellia Oils.

These GLC patterns were taken by OV-17 column, at 260 °C column temperature, 310 °C injection temperature, with Shimazu GC7 AG (FID) and (CR-1A) integrator.

In **Table 5.**, the maximum peaks (49.8 ~ 53.6 %) at retention time 14.6 ~ 15.2 minutes are supposed to correspond to β -sitosterol, and the next peaks which have retention time, 16.3 ~ 16.9 minutes and their area ratios are ca. 32 %, will be some triterpene alcohols.

It will be better to identify these constituents by NMR or M. S.. GLC patterns of rice bran oil were similar to Japanese ones.

Rice Bran Oil and Teaseed Oil

Table 5. USM composition of oils (Readings of integrator)

Peak No.	Retention time (min.)	Peak area % of USM of oils		
		Chinese teaseedA	Japanese teaseed	Japanese camellia
1	2.2— 2.4	1.2	1.2	5.2
2	2.9— 3.6	0.9	0.6	1.1
3	4.8— 5.0	3.1	7.0	6.7
4	5.4	0.6	—	—
5	6.2— 6.4	1.0	0.6	2.1
6	7.2— 7.5	0.8	1.0	0.7
7	7.9	0.2	—	—
8	8.6— 8.8	0.1	0.9	trace
9	9.5— 9.8	2.0	3.2	0.6
10	11.7	4.1	—	—
11	14.6—15.2	52.6	49.8	49.8
12	16.3—16.9	31.8	32.0	31.6
13	20.6	trace	3.0	trace
14	22.7—23.4	0.9	0.9	1.4
15	25.5—26.3	0.7	trace	0.7

2.5 The quality of Cereal Oil Seeds in China.

Table 6. shows the wt.% of bran or germ in cereal oil seeds and oil contents of them. It was investigated and summarized by Tian⁷⁾, and revised partly by Takeshita.

These data have some range, and further deviation will occur industrially because cereal oil ingredients are the byproduct of milling, and bran or germ contains impurities, for examples hull, husk or endosperm, which contributes to decrease final oil contents.

Table 6. Character of Cereals Oil Seeds in China

seed	wt% in seed	oil cont.%	seed	wt% in seed	oil cont.%
ricebran	3—6	15—20	wheat bran	11—20	3.75—6
ricegerm	2—3	18—30	barey bran	11—20	3—6
corngerm 1 (wet milling)	11—17	30—40	millet bran	22—25	13—14
corngerm 2 (dry milling)	15—20	20—28	miro germ	4—7	33—42
wheatgerm	2—3	6—12	miro bran	10—15	7—11

Sources: mainly by Tian & partly revised by Takeshita

3. Discussion

The authors confirmed general quality of Chinese rice bran, and discovered two types of the composition in teaseed oil of China. Furthermore they isolated the new constituents, 22-C fatty acid in it.

The collected samples were not so many that those samples were enough to get good average. However, comparing with imported oilseeds in Japan, those samples can be assumed as normal ones.

Each result of analysis will be discussed oil chemically in the following sections.

3.1 Rice bran and its oil

The oil content of raw rice bran in Changsha, 14.5 % is nearly equal to average value in the world^{4),5)}, but is less than the oil content of Japanese bran, ca. 20 % and parboiled rice bran of south east Asia and USA, 23~25 %. The oil content of rice bran is influenced by milling system of rice, and in Chinese rice bran, the powder of endosperm contaminates in some degree, but the bran does not include the husk powder. The grain size of bran is comparatively fine to Japanese bran.

Recently, it was reported that an improved industrial system of polishing in China gave more oil rich bran.

Almost rice bran crude oil is the product by the expressing process, not solvent extracting in Chinese rice bran oil mill.

The acid value of it is rather low, for example, 10~12. The low acid value shows the fresh rice bran treating, and it is superior to solvent extracted crude oil in some under-developing countries, for example AV 20~40.

However, it has some difficulty for alkali refining, because it includes much impurities like lipoprotein and hydrocarbon. In the oil mills of Hunan province, the consumption of active bleaching earth for alkali refined rice bran oil is twice of the data in Japanese oil mill, and its cause is low grade earth or pretreating difficulty of alkali refining. The crude ash content 6.6 % in rice bran, is normal, which means no polishing additive of inorganic substance. The presscake of rice bran has only 7 % residual oil, and it is excellent data for expressing method.

The studies on the composition of fatty acid or USM of rice bran oil were accelerated by the method of GLC. The authors researched the rice bran status of many countries^{4),5)}, and then resulted that composition of Chinese rice bran oil was also universal, internationally.

However, the oil content of rice bran needs some improvements, industrially.

3.2 The crude and refined oils

The acid value and peroxide value of crude or refined oil are higher than expected values about soybean or rapeseed crude oil and rice bran refined oil.

The blended type edible oil might have the main component of rice bran oil, and color or cloud point corresponded to Japan Agricultural Standard, Rice Bran Oil Specification. However, the flavor and taste were not good, and as the result, the authors judged that deodorization process was not perfect.

