PLANTS AS SOURCES OF OIL

Katalin Perédi Vásárhelyi
Technology Department, Central Food Research Institute, Budapest, Hungary, and

József Perédi
Department of Grain and Industrial Plant Technology, Szent István University, Budapest, Hungary

Keywords: oil crops, vegetable oils, oil seed meals, fatty acids, sterols, tocopherols, triglycerides, utilization of vegetable oils, feedstuffs.

Contents

Summary

Oils and fats have been indispensable substances for mankind, both in nutritional and industrial respects.

They are the most important energy sources in food, and are necessary as functional constituents in the human organism; furthermore, they are carriers of essential nutrients and are important to consistency and flavor in a large number of foods (edible oils and fats). A small part of them—e.g. cold-pressed or pressed oils—have been consumed raw (only after purification), but most are typically marketed in refined form, after physical and/or chemical treatments.

Manufacturers have usually marketed not just individual fats, but fat mixtures containing various fats, or have also produced, by further processing, other such as margarine, food fats, etc.

Oils and fats have long been vital basic and subsidiary materials, either directly or transformed, as oleochemicals in a number of industrial branches.

Owing to these various demands, it has been required to increase their quantity from year to year. This has been basically achieved by increasing the cultivation of oil plants, since animal fats are practically by-products, and their quantitative increase would need an expensive extension of animal husbandry.
The amounts (in thousand tons) of the most significant fats in the world produced during 2000 were as follows (Table 1.) /1/.

Plant fats	**Thousand tons**	Animal fats	**Thousand tons**
Soybean oil	25,546	Tallow	8,199
Palm oil	21,825	Lard	6,716
Rapeseed oil	14,467	Butter fat	6,026
Sunflower oil	9,677	Fish oil	1,416
Peanut oil	4,573	**Total**	**22,357** (19.2%)
Cottonseed oil	3,852		
Coconut oil	3,272		
Olive oil	2,545		
Palm kernel oil	2,688		
Corn oil	1,968		
Tall oil*	1,500		
Sesame oil	715		
Linseed oil	698		
Cocoa butter*	500		
Castor oil	494		
Total	**94,320** (80.8%)		
Altogether: 116,677 (100%)			

Source: /1/

*: estimated value

Table 1: The amounts (in thousand tons) of the most significant oils and fats produced in the world during the year 2000

The above data have shown the importance of plant oils, moreover, the majority of their raw materials have ‘double utilization’, since the crops of most of them contain much protein, in addition to oil. So, their substances remaining after oil extraction—meals or cakes—have been important feed additives with high protein content, moreover, they can also be human additives suitable for food industrial purposes. In view of the above, the cultivation of oil crops has been extensively improved all over the world. In breeding procedures, novel scientific knowledge has been applied, such as, mutation and genetic manipulation, in order to increase yields and obtain for public cultivation disease- and insect-resistant plants of appropriate composition (high oil content, high protein content, targeted fat composition, etc.). They are well suited to meet the varied and changing demands of utilization.

1. Introduction

There are several hundreds of utilisable fat kinds known in the world, but many of them have been subject to uneconomic exploitation or, owing to limited availability of their raw materials, are of only local significance and are, therefore, rarely marketed.

Oils and fats utilized and marketed on a large scale, having importance in world trade, are relatively few in number, amounting to only 25-30. The majority of them (about 80%) originate from plant crops. For various reasons, including weather conditions, prices, demands, etc., the quantities produced have differed greatly from one year to another. Nevertheless, their number and amount might increase in the future, since novel sources of raw materials have been extensively revealed, and cultivation of fat raw materials, presently of local importance, has been improved.

All of them are grouped and classified according to their origin, in the first place. So, plant (vegetable) oils and fats are distinguished as products originating from fruit pulp, seed and other plant parts. This article deals with the most significant of them.

2. Soybean (Glycine max L.)

Some 22% of fats produced in the world have been soybean oil, originating from soybean (*Glycine max* (L.) Merrill). The plant has been cultivated in large quantities in several countries all over the world. Unlike other oil plants, its crop contains more proteins than oil, and it is more a protein crop than an oil crop. It is generally considered to be the most significant protein crop in the world.

