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LIPOPHILIC EXTRACTS IN PHYTOTHERAPY AND PHYTOCOSMETICS: PRODUCTION AND BIOLOGICAL PROPERTIES

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This review considers methods of obtaining lipophilic extracts from plant raw material, and their composition, biological properties, and use in phytotherapy and phytocosmetics.

More than 40% of the drugs used in medicine are based on preparations of plant origin [1]. The majority of biologically active substances (BASs) and individual drug preparations isolated from plants are less xenogenous than synthetic substances and do not have pronounced side effects on the organism in prolonged use [2, 4]. These preparations are included in metabolic processes of animal cells more smoothly and, in their biological effect, approximate to the action of natural metabolites participating in the processes of the internal metabolism. Among them, substances have been found with hypoglycemic, hypolipoproteinemic, antiatherosclerotic, and hepatoprotective properties that also possess pronounced immunomodulating and antiallergic effects. They are used for treating the cardiovascular, hepatobiliary, and immune systems and are widely employed in medical phytocosmetics [2, 3].

In the cosmetics industry a tendency is being followed to the ever-increasing use of plant extracts as necessary bioactive additives in the creation of new formulations with medicinal and prophylactic properties. It must be mentioned that the same demands are made on extracts used in cosmetic products as on those intended for phytotherapy [3]. The variety of extracts included in cosmetics is constantly expanding through the use of new wild species and vegetable, orchard, and technical crops and the wastes from their processing [4].

In the present review an attempt has been made to throw light on modern directions in the technology of the production of plant lipophilic extracts (LEs) and their use in phytotherapy and medicinal cosmetics. Since the main direction in the industrial production of medicinal cosmetics is the search for agents for the care of the skin slowing down the processes of aging and for hair care preparations [5], our main attention is devoted to the use of LEs in these types of compositions.

Depending on the degree of nonpolarity of the extractant and the type of raw material, lipophilic extractions may be divided into three main groups:

— oil extracts obtained by steeping mainly the vegetative organs of plants with vegetable and mineral oils and animal fats;

— nonedible oils extracted by nonpolar solvents from seeds or, more rarely, fruits of known crop plants and nontraditional species; and

— lipophilic extracts obtained from the epigeal parts of plants, roots, and the wastes of their treatment with nonpolar or weakly polar solvents and with liquefied gases or mixtures of them.

Oil extracts and medicinal oils from the seeds of some food and technical crops are well known galenical preparations that are still in wide use at the present time [6]. Earlier, oil extracts were obtained mainly from alkaloid-bearing and essential-oil plants [7]. The comminuted raw material was treated with ethanol or a solution of ammonia in ethanol and was steeped with olive or sesame oil at 60-70°C. At the present time, oil extracts are prepared by the direct treatment of the raw material with vegetable or mineral (paraffin) oils and animal fats and their individual fractions. On contact with plant raw material, oils and fats — in spite of their low extraction capacity — are enriched with fat-soluble vitamins, paraffins, waxes,

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and other nonpolar components, which makes it possible to use such extracts for medicinal and prophylactic purposes and in cosmetics.

As a rule, the raw material used for oil extracts is a mixture of several plant species and the use of a single species is less common. In the latter case, to impart a complex of additional properties to the preparations several oil extracts are added to them.

Oil extracts of the vegetative organs of the known medicinal plants *Salvia officinalis* L., *Cannabia indica* L., *Rosmarinus officinalis* L., *Hypericum perforatum* L., *Matricaria chamomilla* L., *Calendula officinalis* L., etc., possess tonic, regenerating, anti-inflammatory, and antiburn properties, thanks to which they are used as components of skin care products [8, 10] and as the bases of medical preparations for the treatment of psoriasis, rheumatic and asthmatic states, and burns [11, 12].

Extracts in mink fat are obtained by adding a mixture of two solvents (ethanol and Khladon [~Freon] 113) to the comminuted raw material, steeping for 4 h at the ordinary temperature, and, with stirring, adding a low-melting fraction of the fat at about 50-60°C [13]. Such extracts are found to contain a complex of vitamins A, E, C, B_1, and B_6, essential oils, azulene, resins, balsams, and gums. New formulations of creams for withering facial skin have been developed with mink-fat-based extracts from the herbage of *Achillea millefolium* L., the stigmata of *Zea mays* L., the fruit of *Rosa cinnamomum* L. [14], and the herbage and flowers of *Hypericum perforatum* L. and *Matricaria chamomilla* L. [15]. Preparations stimulating hair growth [16] and a hair shampoo [17] have been created from analogous extracts of the rhizomes of *Acorus calamus* L., the fruit of *Capsicum annuum* L., the flowers of *Matricaria chamomilla* L., and the herbage of *Hypericum perforatum* L.

A mixture of fractions of mono-, di-, and triacylglycerols (TAGs) of unsaturated fatty acids obtained by the glycerolysis of sunflower seed oil has been used successfully for the extraction of vitamins and pigments from *Medicago sativa* L., the monoacylglycerol fraction proving to be a more effective extractant for chlorophylls, carotenoids, tocopherols, nicotinic acid, and vitamin B_1 [18].