The rice bran wax has saponification value 71, iodine number 34.8, and melting point 68 °C. Its color was greenish brown, and it would be only pressed and not be hydrogenated. The rice bran wax is useful for blending to polishing products, in spite of its not high grade.

If it is fractionated by solvent, for example alkyl ketones, the melting point of it will be elevated to near 80 °C, and it will be harder than this sample.

3.3 Tea seed and Teaseed oil

The tea seed oil is a mainly produced in Hunan province. It resembles to Japanese camellia oil. The oil content of seed is more than 30 %. Japanese tea seed oil is mainly consumed industrially, in spite of its easily refinable property.

Rice Bran Oil and Teaseed Oil

The fatty acid composition of Chinese teaseed oil is characteristic as edible oleic oil. Its oleic acid content is about 50~80 %, The main constituents of USM^{19),20)} are only two kinds of sterol or triterpene alcohols. Bailey⁶⁾ stated in his book that, the exact identification of fatty acid of Chinese teaseed oil by GLC had not been reported.

Here, the authors isolated the 22-C-F-1 fatty acid as a new component of a crude teaseed oil, but it must be checked that it is not rapeseed contamination at oil mill. The calculation of fatty acid balance denies the contamination, but further investigation will be reported in the second paper in future. (Figure 4 and Table 4)

Here, the authors discuss the difference of fatty acid and USM composition of Chinese teaseed, Japanese teaseed and camellia oil.

The content percent of C-16~18 are classified to Japanese camellia and Japanese teaseed types. Their USM composition were similar each other. (Fig 3 and Table 5)

The history of studying on teaseed oil is very long. M. Tsujimoto^{8~10)}, S. Ueno¹¹⁾ and T. Tsuchiya¹²⁾ reported many data, in Japanese National Chemical Laboratory's Report¹⁰⁾, their edited book⁸⁾ and oil chemical handbook¹²⁾ Tsujimoto⁸⁾ and K. Kobayashi had sampled teaseed in Changsha of Hunan province more than eighty years ago, and compared with other country's seed oil.

Table 7 was reported by them.

Table 7. Teaseed Oil analysis by Tsujimoto et al.⁸⁾

Sample	S. G.	AV	SV	IV	n _D ²⁰	references
Changsha	0.917	1.4	190.5	84.9	1.469	M.T & K.K.(seed)
China	0.918	7.4	189.5	85.8	1.469	S. Ueno (oil)
Japan			188	88.9		Wijs

They showed that camellia oil was more different than Sasanqua (*Thea sasanqua* Nois)

Table 8 Teaseed (THEACEAE) oil analytical data summarized by Hilditch et al.¹⁵⁾

Oilseed kind/C-No.	14C	16C	18C, F-0, F-1, F-2,	20C	22C-F-0, F-1,
<i>Thea sinensis</i> , (Griffiths & Hilditch-1934)					
Teaseed, China, India, etc.	0.3	7.6	0.8 83.3 7.4	0.6	— —
Teaseed, China, (Ueno & Ueda)	—	6	— 84 10	—	— —
Teaseed, China, (Weerakoon)	—	8.9	3.7 79.2 8.2	—	— —
<i>Camellia japonica</i> (Kaufmann)					
Japanese tea seed, Japan	—	—(11)—	87 2	—	— —
<i>Camellia sasanqua</i> (Child)					
Ceylon tea seed, Ceylon	—	—(13)—	72 15	—	— —
<i>Thea sasanqua</i> , Indian T.S.					
Assam (Chakrabarty)	2.0	15.0	0.3 58.4 24.3	—	— —
ibid., Darjeeling	2.6	16.1	0.4 59.0 22.3	—	— —