Its gene centre is supposed to be the north-eastern part of China, where it has been cultivated since 2800 B.C. It was exported to Korea, Japan, and, much later in the 1800s, to Europe and America. At present, soybean is cultivated on 74.3 million hectares and its production has amounted to approximately 161 million tons a year (yield 2.17 t/ha), with the following distribution: 74 million tons in USA; 34 million tons in Brazil; 21 million tons in Argentina, 14 million tons in China, 3 million tons in Paraguay, 1 million tons in EC countries, and 14 million tons in other countries /1/, /2/. Its cultivation has been widespread owing to its valuable nutrients. The bean, as well as its oil and meal are well utilizable for eating and feeding purposes, and they are also used by a number of branches of industry. Its protein has had vital importance in the world's animal keeping. The cultivated species belong, within the Fabales order, to the Papilionaceae family, *Glycine* genus, that has two subgenus namely, *Soja* (Moenck) F. J. Herm., and *Glycine* Willd including *Glycine max* in addition to other species.

2.1. Biology, morphology

Soybean is an annual, shrub-like plant. Its roots have a taproot-system, penetrating deep into the soil (1.5-2.0 metres). Thalluses of *Rhizobium japonicum*, living in symbiosis with the plant and able to fix atmospheric nitrogen, are present in the form of nodules, on the lateral roots.

It has a thin stem, 50-140 cm high, stiff, supplied with powerful side-shoots. The plant is covered with fine hair. Its leaves are scattered, and mainly pinnatifid. The hairy leaves are joined with the stem by long leaf blades that become brown and fall off at the end of the cultivation period.

Its flowers are found in the axils of leaves. They are racemes, small (5-8 mm) with white and lilac colors. The pods are 4-7 cm long, straight or slightly arched, hairy pods that are placed on the stem ”one above the other”. There are 2-4 pods, side by side, in a node form, and 2-4 seeds develop therein. As many as 100 pods may grow on one plant.

2.1.1. Climate- and soil demand

A total heat amount of 2200-2500 ºC is needed for its cultivation, half of which is required from flowering to the starting of withering. Therefore, areas between latitudes of ~30 to 49 degrees are the most suitable. It has a rather high demand for water; approx. 700-800 l water is needed for 1-kg dry matter, i.e. approx. 450-750 mm rainfall /3/. (Total heat amount = sum of degree-days during the lifetime. Degree days calculated by subtracting the minimum threshold temperature /usually 10 ºC/ from average temperature each day).

2.1.2. Agrotechnics

Great care has to be taken for thorough preparation of the soil (periodical deep cultivation), as well as weed eradication and nutrient supply. Substantial crops are produced on fertile soils with good water supply. Its specific nutrient supply is N 24-75; P_2O_5 20-64; K_2O 22-65; CaO 28-52 kg/t seed. Its crop rotation is mainly a function of soil-humidity supply. It can be sown in a smooth soil of 8-10 °C temperature, in a depth of 3-5 cm, at a row spacing of 45-50 cm, so that 500 000 to 700 000 plants can develop on one hectare. Freedom from weeds is an important factor in its cultivation, and, consequently, gene-manipulated soybean varieties, resistant to herbicides, have been lately cultivated /3/, /4/.

Its major diseases are: soy mosaic (Soya virus 1), bacterial leaf-blight (*Pseudomonas glycinea* Coerper), bacterial soy disease (*Pseudomonas tabaci* Wolf & Foster), soy mildew (*Peronospora manshurica* /Naum./ Syd. Ex Gaum), withering (*Fusarium oxisporum* Synder & Hansen), and white mildew rot (*Sclerotinia sclerotiorum* de Bary). Protection must be made against its parasites, such as, wireworms, larvae of owlet moths, acacia-moths, root knot nematode and tree-louses /3/.