There is increasing use in phytotherapy and phytocosmetics of nonfood oils from the fruit and seeds of various plant species having in their compositions a broad spectrum or a raised level of lipophilic substances, certain fatty acids, and fractions with specific biological activities or physicochemical properties. Thus, carotenoid pigments possess an epithelializing, anti-inflammatory, analgesic, immunomodulating, and carcinoprotective action, in view of which oils and narrow fractions enriched with a mixture of them or with β-carotene are used for treating various diseases in pediatry, gynecology, ophthalmology, and oncology [19, 20].

Phytosterols are known as bioactive emulsifiers [21] and complexing agents interacting with acids, phenols, alcohols, and some heterocyclic substances and influencing the structure and permeability of membranes [22]. The higher, $C_{20:0}-C_{28:0}$, alcohols stimulate reparative processes and the growth of granulations [23]. TAGs of higher unsaturated and saturated acids promote the normal growth and functioning of the cells of the epidermis [24].

With a model of the horny layer of the skin, it has been shown that the 18:1(9) acid determines to a considerable degree the ease of penetration of valuable BASs through the skin [25], increases cutaneous permeability, and improves the diffusive properties of liposoluble preparations [26]. Consequently, their lipophilic-hydrophilic properties are important physicochemical parameters of a series of drugs, ensuring their penetration, retention by cells, and transport to the active centers of receptors [27].

Some low-, medium-, and high-boiling high-molecular-mass fatty acids and their derivatives (esters, salts, monoacylglycerols) exhibit antimicrobial, antifungal, and anticarious activities [28]. The therapeutic action of the seed oils of *Borago officinalis* L., *Oenothera biennis* L., and *Ribus nigrum* L. in disturbances of the cholesterol metabolism and cardiovascular diseases is connected with the presence of the γ-18:3(6,9,12) acid [29]. In view of the affinity of γ-18:3-containing TAGs for the surface of the skin and its keratin layer and also their high moisture-retaining capacity, such oils possess a favorable dermatological effect [30, 31].

Extracts obtained with hydrocarbon solvents of a γ-18:3-containing oil in combination with low-molecular-mass TAGs from other sources and with vitamins are used for reanimation and the treatment of the exhausted organism, for dietetic purposes, and for the correction of disturbances of the digestion of fats and metabolism in certain diseases [32]. Cosmetics with improved dermatological and humidifying properties based on γ-18:3-TAGs with free γ-18:3, α-18:3(9,12,15), 18:2(9,12), 20:3(8,11,14), and 20:4(5,8,11,14) acids and their salts have been patented for facial skin care [33, 34].

The seed oil of *Pinus sylvestris*, which contains the 18:3(5,9,12) acid (isolinoleic) and the oil of *Macadamia sp.*, with a fatty acid composition analogous to that of skin fat, have a high affinity for the epidermis. Preparations for the care of the skin based on them do not irritate it and they increase its elasticity [35, 36].

The oil of the flesh of the pericarp of *Hippophae rhamnoides* L. obtained by extraction with sunflower seed or soybean oil [37] is enriched with lipophilic BASs. These include vitamins E and F, carotenoids (carotene, cryptoxanthin, zeaxanthin, physalien) [38], β-sitosterol, 24-methylenecycloartanol, α- and β-amyrins, erythrodiol, uvalol, citrostadienol, 24-ethyl-Δ^7-cholesten-3β-ol, and the C_{18}, C_{20}, C_{22}, C_{24}, and C_{26} alkanols [39]. The TAGs of this oil contain the physiologically active palmitoleic 16:1(9) acid [40]. It has been established experimentally that the oil of *H. rhamnoides* isolated by extraction with organic solvents is considerably superior in biological value to the pharmacopeial product, which is extracted with sunflower seed or soybean oil [40]. Such BASs as alkanols, phytosterols, and tocopherols are found at a level of 2.5% in the extraction oil and 1.5% in the pharmacopeial product, while the 16:1(9) acid is present only in the extraction sea buckthorn oil [40]. The oil possesses a high epithelializing and wound-healing effect and accelerates fibrogenesis and the synthesis of collagen [41], thanks to which it is widely used in phytotherapy [6] and in preparations for the care of children's skin [42], for the treatment of withering facial skin [43], and for strengthening the hair [44].

With the aim of a more complete retention of the complex of lipophilic BASs it is proposed to obtain plant oils for cosmetics without using an extractant. A mixture of fresh and dry fruits, vegetables, and vegetative and generative organs is ground to a homogeneous paste and the solid phase is first separated from the oily aqueous phase at 28°C, after which the oil is separated from the aqueous phase at a total length of the process not exceeding 2.5 h. As a rule, this method gives 8-35% of oil, 38-76% of aqueous phase, and 14-37% of solid residue [45].

It is known that oxidized metabolites of plant oil fatty acids possess a definite toxicity [46, 47]. However, a preparation that has been used successfully for the regeneration of brittle skin in patients who have been in a recumbent position for a long time has been developed from highly oxidized *Zea mays* L. oil. The highly oxidized oil is obtained by saturation with oxygen and simultaneous UV irradiation at a controlled intensity to a degree of peroxidation of 50-120 millieq. and a level of oxygenated TAGs having absorption maxima in the UV spectra at 232 and 270 nm of 5-40% [48].