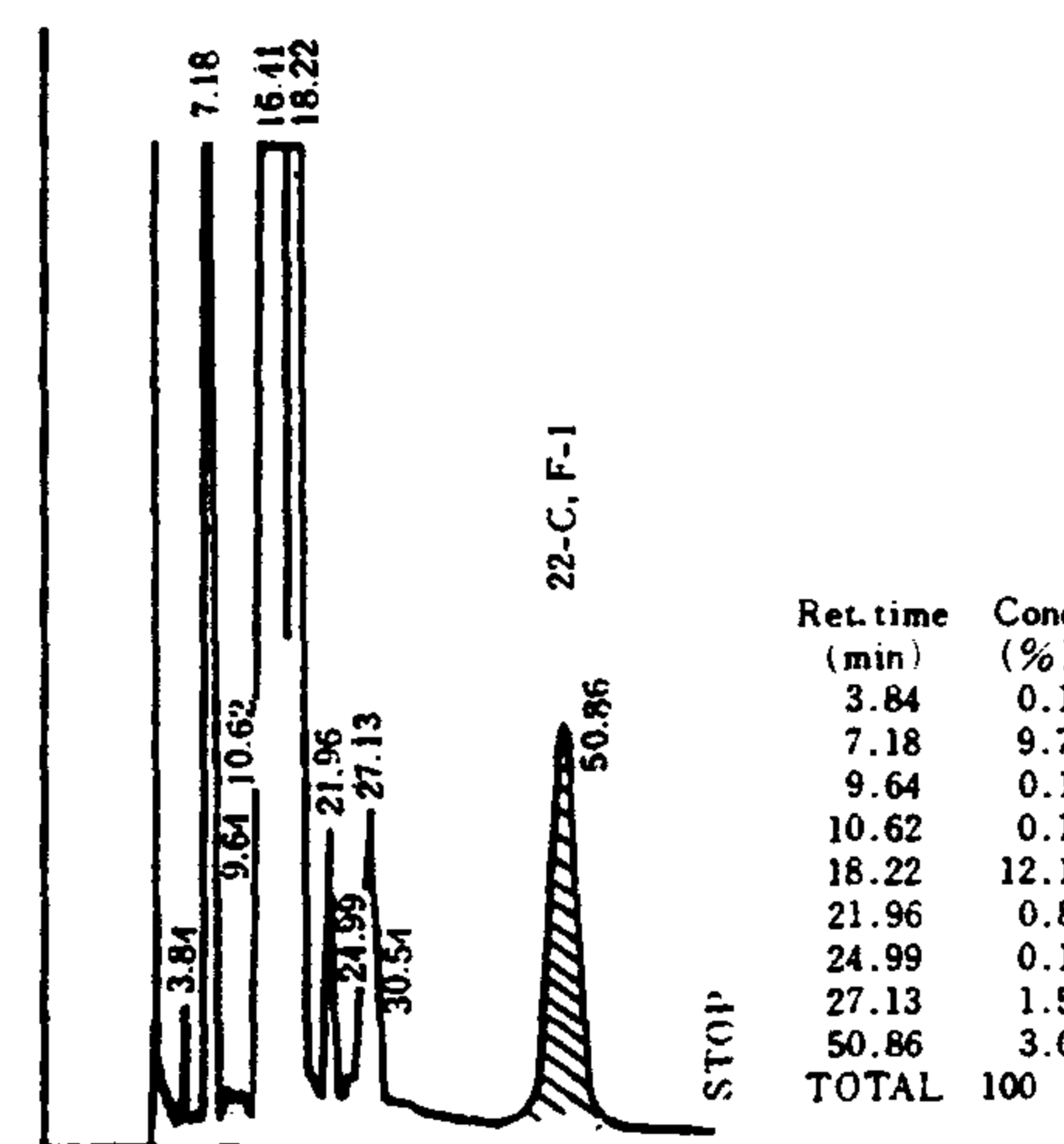


Fig 4. GLC pattern of F.A. composition of Chinese Tea seed Oil

oil from teaseed oil, and stated that saponin in teaseed oil was removed in the course of refining, especially by alkali refining.

T.P. Hilditch¹⁵⁾ summarized several data of fatty acid composition, by old analytical methods also before GLC became popular. (Table 8)^{13), 14), 16~18)}

Authors confirmed by these data that Chinese teaseed oil had two types, but generally 20 C and 22 C fatty acids, especially erucic acid was not isolated before GLC method was not developed.

3.4 Miscellaneous Oils

Miscellaneous oil seed samples could not be collected in this time.

It was reported that cotton seed oil was consumed as frying oil without alkali refining locally. The cottonseed crud oil contains poisonous gossipol, but it will be easily removed in a alkali refining process, before bleaching, and so alkali refining is recommended. Sunflower seed production is growing quickly in the world, and in this country, the seed is important edible vegetable oil resource, because its plantation is suitable to above mentioned regions.

4. Conclusions

Several Chinese oil seeds and oils were collected and investigated. The authors confirmed that there were two kinds in Chinese teaseed, and isolated 22-C fatty acid from one of them. However, another type of Chinese teaseed, Japanese teaseed and camellia oils did not have such component. The fact will contribute to the identification of Chinese teaseed oil.

Rice bran oil produced in China has normal industrial qualities, and common oil chemical properties to Asian rice bran oils, however, oil content of bran needs improvement by a new milling system. Rice bran and corngerm are important potential oil resources in China also.

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中国産油糧種子の組成と工業的評価の研究 第1報 米ヌカ油と茶実油の成分

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中部中国産油糧種子, 特に米ヌカと茶実とを中心に採集, 分析および調査して, 日本などの対応する原料と比較研究した。試料種子および種子油はいずれも正常で優れた品質であったが, 中でも湖南省産茶実は油分 30 %, 成分脂肪酸はオレイン酸 80 %, 炭素数 20~22 の脂肪酸をそれぞれ 1.2 % および 2~3 % 含み, 日本のツバキ油や茶実油と明瞭な差を示したが, 不けん化物では顕著な差が見られない。米ヌカとトウモロコシ胚芽とは中国の潜在油脂資源であるが, それらの組成は国際的に平均の数値に近く, 油分 14.5 % で工業的に圧搾した原油の酸価は 10 前後と低酸価であった。