After falling or desiccating of the leaves, the crop is harvested with a combine, when the moisture content of seeds is 15-18%. Following this, and prior to a long period of storing, drying to 10-12% decreases moisture content /4/.

2.1.3. Varieties

There are many varieties. Over 100 varieties are cultivated just in USA. Varieties are generally classified according to their breeding season: 85-110 days for the so-called 00 varieties, 95-120 days for 0 varieties, 110-130 days for I. varieties, 120-140 days for II varieties and 130-150 days for III varieties. Genetic modification of some characteristics has been achieved recently; especially in respect of resistance to weed killers (Round-Up Ready, STS), inner content and fatty acid composition of seeds, etc. Breeding objectives are increase in yield, resistance against lodging and shattering, even maturation, modification of fatty acid composition, etc. Under favorable conditions of cultivation, the yield is 2.8 to 3.7 tons/ha.

2.2. Characteristics of the seed

The seeds are nearly spherical in shape and have a diameter of 6-10 mm. The seed coats of the beans are mostly yellow or brown or a combination of these colors. They have a characteristic ‘navel’. Thousand seed weight is 70-150 grams.

2.2.1. Major components

The seed consists of three major parts: coat (or hull), cotyledons and germ (or hypocotyl). Their amount and that of their major components are outlined in Tables 2 and 3 /4/, /5/, /6/, /7/. A characteristic change in composition was found to be an increase in protein percentage with a decrease in % of fat (negative correlation).

Component	Value (dry matter %)
Crude protein	36.9 - 46.7
Crude fat	17.8 - 24.5
Crude fiber	4.3 - 7.6
Ash	3.7 - 5.9

Sources: /4/, /5/, /6/

Table 2: The composition of soybean

Name	Yield (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrates (%)
Whole soybean	100.0	40.3	21.0	4.9	33.9
Cotyledon	90.3	42.8	22.8	5.0	29.4
Hull	7.3	8.8	1.0	4.3	85.9
Hypocotyl	2.4	40.8	11.4	4.4	43.4

Source: /7/

Table 3: Chemical composition of soybeans and their main components

A major part of its proteins is readily soluble in water. It contains much globulin, among others, glycinin and phaseolin. There is much legumelin and soy legumelin among its albumins /4/. Their amino acid composition has a favorable biological effect: high lysine content and digestibility. Their informative amino acid composition is presented in Table 4 /6/.

Amino acid	Value (%)
Alanine	4.0
Arginine	7.0
Aspartic acid	11.3
Cystine	1.6
Glutamic acid	17.2
Glycine	4.0
Histidine	2.7

Isoleucine	4.9
Leucine	8.0
Lysine	6.4
Methionine	1.4
Phenylalanine	5.3
Proline	4.7
Serine	5.0
Threonine	4.2
Tryptophan	1.2
Tyrosine	3.9
Valine	5.3

Source: /7/

*: g amino acid / 100 g protein

Table 4: Amino acid composition of soy flour

45% of the approx. 35% carbohydrates are soluble, while 55% are insoluble. Its average composition in dehulled soy-meal (cotyledons-carbohydrate) can be seen in Table 5 /7/.

	Carbohydrate	**Value (weight%)**
Monosaccharides	Glucose	Trace
Oligosaccharides	Sucrose Raffinose Stachyose	5.7 4.1 4.6
Polysaccharides	Arabinan Arabinogalactan Acidic polysaccharides	1.0 8 – 10 5 – 7

Source: /7 a/

Table 5: Carbohydrate constituents of dehulled, defatted soybean flakes

2.2.2. Minor components

Seeds are rich in minerals and vitamins, as can be seen in Table 6 /6/.