New biologically active lipid cosmetic and dermatological preparations include mixtures of unsaturated fractions of extraction soybean and sunflower-seed oils and the seed oils of *Persea gratissima* L., *Zea mays* L., and *Ziziphus jujuba* Mill., taken in definite ratios [24]. A lotion has been developed for the activation of the hair the active principle of which consists of oils from the seeds of *Sesamum indica* L., *Arnica montana*, L., *Persea gratissima*, L., and *Daucus sativus* Rochl. [49]. A mixture of the 14:1-18:1 acids and their salts and esters and other derivatives is included in foodstuffs and medicinal preparations for regulating disturbances of the fats metabolism and for the prophylaxis and treatment of obesity, sugar diabetes, and atherosclerosis [50].

One of the reasons for the premature aging of the skin is the chronic action of UV-B radiation (λ320-280 nm), which causes its burning and the formation of the tanning pigment, melanin. In some cases the development of photoallergic reactions, photodermatoses, and skin cancer is possible. The UV-B absorbers in use pass 2-4% of the UV-B rays, predominantly in the tanning region [51]. UV absorbers are also found among lipophilic compounds. Lipophilic UV absorbers are concentrated in the unsaponifiable fractions of certain oils. Thus, the unsaponifiable substances from the oil of *Sesamum indicum* L. include 3-8% of phytosterols and saturated and unsaturated acids, including arachidonic — the 20:4(5,8,11,14) species — while in the unsaponifiables of the germ oils of *Triticum aestivum* L. there are 5-20% of phytosterols and more than 1% of tocopherols [52]. These fractions have been included in cosmetics absorbing UV-B radiation, the effectiveness of their mixture being higher than that of each separately or that of a mixture of the oils themselves. Concentrates (10-30%) of the unsaponifiable substances are isolated from these oils. Unsaponifiable fractions from the plants *Medicago sativa* L., *Glycine max.* L., *Zea mays* L., *Avocado persea* L., and *Olea europea* L. with the property of regulating melanocyte-forming processes have been included in dermatological preparations for the treatment of vitiligo and other skin diseases connected with a disturbance to the biosynthesis of melanin or its precursors.

The germ of *Triticum aestivum* L. grains contains a considerable amount of vitamins E and F, provitamin A, lecithin, phytosterols, and estrogenic substances [38]. A two-stage method has been developed for obtaining LEs from *T. vulgaris* L. and *T. aestivum* L. by extracting the comminuted raw material in the first stage with diethyl ether, alcohol, hexane, a solution of caustic soda, and/or a mixture of activated water (pH 9-12) with these extractants at 25-35°C for 1-5 min, and in the second stage with a mixture of hexane and ether in a ratio of 8:2 containing 0.1-0.6% of a surface-active food substance [54]. A high-quality vitaminic LE is obtained with a yield of 95-98% from *T. aestivum* L. shoots with the aid of petroleum ether in a Soxhlet apparatus at 25°C for 30 min. This method permits the natural BAS complex to be preserved, thanks to which the LEs are widely used in cosmetic and medicinal preparations [55].

Lipophilic extracts from vegetative organs are distinguished from plant oils by the content (1-10%), composition, and ratio of the components. For the extraction of the LEs use is made of such hydrophobic organic solvents as low-boiling

hydrocarbons, ethers, and lower alcohols and mixtures of them. Many LEs isolated with the aid of gasoline, hexane, and petroleum ether have been found to possess antiulcer, wound- and burn-healing properties.

An LE has been obtained from the dry epigeal part of *Daucus sativus* (Hoffm.) Roehl. by using gasoline (phase ratio 1:25 in the first, and 1:1 in the two following extractions). It was found to include about 60% of triacylglycerols, alkanols, polyprenols, and triterpenols. This extract is the active base of a preparation with wound-healing and antiburn activity [56]. It has been proposed to use it together with the LEs of other plants in a deodorizing agent [58].

Not only the unsaponifiable but also the saponifiable part of the gasoline LEs from some plants may possess a similar activity spectrum. Thus, the needles of individual species of Pinaceae are extracted with boiling gasoline, the extract is evaporated, the residue is saponified with alkali, and the saponified part is treated with an alcoholic solution of a salt of a bivalent metal (Cu, Zn, Co) until a metal-containing complex is obtained. The latter is dissolved in an aqueous glycerol phase and a preparation is obtained that possesses bactericidal, wound-healing, emollient, and deodorizing effects and that can be used in soap-boiling and in the perfumery and cosmetics industries [59].

A lipophilic extract of *Ajuga turkestanica* (Rgl.) Brig obtained by steeping the dry epigeal part with chloroform at the ordinary temperature can be used in various cosmetic media for the directed prophylaxis and treatment of skin aging processes, since it contains free fatty acids, triacylglycerols, sterol esters, carotenoids, and other bioactive lipids [60].