Vitamins	**Value (mg/100g)****	**Minerals**	**Value (mg/100g)****
Tocopherols	15.3	Na	4.0
Vitamin B1	0.99	K	1740. 0
Vitamin B2	0.52	Mg	247.0
Vitamin B6	1.19	Ca	257.0
Nicotinamide	2.51	Mn	2.8
Panthothenic acid	1.92	Fe	8.6
Biotin	0.06	Cu	0.1
Folic acid	0.23	Zn	1.0
-	-	Ni	0.7
-	-	P	591.0
-	-	Se	0.06

Source: /6/
*: moisture content 8.5%
**: average values

Table 6: Vitamins and minerals in soybean

Soybean also contains, in small quantities, a number of other nutritive and anti-nutritive matters. The most important ones of the latter are trypsin-inhibitors that inhibit trypsin, the proteolytic enzyme of humans and animals, thus hindering digestibility of seeds. Therefore, their inactivation is required. Among them, Kunitz and Bowman-Birk inhibitors are the most important ones. Both are peptides (Figure 1). The former consists of 181 amino acids and has two disulfide bonds, the latter is smaller and has seven disulfide bonds /8/.

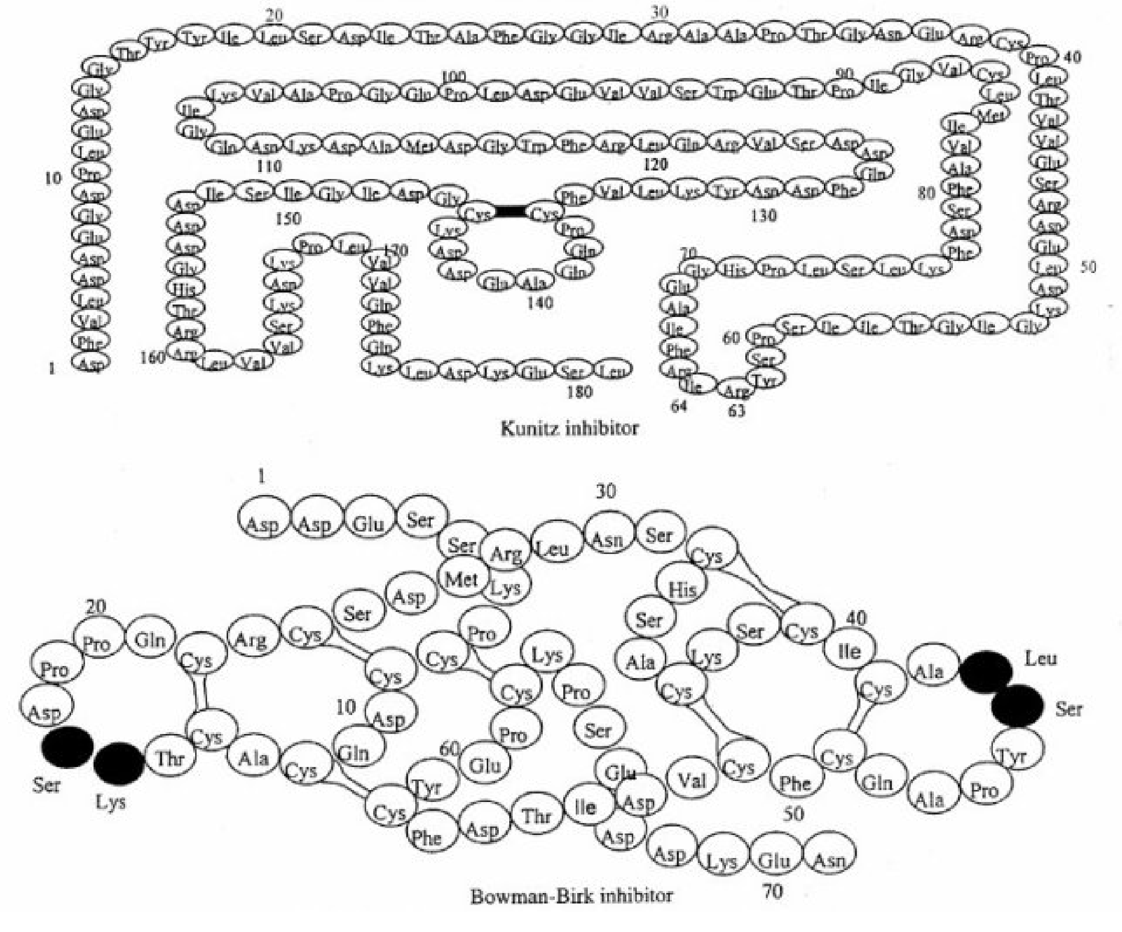

Figure 1: Amino acid sequences of Kunitz and Bowman-Birk inhibitors