A higher yield of LEs is achieved by the use of a mixture of hydrophobic and hydrophilic solvents as extractants. LEs are extracted with a mixture (2:1) of gasoline and ethanol or isopropanol from fresh biomass of *Mentha piperita* L., which contains TAGs, glyco- and phospholipids, free fatty acids (including the 16:0, 18:1, 18:2, and 18:3 species), esters of these acids with lower and higher alkanols, phytosterols and their derivatives, paraffins, carotenoids, chlorophylls and their derivatives, and an essential oil. The first stage involves extraction for 3-6 h with constant stirring, and the second stage takes 8-15 h, followed by the evaporation of the combined extracts in vacuum at 50°C [61].

Peroral, parenteral, and external medicaments with a broad action spectrum have been proposed that contain a complex of lipids isolated by the extraction of plants of the families Cruciferae (*Brassica nigra* (L.) Koch. and *Sinapis alba* L. et al.), Linaceae (*Linum glandulosum* L. et al.), Pedaliaceae (*Harpagophytum procumbens* L. et al.), Resedaceae (*Reseda lutea* L. et al.), Rosaceae (*Filipendula ulmaria* (L.) Maxim.), Saxifragacaeae, and others, with polar and nonpolar solvents at 60°C for 48 h. The extract is cooled, filtered, brought to pH 8, filtered again through molecular sieves, concentrated in vacuum, and left for 48 h, and the resulting deposit is separated off, washed with water, and dried [62]. The LEs isolated from plants of the Resedaceae family in this way contain 31.5% of the α-18:3 acid, 13.5% of the 16:0 acid, 8.0% of the 18:1 acid, 10.0% of the 18:2 acid, 18.0% of α-tocopherol, and 18.0% of β-sitosterol. The biological effect of the LEs on their use in anti-inflammatory cosmetics and medicinal preparations is due to the α-linolenic acid, while the other components promote the penetration of the α-18:3 acid through the cell membranes [63].

Low-boiling hydrocarbons and their mixtures with hydrophilic solvents extract lipophilic and lipid substances from raw material fairly completely, but their elimination from the extracts requires a considerable consumption of energy. In the manufacture of food products, chemicals, pharmaceuticals, and cosmetics in industrially developed countries, ever-increasing use is being made of liquefied gases — especially carbon dioxide under subcritical and supercritical conditions. Liquid food-grade carbon dioxide in the subcritical state is obtained at 31.4°C and a pressure below the critical level, and in the supercritical state it is obtained at a temperature above the critical level and at high pressure. The favorable properties of this extractant are its high selectivity with adequate dissolving power, chemical inertness, easy and complete elimination from the extract on evaporation, noncombustibility, and absence of explosion hazards.

Liquid CO_2 does not support the vital activity of microorganisms, in view of which CO_2 extracts are self-sterilizing. Extraction with food-grade CO_2 permits the retention in the extract of the antioxidant, organoleptic, and native properties of the components of the raw material [64]. LEs have been extracted with liquid CO_2 in the subcritical state from 69 species of medicinal, essential-oil, and spice and aromatic plants, cereals, fruits, and the epigeal parts, roots, and wastes from the processing of vegetable biomass [65]. However, being a weakly polar solvent, liquid CO_2 does not extract well, if at all, such BASs as glyco- and phospholipids, some neutral lipids, carotene derivatives, and chlorophylls [66, 67].

A CO_2 extract of the herb *Artemisia taurica* Willd. obtained at 22-28°C for 1.5 h contains 5-10% of essential oil, 3-4% of free fatty acids, tocopherols, waxes, hydrocarbons, and bound fatty acids [68]. A carbon dioxide extract of *Matricaria chamomilla* L. flowers with an analogous extract of *Daucus sativus* Roshl. seeds intensifies the tone of a hair dye, increases the persistence of the coloring effect while preserving the natural state of the skin [69], and, in a mixture with a CO_2 extract of the cones of *Humulus lupulas* L., an oil extract of propolis, and a fatty-oil extract of coffee form the active principle of a

photoprotective cosmetic [71]. In addition to liquid carbon dioxide, such liquefied gases as Khladons [~Freons], xenon, pentane, etc. are used [72, 73].

A comparative study of the antibacterial action of various extracts of the herb *Salvia officinalis* L. showed that of the six extracts obtained with the aid of liquid carbon dioxide, petroleum ether, acetone, diethyl ether, a Khladon (trichlorofloromethane), and ethanol, the greatest capacity for suppressing and retarding the growth of staphylococci and bacilli (12 species of test microbes) was possessed by the petroleum ether extract, and this property was characteristic in the smallest degree of the CO_2, the acetone, and the diethyl ether extracts [74]. Taking this into account, to obtain agents with a given therapeutic and prophylactic action and increased activity, various combinations of hydrocarbon, oil, alcohol-glycerol, Khladon, and CO_2 extracts are used. For example, to improve the bactericidal and anti-inflammatory properties of a face cream, a Khladon extract of *Rosa cinnamomum* L. fruit, an oil extract of *Crataegus oxycantha* L. fruit, and alcohol-glycerol extracts of *Apium graveolens* L., *Plantago psyllium* L., and *Polygonum hydropiper* L. and, in addition, a low-melting fraction of mink fat are incorporated in it [75].

Valuable sources of lipophilic BASs are solid and liquid processing wastes of the essential-oils, foods, and pharmaceuticals branches of industry. The extraction of plant wastes enables the degree of utilization of the plant raw materials to be raised and the variety of BASs for cosmetics, pharmaceuticals, and food products to be expanded.