Owing to wet heat treatment (toastering), they are denaturized and lose their activity. Other antinutritive matters are haemagglutinins (lectins), goitrogens, allergens and antivitamins D, E, B12. Its unfavorable enzymes are lipoxygenase, causing off-flavor, and urease, releasing ammonia in the case of feed with urea content.

It also contains special phytochemicals, such as, isoflavones, saponins, phytic acid and phenolic acids. Among them, great significance is attributed to isoflavones (genistein, daidzen, and glycitein) in the prevention of heart diseases and cancers (Figure 2). Their amount is 0.15-0.25% /9/.

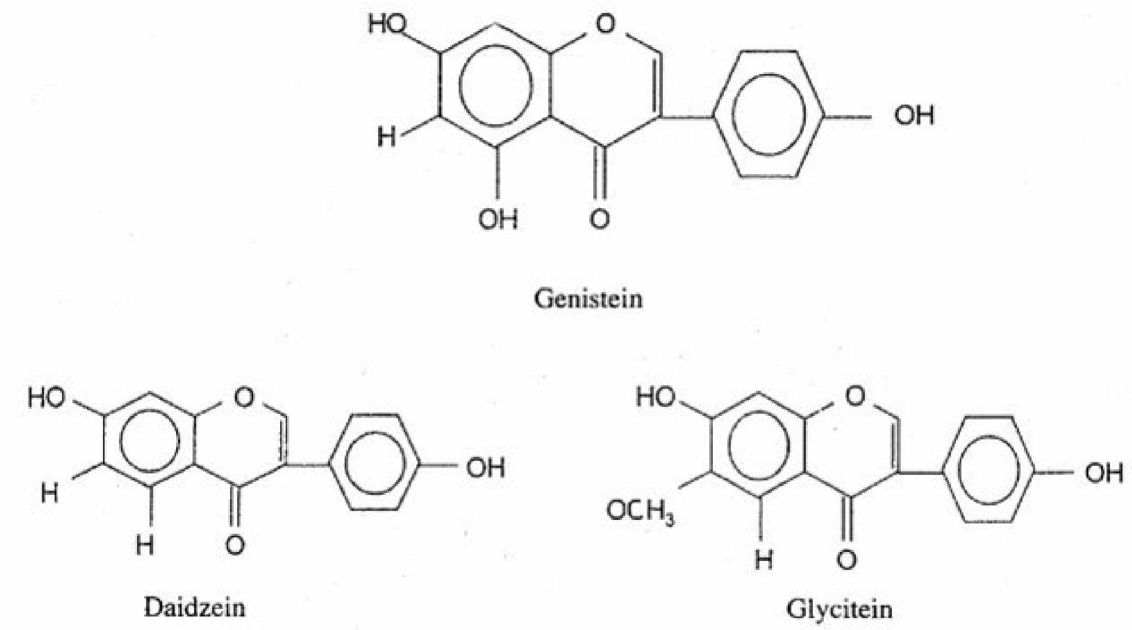

Figure 2: Structures of soy isoflavone aglucones

2.3. Characteristics of the oil

This oil has been produced in the largest quantity in the world. Its amount was 25.5 million tons in 2000.

2.3.1. Major components

Its special feature is that even owing to various environmental factors, its fatty acid composition changes to a relatively small extent, only. Its polyunsaturated fatty acids have an amount of 55-67%, 80-90% of which being linoleic acid, while 10-20% is α-linolenic acid. This is the reason why it is susceptible to oxidation. Its fatty acid composition and major characteristics are demonstrated by data in Tables 7 /10/ and 8 /10/, /11/.