After the isolation of an essential oil from the epigeal part of *Lavendula vera* L. and *Salvia sclarea* L. by steam distillation, the residual plant biomass is extracted with petroleum ether, giving an LE containing BASs: 4-10% of carotenoids, waxes, about 16% of fatty acids, phytosterols, and 30% of phospho- and glycolipids (PLs and GLs) [76, 77]. A cream for the treatment of greasy facial skin [78] and a bath product with enhanced deodorizing, tonic, and aromatic properties [79] have been created from the LEs of *Lavandula vera* wastes.

Essential preparations based on PLs are used for treating cardiovascular and dermatological diseases, alcoholism, hepatitis, and radiation syndrome. Individual classes of them stimulate immunity, restore disturbed membrane functions, and activate or modify the activity of enzymes [80, 81]. Apart from this, PLs and GLs possess surface-active properties and form a group of nontraditional SAAs [surface-active agents] [82].

A method of obtaining LEs enriched with PLs and GLs envisages the use of liquid or resinous wastes from the production of the alkaloid-type drug allapinin, the raw material for which is the epigeal part of *Aconitum leucostomum* Worosch. The wastes are washed with water to neutrality and allowed to stand, and the organic phase is decanted off, filtered, and evaporated. The LE from *A. leucostomum* wastes consists of a mixture of PLs, GLs (57%) and neutral lipids enriched with the 18:1 and 18:2 fatty acids, chlorophyll derivatives, and minor amounts of alkaloids [83, 84].

A hair shampoo with enhanced foaming capacity, increased stability on storage, improved organoleptic properties, and a reduced content of surface-active agents has been developed from the LE of *A. leucostomum* [85].

A method has been proposed for obtaining an LE increasing skin metabolism from the liquid waste (chloroform mother solution) of the processing of *Rhaponticum carthamoides* (Willd.) Iljin. [86] by evaporating the solvent from the waste, adding ethanol to the residue, evaporating the chloroform–methanol phase, precipitating impurities from the concentrated extract with 70% ethanol, allowing the mixture to stand, and eliminating the impurities by decantation [87]. In this LE have been found about 33% of lipids consisting of the 16:0, 16:1, 18:1, and 18:2 fatty acids, mono-, di-, and triacylglycerols, esters of fatty acids with sterols and triterpenols, fatty alkanols, 28% of flavonoids, and about 2% of tanning substances [88]. The LE is included in the formulation of a foaming washing agent for children that has a good cleansing and deodorizing effect and does not cause dryness of the skin [88, 89].

Individual ecdysteroids and their derivatives isolated from rhizomes of *Rhaponticum carthamoides* are used in cosmetic and dermatological preparations that impart softness and smoothness to the skin, heal psoriasis, and restore the epidermis [90]. A biostimulating preparation for the care of the scalp and the hair with a broad spectrum of biological action based on edible plant oils and castor oil contains LEs from the processing wastes of *Rhaponticum carthamoides* and *Aconitum leucostomum* as biologically active additives [91].

It has been shown that the wastes from the processing of the medicinal plants *Aralia mandshurica* Rupr. et Maxim., *Digitalis lanata* Ehrh., *Glaucium flavum* Grantz., *Ephedra equisetina* Bunge, and *Ferula varia* L. may serve as sources of biologically active LEs [92]. Phytosterols, triterpenoids, coumarins, an essential oil, and pigments (5.7%) have been found in the epigeal part of *Hypericum perforatum* L. After the production of a medicinal preparation — a tincture in 40% ethanol — these lipophilic compounds are concentrated in the meal (5.3%), and they are isolated by the use of extractants — acetone, chloroform, dichloroethane, and 96% ethanol — of which the best has proved to be chloroform [93].

A valuable raw material for obtaining LEs is formed by the wastes of the rice industry — rice bran. The bran is extracted with gasoline at 60°C for an hour once [94] or without heating four times at a phase ratio of 1:2.5 in the first extraction and 1:1 in the following three [95]. Rice LE contains waxes, triacylglycerols, fatty acids, chlorophylls, phytosterols, carotenoids, monoacylglycerols, and phospholipids [96]. It forms part of the active principle in a hydrating agent protecting the skin from premature aging, from the formation of wrinkles, and from drying under the influence of climatic conditions [97], and it is used in a preparation accelerating hair growth [98, 99]. A product with antibiotic, antiseptic, antifungal, and antiputrefactive action is obtained by the partial neutralization of rice bran LE with alkali, eliminating the total fatty acids, and then isolating an active fraction of unsaponifiable compounds [100].

Thus, extracts obtained from native plant raw material or the processing wastes of the essential-oil, pharmaceutical, and food industries are widely used in phytotherapy and phytocosmetics. Modern methods for their isolation permit various extracts containing highly active lipid and lipophilic substances to be obtained.

Oil extracts, edible and inedible, including medicinal oils, contain fat-soluble pigments, vitamins, and paraffinic and aromatic hydrocarbons, in addition to triacylglycerols and unsaturated and saturated fatty acids, and they are therefore frequently used orally and intranasally in diseases of the upper respiratory tracts and externally in neuralgias and rheumatism and also, very widely, in the preparation of various cosmetics for the care of the skin and the hair.