Fatty acid	Value (weight%)
12 : 0	ND - 0.1
14 : 0	ND - 0.2
16 : 0	8.0 - 13.3
16 : 1	ND - 0.2
18 : 0	2.4 - 5.4
18 : 1	17.7 - 26.1
18 : 2	49.8 - 57.1
18 : 3	5.5 - 9.5
20 : 0	0.1 - 0.6
20 : 1	ND – 0.3

20 : 2	ND - 0.1
22 : 0	0.3 - 0.7
22 : 1	ND - 0.3
24 : 0	ND - 0.4

Source: /10/

Table 7: Fatty acid composition of edible soybean oil

Characteristic	**Value**
Relative density (20°C/20°C)	0.919 - 0.925
Refractive index (40 °C)	1.466 - 1.470
Saponification value	189 - 195
Iodine value (Wijs)	124 - 139
Unsaponifiable matter (%)	≤1.5
Titer (°C)* +	14 - 25
Solidification point (°C)* +	-10 - -16
Viscosity (Pas at 25°C)	0.05

Sources: /10/, /11/*

+: wqi

Table 8: Main characteristics of edible soybean oil

Owing to the considerable unsaturated fatty acid content, its triglycerides practically all contain at least two unsaturated fatty acids and ~25% of the glycerides contain linolenic acid: LeLeL 1%, LeLeS 1%, LeLL 7%, LeLO 5%, LeLS 4%, LeOO 2%, LeOS 3%, LeSS 2% (mole %). /Le = linolenic acid, L = linoleic acid, O = oleic acid, S = saturated acid/. /12/

Mutation and genetic manipulation could basically change the fatty acid composition of the oil, recently, so that the oil originating from these new varieties cannot be called soybean oil any more (Table 9) /13/.

Fatty acid	**Low linolenic oil Value (wt%)**	**High stearic oil Value (wt%)**
16 : 0	10.5	8.0
18 : 0	4.1	24.0
18 : 1	37.7	20.2
18 : 2	44.0	40.0
18 : 3	3.7	6.3
20 : 0	-	1.5

Source: /13/

Table 9: Approximate fatty acid composition of “new soybean oils”

-
-
-

Bibliography

Oil World Annual 2000/2001.

FAOSTAT Database

Kurnik,E.: A szója. Akadémiai kiadó, Budapest, 1962.

Bódis,L., Kralovánszky,U.P.: A szója. Mezőgazdasági Kiadó, Budapest, 1988.

Eckey,E.W.: Vegetable Fats and Oils. Reinhold P. C., New York, 1954.

Souci,S.W., Fachmann,W., Kraut,M.: Food Composition and Nutrition Tables. WVG., Stuttgart, 1989.

Erickson,D.R.: Practical Handbook of Soybean Processing and Utilization. AOCS Press, Champaign, Illinois, US. 1995.

a/ Smith,A.K., Cirek,S.J.: Soybeans: Chem. and Techn. Vol.1. Proteins. AVI Publ. Co., Westport, CT., 1972.

Mangino,M.: Food Proteins. Ohio Stat. Univ. Courses, 2002.

Liener,I.E.: J.Am. Oil Chem. Soc., Vol.58, p.406-415, 1981.

Codex Alimentarius Hungaricus, 2-4211: Vegetable Oils, Budapest, 1997.

a/ Itoh,T., Tamura,T., Matsumoto,T.: J. Am. Oil Chem. Soc., Vol.50, p.122-125, p.300-303, 1973.

The Merck Index, Merck Co. Inc., Rahway, N.J., US, 1976.

Gunstone,F.D., Padley, F.B.: J. Am. Oil Chem. Soc., Vol.42. p.957-961, 1965.

White,P.J., Miller,L.A.: J. Am. Oil Chem. Soc., Vol.65, p.1344, 1988.

Weber,E.J.: J. Am. Oil Chem. Soc., Vol.58, p.898, 1981.

American Soybean Ass.: Standards and Specification for Soybeans, Soybean oils and Soybean meal.

NRC, US-Canadian Tables of Feed Comp. 3rd edn., Nat. Ac. Press, Washington, DC, 1982.