The lipophilic plant extracts used at the present time differ significantly from oil extracts by the diversity of their lipophilic components. They are richer in such physiologically active substances as flavonoids, sterols, triterpenoids, etc. Their biological activity is shown to a more pronounced degree and the spectrum of their pharmacological action is far broader. Lipophilic plant extracts have been used to create medicaments for parenteral, peroral, and external use that exhibit antipyretic, anti-inflammatory, analgesic, antiburn, wound-healing, antitumoral, antiallergic, and antiviral actions. The same extracts form the active principles of various cosmetics with photoprotective, anti-inflammatory, UV-absorbing, bactericidal, emollient, and deodorizing properties.

REFERENCES*

1. Medicinal Plants [in Russian], Vysshaya Shkola, Moscow (1975), p. 47.
2. É. T. Oganesyan, A. V. Simonyan, S. Kh. Chomaeva, et al., Abstracts of a Russian Scientific Congress on Man and Medicine [in Russian], April 12-16, 1992, Russian Human Health Fund, Moscow (1992), p. 212.
3. E. Diwald, Seifen–Öle–Fette–Wachse, **115**, No. 2, 36 (1989).
4. P. Alexander, Manuf. Chem., **60**, No. 10, 22 (1989).
5. I. Yu. Bogdanovich, S. V. Baranov, G. Ya. Legin, et al., Review Information from AgroNIITÉIPP [Agricultural Scientific Research Institute of Technical and Economic Information for the Food Industry] [in Russian], Pishch. Prom-st', Moscow (1989), Ser. 21, 8, 3.
6. M. D. Mashkovskii, Drugs, Parts 1 and 2 [in Russian], Meditsina, Tashkent (1987), pp. 624 and 575.
7. I. A. Murav'ev, Drug Technology [in Russian], Meditsina, Moscow, Vol. 1 (1980), p. 392.
8. V. F. Faust, US Patent 4,511,555 (1985).
9. M. V. Ogilets, Kh. É. F. Soone, O. E. Aumre, et al., USSR Inventors' Certificate 1,335,287 (1987).
10. É. M. Eremina, M. V. Ogilets, L. V. Simonova, et al., USSR Inventor's Certificate 1,599,018 (1990).
11. F. I. Mamchur, S. T. Dzyubak, N. P. Zbirak, and Yu. P. Pilipenko, USSR Inventor's Certificate 543,399 (1977).
12. F. Horvath, US Patent 5,165,932 (1994).
13. M. V. Ogilets, L. É. Alksne-Alksnit, Ts. R. Kreishmanis, et al., USSR Inventor's Certificate 997,684, Byull. Izobret., No. 7, 13 (1983).
14. M. V. Ogilets, Ts. R. Kreishmanis, V. K. Pieshin'sh, et al., USSR Inventor's Certificate 1,301,403 (1987).
15. M. V. Ogilets, N. F. Kakovskaya, N. F. Konoval'chikova, et al., USSR Inventor's Certificate 1,102,600 (1984).
16. M. V. Ogilets, G. A. Kazakova, N. V. Korotkaya, et al., USSR Inventor's Certificate 1,130,347 (1984).

*The dates given for all Patents, Patent Applications, and Inventors' Certificates are those of the year in which the corresponding information appeared in a relevant Russian abstract journal — Translator.

17. M. V. Ogilets, M. I. Shukhman, Kh. E. Devlisheva, et al., USSR Inventor's Certificate 16,166,703 (1990).
18. L. F. Burkovskaya, N. A. Artamonova, and D. A. Kovin'ko, Vestnik Sel'skokhozyaistvennykh Nauk Kazakhstana, **107**, 63 (1984).
19. I. A. Murav'eva and G. N. Koval'skaya, Farmatsiya, No. 6, 24 (1989).
20. A. V. Sergeev, S. A. Korostylev, and N. A. Shereenteva, Vopr. Med. Khim., No. 4, 42 (1992).
21. V. V. Sokirka, V. V. Panina, B. V. Shemeryankin, et al., Khim-farm. Zh., No. 9, 1102 (1987).
22. D. V. Ioffe, Usp. Khim., No. 2, 333 (1986).
23. V. A. Mironov, G. S. Vasil'ev, V. S. Matrosov, et al., Khim.-farm. Zh., **17**, No. 10, 1242 (1983).
24. M. Gloor, Seifen–Öle—Fette–Wachse, No. 2, 42 (1990).
25. P. Y. Stoof and H. Y. G. Bila, Ned. Tijdschr. Diet., **46**, No. 2, 25 (1991).
26. R. Lange and G. Lee, Eur. J. Pharm. Biopharm., **28**, No. 2, 18 (1992).
27. E. Sturdik, L. Drobnika, S. Balaz, and M. Antalik, Zb. Pr. Chemickotechnol. Fak. SVST, 1979-1981, Bratislava (1986), p. 109.
28. C. E. Isaak, H. Thomar, K. Kim, and W. C. Heird, PCT Patent N89/06124 (1990).
29. A. Uzzan, Rev. Fr. Corps Gras, **35**, No. 12, 501 (1988).
30. D. Allen and B. Allen, US Patent 4,737,360 (1989).
31. F. Utida, Jpn. Patent Application 2,300,107 (1992).
32. F. Mendy, French Patent Application 2,490,361 (1983).
33. T. A. Papaconstantin and C. Bonne, French Patent Application 2,604,624 (n.d.).
34. J.-P. Marty, French Patent Application 2,557,452 (1985).
35. E. Sada, M. Utida, and S. Okamura, Jpn. Patent Application 61-63610 (1987).
36. M. Y. Matsuyama and T. Kubada, Jpn. Patent Application 63-57515 (1989).
37. Yu. A. Koshelev and L. D. Ageeva, in: Sea Buckthorn [in Russian], Lesnaya Prom-st', Moscow (1978), p. 150.
38. Cosmetics and the Theoretical Bases of Modern Practical Cosmetology [Russian translation from German], Vysshaya Shkola, Kiev (1990).
39. V. L. Salenko, V. A. Raldugin, and V. A. Pantegova, in: The Biology, Chemistry, and Pharmacology of Sea Buckthorn [in Russian], Nauka, Novosibirsk (1983), p. 42.
40. A. K. Svetlov, S. K. Seit-Ablaeva, N. N. Tsekhina, et al., Abstracts of a Scientific and Technical Conference on the Modern Technology of Processes for the Manufacture of New Types of Food Products and Additives [in Russian], Part 1, Kiev (1991), p. 119.
41. L. D. Lebedev, N. E. Akmolova, K. Kh. Khaidarov, and M. V. Ismailova, Advances in the Biology, Chemistry, and Pharmacology of Sea Buckthorn [in Russian], Novosibirsk, Siberian Division of the USSR Academy of Sciences (1991), p. 151.
42. V. Popovuciu, T. Zeno, and F. Albu, Romanian Patent 90330 (1988).
43. M. V. Ogilets, Yu. T. Korobka, N. V. Gorshkova, et al., USSR Inventor's Certificate 952,257.
44. A. P. Levina, M. V. Ogilets, U. É. Braslin'sh, et al., USSR Inventor's Certificate 1,346,157 (1987).
45. C. Pintel, French Patent Application 2,684,388 (1994).
46. I. L. Kuranova, S. L. Gordienko, and E. V. Filonova, Plants and Chemical Carcinogens [in Russian], Nauka, Leningrad (1979), p. 119.
47. D. Moch, T. Schewe, and S. Kuhn, Biomed. Biochim. Acta, **49**, No. 4, 201 (1990).
48. S. Desjonqueres, EPB Patent Application 0293,535 (1989).
49. P.-M. Sharfe, French Patent Application 4,134,137 (1994).
50. D. D. Brilhart and G. L. Maurer, US Patent 5,198,250 (1994).
51. I. Yu. Bogdanov, S. V. Baranov, G. Ya. Legin, et al., Review Information from AgroNIITÉIPP [Agricultural Scientific Research Institute of Technical and Economic Information for the Food Industry] [in Russian], Pishch. Prom-st'., Moscow (1989), Ser. 21, 8, 15.
52. A. Ranculer and F. Laigneau, French Patent Application 2,692,783 (1995).
53. J.-N. Thorel, French Patent Application 2,698,785 (1995).
54. V. T. Grin', Russian Patent 1,819,288 (1993).
55. K. Karwowska and E. Kostrzewa, Nahrung, **22**, No. 5, 491 (1988).
56. N. Ul'chenko, A. I. Glushenkova, Sh. Sh. Sagdullaev, et al., Uzbek Patent N2278.