Proc. of Palm Oil Familiarisation Programme, PORIM, Malaysia, 1983.

Basiron,Y., Ma Ah Ngan: Palm Oil Developments, Vol.32, p.1-8, 2000.

Basiron,Y., Mohd Nasir, Hj., Amiruddin Hj., Abdullah R.: Palm Oil Developments, Vol.31, p.1-6, 1999.

Duke,J.A.: Handbook of Energy Crops, 1980.

Pocketbook of Palm Oil Uses, Palm Oil Res. Inst. of Malaysia, Kuala Lumpur, 1997.

Hilditch,T.P., Jones,E.E.: J. Soc. Chem. Ind., Vol.49, p.363-368T, 1930 and Vol.50, p.171-176T, 1931.

Siew,W.L., Berger,K.G.: Porim technology, PORIM, Kuala Lumpur, No.6, 1981.

Bezard,J., Moretain,J.P., Bugart,M.: Fette Seifen Anstr., Vol. 79, p.399, 1977.

Bocz,E., et al.: Szántóföldi növénytermesztés. Mezőgazdasági Kiadó, Budapest, 1992.

Eőri,T.: A repce termesztése. Mezőgazdasági Kiadó, Budapest, 1986.

Niewiadomski, H.: Rapeseed. Elsevier, Amsterdam, 1990

Rutkowski,A., Kozlowska,H.: Sruta rzepakowa, WPL. Warsawa, 1967.

AOCS, Official and Tentative Methods, Table I., p.1-46, Chicago, 1946.

Frank,J., Szabó,L.: A napraforgó (Helianthus annus). Akadémiai Kiadó, Budapest, 1989.

Jáky,M., Kurnik,E., Perédi,J., et al.: Fette Seifen Anstrichmittel, Vol.82, p.110-116, 1980.

Bene,E., Hunyadi,L., Lindner,E., Vépy,E.: Szappanok és mosószerek. Műszaki Könyvkiadó, Budapest, 1957.

Pardun,H.: Analyse der Nahrungsfette. Verlag P. Parey, Berlin, 1976.

Jáky,M., Jónap,L.: Olajipari növények termesztése és feldolgozása. Mezőgazdasági Kiadó, Budapest, 1957.

Röbbelen,G., Downey,R.K., Ashri,A.: Oil Crops of the World. Mc Graw-Hill Publ. Comp., New York, 1989.

Gunstone,F.D., Qureshi,M.I.: J. Am. Oil Chem. Soc., Vol.42, p.961-965, 1965.

Luchetti,F.: Eur. J. Lipid Sci. Techn., Vol.104, p.559-563, 2002.

Ünal,K., Nergiz,C.: Grasas y Aceites, Vol.54, p.71-76, 2003.

International Olive Oil Council: Trade Standard Applying to Olive Oils and Olive-pomace Oils. Madrid, 2003.

Kiritsakis,A., Kanavouras,A., Kiritsakis,K.: Eur. J. Lipid Sci. Techn., Vol.104, p.628-638, 2002.

a/ Servili,M., Montedoro,G.F.: Eur. J. Lipid Sci. Techn., Vol.104, p.602-613, 2002.

Sólyom,L., Kudron,J.: Keményítő és keményítőipari termékek gyártása. Mezőgazdasági Kiadó, Budapest, 1985.

Grandel,F: Fette Seifen Anstrich., Vol.42, p.185-187, 1940.

Watson,St.A., Ramstad,P.E.: Corn: Chemistry and Technology. AACCh Inc., St. Paul, Minnesota, US, 1991.

Perédi,J., Balogh,A.: Olaj Szappan Kozmetika, Vol.31, No.2, p.47-52, 1982.

El-Mallah,M.H., Muruis,T., El-Shami,S.: Grasas y Aceites, Vol.50, No.1, p.7-15, 1999.

Weber, E.J.: J. Am. Oil Chem. Soc., Vol 58, p.898, 1981.

Cunnane,S.C., Thompson,L.U.: Flexseed in Human Nutrition. AOCS Press, Champaign, Illinois, US. 1995.

Wannerberger,K., Nylander,T., Nyman,M.: Acta Agric. Scand., Vol.41, p.311, 1991.

Axelson,M.J., Sjövall,J. Gustafsson,B., Setchell,K.D.R.: Nature, Vol.298, p.659, 1982.

Moraghan,J.T.: Plant and Soil, Vol.150, p.61, 1993.

ASTM Standard D 234-1982.

Gunstone,F.D., Padley,F.B.: J. Am. Oil Chem. Soc., Vol.42, p.957, 1965.

Szabó,L., Jáky,M.: A ricinus. Akadémiai Kiadó, Budapest, 1983.

Muller-Mulot,W.: J. Am. Oil Chem. Soc., Vol.53, p.732-736, 1976.

Soó,R.: Fejlődéstörténeti növényrendszertan. Tankönyvkiadó, Budapest, 1963.

Tóth,J.: Az olajtökmag termesztésének technológiája. Öntözési Kutató Intézet, Szarvas, 1982.

Bíró,Gy., Lindner,K.: Tápanyagtáblázat. Medicina Kiadó, Budapest, 1988.

Mansour,E.A., Dworschák,E., Lugosi,É., Barna,M.: J. Sci. Food Agric., Vol.61, p.73-78, 1993.

Hagers Handbuch der Pharmazeutischen Praxis, Spinger Verl., Berlin, 1971.

Tsaknis,J., Lalas, St., Lazos,E.S.: Grasas y Aceites, Vol.48, No.5, p.267-272, 1997.

Biographical Sketches

Katalin Perédi Vásárhelyi was born in 1952, in Budapest, Hungary. A married man, he lives in Budapest and has an Msc in Food Engineering, (1977, University of Horticulture and Food, Budapest) and a 1986 University doctoral degree, from the University of Horticulture and Food Industry, Budapest He has worked since 1977 at the Central Food Research Institute (KÉKI), Budapest, first as assistant researcher, then scientific researcher, the head of a department, then senior scientific researcher.
His research activities involve: development of processes for preparing oilseed protein concentrates and isolates; investigation of functional properties of food proteins; analysis of fats and oils; supercritical fluid extraction of oilseeds and biological active components; investigation of antioxidant activities; production of packaging materials with biological decomposition; and utilization of food processing by products.
He is a member of the Hungarian Association of Food Science and the Hungarian Society of Nutrition

József Perédi was born in 1922 in Kispest, Hungary. A married man, he has an MSc Chemical Engineering (1944, József Nádor University of Technical and Economic Sciences, Budapest), a PhD in Chemistry (1967, Hungarian Academy of Sciences) a DSc Chemical Science (1995 Hungarian Academy of Sciences) and a Dr. habil. (2003 West Hungarian University). He currently has an office at Szent István University, Department of Grain and Industrial Plants Technology, Budapest, Hungary. His employment record is as follows:
Food and Oil Factories in Hungary (chemical engineering, head of laboratory)
Hungarian Experimental Institute for Agricultural Industries, Budapest (head of a department)
Research Institute for Vegetable Oil and Detergent Industry, Budapest (head of a department, vice director, director)
University of Horticulture and Food Industry resp. Szent István University, Budapest (Associate professor)
His research activities involve chemistry, technology, analysis and quality control of fats and oils, lipid oxidation, fat modifying reactions, improving oilseed-meals quality for feed products, investigation and estimation of new oil-bearing materials.
*Memberships***:**
Hungarian Association of Food Science
Hungarian Society of Nutrition
Deutsche Gesellschaft für Fettwissenschaft
European Federation for the Science and Technology of Lipids
Editorial Board of the Journal Olaj Szappan Kozmetika
National Subcommitee of Codex Alimentarius of Fats and Oils
Lipid Working Group of the Hungarian Academy of Scences
Oils and Fats Working Group of Hungarian Standards Institution
Hungarian Society of Agricultural Sciences