57. Yu. K. Vako, Jpn. Patent Application 61-40646 (1987).
58. A. Fujikawa, Jpn. Patent Application 61-93109 (1987).
59. V. A. Nekrasova, V. T. Kurnychina, T. V. Nikitina, and A. I. Fragina, Russian Patent Application 92,014,885/14, Izobret., No. 4, 21 (1995).
60. V. N. Syrov, Z. A. Khushbaktova, I. Tolibaev, et al., Khim.-farm. Zh., No. 11, 46 (1994).
61. T. V. Khomova, S. D. Gusakova, and A. I. Glushenkova, Uzbek Patent 1757 (1994).
62. J.-P. Masse, C. Taillade, and C. Lucas, French Patent Application 2,649,332 (1991).
63. J.-P. Masse, PCT Patent Application 88,103,406 (1989).
64. V. A. Popov and A. G. Kladii, Pishch. Prom-st', No. 8, 36 (1995).
65. T. K. Roslyakova, E. A. Maksimova, and N. S. Troitskaya, Ekspress-inf. TsNIITÉIPP [Express Information from the Central Scientific Research Institute of Technical and Economic Information for the Food Industry], Moscow (1986), Ser. 5, 3, 10.
66. S. S. Morozova, L. A. Kupriyanova, and A. V. Pekhov, Ekspress-inf. TsNIITÉIPP [Express Information from the Central Scientific Research Institute of Technical and Economic Information for the Food Industry], Moscow (1986), Ser. 5, 4, 15.
67. E. A. Utkina and T. N. Mikhailova, Ekspress-inf. TsNIITÉIPP [Express Information from the Central Scientific Research Institute of Technical and Economic Information for the Food Industry], Moscow (1986), Ser. 6, 4, 17.
68. S. S. Morozova, A. V. Pekhov, G. Z. Shishkov, and S. V. Butto, Ekspress-inf. TsNIITÉIPP [Express Information from the Central Scientific Research Institute of Technical and Economic Information for the Food Industry], Moscow (1986), Ser. 5, 2, 12.
69. T. K. Roslyakova, A. A. Karmalyuk, N. A. Poda, et al., USSR Inventors' Certificate 1,553,128 (1990).
70. M. V. Ogilets, M. N. Shukhman, G. G. Yurkovskaya, et al., USSR Inventors' Certificate 1,699,463 (1991).
71. L. G. Usalka, É. A. Shaftan, N. S. Mikhailov, et al., USSR Inventors' Certificate 806036 (1981).
72. B. A. Rudenko, Review Information from AgroNIITÉIPP [Agricultural Scientific Research Institute of Technical and Economic Information for the Food Industry] [in Russian], Moscow (1989), Ser. 21, 3, 18.
73. R. D. Kusova and N. P. Vetrov, USSR Inventors' Certificate 1,557,154 (1990).
74. V. T. Cherevatyi, T. N. Vashchenko, and G. Z. Shishkov, Rastit. Resurs., **16**, 137 (1960).
75. A. P. Levina, M. V. Ogilets, M. M. Mikel'son, et al., USSR Inventors' Certificate 1,627,180 (1991).
76. T. V. Khomova and S. D. Gusakova, Maslo-zhir. Prom-st', No. 10, 30 (1981).
77. T. V. Khomova, S. D. Gusakova, A. I. Glushenkova, and A. P. Shlyapnikova, Khim. Prir. Soedin., 707 (1984).
78. N. B. Koroleva, O. M. Burylina, Z. Ya. Zalem, et al., USSR Inventors' Certificate 1,382,477 (1988).
79. G. P. Gavrilova, N. A. Aslanov, N. G. Lopatina, et al., USSR Inventors' Certificate 1,616,671 (1990).
80. A. E. Stepanov, Yu. M. Krasnopol'skii, and V. I. Shvets, Physiological Lipids [in Russian], Nauka, Moscow (1991), p. 136.
81. Yu. M. Krasnopol'skii, I. I. Gol'bets, G. A. Sennikov, and V. I. Shvets, Khim.-farm. Zh., No. 7, 13 (1981).
82. I. L. Parra, J. Guinea, M. A. Manresa, and M. Robert, J. Am. Oil Chem. Soc., No. 1, 141 (1989).
83. T. V. Khomova, S. D. Gusakova, A. I. Glushenkova, and R. M. Galyautdinova, Khim. Prir. Soedin., 37 (1995).
84. T. V. Khomova, S. D. Gusakova, A. I. Glushenkova, et al., Uzbek Patent 644 (1994).
85. M. P. Kim, T. V. Khomova, S. D. Gusakova, et al., Uzbek Patent 638 (1994).
86. A. U. Mamatkhanov, M.-P. I. Shamsutdinov, and T. T. Shakirov, Khim. Prir. Soedin., 601 (1983).
87. T. V. Khomova, S. D. Gusakova, A. I. Glushenkova, et al., Uzbek Patent 528 (1994).
88. T. V. Khomova, S. D. Gusakova, and A. I. Glushenkova, Khim. Prir. Soedin., 210 (1995).
89. T. V. Khomova, S. D. Gusakova, A. I. Glushenkova, et al., Uzbek Patent 484 (1994).
90. A. Maybeek, F. Bonte, and G. Redziniak, French Patent Application 2,696,075 (1995).
91. T. V. Khomova, S. D. Gusakova, and A. I. Glushenkova, Uzbek Patent 1,938 (1994).
92. T. V. Khomova, S. D. Gusakova, and A. I. Glushenkova, Khim. Prir. Soedin., 19 (1996).
93. V. V. Shatilo, in: Proceedings of the 29th Regional Conference on Pharmacy and Pharmacology [in Russian], Pyatigorsk (1994), p. 82.
94. V. M. Kopeikovskii, A. S. Arutyunyan, V. L. Proskurina, and V. Ya. Doroshenko, Maslo-zhir. Prom-st', No. 4, 19 (1971).
95. M. Talipova, A. I. Glushenkova, Kh. N. Aripov, et al., Uzbek Patent 2,525 (1995).

96. E. V. Martovshchuk, V. M. Kopeikovskii, A. A. Asvatur'yan, and N. M. Vlasova, Maslo-zhir. Prom-st', No. 9, 11 (1987).
97. Y. Klosa, FRG Patent Application 3,938,284 (1991).
98. T. Fukumura, Jpn. Patent Application 429,922 (1995).
99. L. A. Kuprianova, É. M. Sobolev, and A. V. Pekhov, Pishchev. Izv. Vyssh. Uchebn. Zaved., Tekhnol., Krasnodar (1986).
100. T. Tsutiya, Jpn. Patent Application 56-43715 (1982).