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Oilseeds as a source of antioxidants

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SUMMARY. Oilseeds and fruits contain not only oil-soluble antioxidants, but various polar compounds possessing antioxidant activity as well. The simplest aproach to their use in foods is to include oil or seeds directly in a food product, which enhances its resistance to oxidative rancidity. During oilseed processing, non-polar oil-soluble antioxidants pass into the edible oil and contribute to its higher oxidative stability. Such oils may be added directly to food products or blended with less stable ones to improve their stability. Semipolar antioxidants remain mainly in extracted meals, which can also be used to improve stability of food products. Application of some meals to food products is, however, not acceptable because of their detrimental effect on organoleptic properties of food products. Obtaining extracts from meals rich in antioxidants is expensive and their application to food products is connected with a health risk, therefore an official approval based upon toxicological testing is required. Certain extracted meals may serve as potential sources of plant antioxidants, however, a thorough research is required before their practical use.

KEYWORDS: antioxidants; edible oils; extracted meals; oxidation

The search for natural antioxidants for the stabilization of lipid foods against oxidative rancidity has been a favourite topic during the last 30 years. Among other plant products, oilseeds are important sources of antioxidants, and several review papers and books have been published on the subject [1-8]. Some oil-rich plants, e. g. nuts, are consumed without processing, but oilseeds are normally processed to obtain edible oils and the residual ex-

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tracted meals are commonly used as feed or even as fuel. Oil-soluble antioxidants pass into the oil fraction, but the majority of the more polar antioxidants, which are mostly phenolic substances, remain in the extracted meal.

Both edible oils and extracted oilseed meals may be used for food preparation. Polar extracts from oil-extracted meals, obtained by using organic solvents, are important for elucidating the mechanism of antioxidant action and could also be used as antioxidants, but this second extraction and subsequent purification steps would be expensive. The concentrated antioxidant preparations would need to be tested for possible health risks before used as commercial food additives. Therefore, we shall concentrate our discussion on the possibility of applying processed products without further purification.

Application of edible oils

All edible oils contain tocopherols, which are powerful antioxidants in pork lard and other animal fats, which do not contain any natural antioxidants. Their activities are substantially lower in vegetable oils, which already contain tocopherols in nearly optimum concentrations. As γ-tocopherol is more active in fats and oils than α-tocopherol, edible oils rich in γ-tocopherol, such as soybean, corn or rapeseed oils, could be added to edible oils poor in γ-tocopherol, such as sunflower oil, to improve the oxidative stability of the blend. The tocopherol content is higher in soybean oil than in rapeseed oil, and some samples of sunflower oil have even lower tocopherol content [9, 10]. Palm oil contains tocotrienols, which have nearly the same efficiency as the respective tocopherols.

Some oils, e. g. olive oil, contain larger amounts of other phenolic antioxidants than tocopherols, but olive oil is too expensive to be used for the stabilization of other edible oils. It contains monophenolic components and derivatives of *o*-diphenols [11, 12], e. g. hydroxytyrosol, secoiridoids (such as oleuropein and its aglycone), ligstroside, rutin and luteolin 7-glucoside, and lignans, mainly acetoxypinoresinol and pinoresinol [13, 14]. These substances are discussed further under „Olive oil cakes“.

The situation is more favourable in the case of sesame oil because it contains several oil-soluble antioxidants derived from lignans [15], and is relatively cheap. It could be blended with other, less stable oils, added to animal fats or added to complex foods during their preparation. For further information, see later under „Sesame Extracted Meal“.

Evening primrose oil is used for special dietary purposes, but it is also very stable in spite of its high polyunsaturated fatty acid content. The reason is its relatively high tocopherol content, 260 $mg.kg^{-1}$ [16], and the presence of other active substances. Because of its high price, it would not be used for stabilization of other edible oils, but the application in special dietetic oils, cosmetic or pharmaceutical products is not excluded.

Rapeseed/canola defatted meal

Rape (*Brassica napus* L.) is one of the leading oil-bearing crops in the world. The newest cultivars are very low in erucic acid and substantially lower in glucosinolates than traditional rapeseed. Oil produced from summer rape (*Brassica rapa* L.) is called canola. The tocopherol content in rapeseed oil is relatively high [9]. The oil is used for edible purposes, while the meal is used only as feed.

Oil-extracted rapeseed meals contain 1–2 % phenolics, i. e. about 10 times more than soybean meal [17], and the meals include components from the benzoic and cinnamic acid series. They are present as free acids, insoluble bound acids, soluble phenolic esters and glycosides [18, 19]. About 80 % of the phenolic acids in rapeseed meal are bound to choline as esters, and are termed sinapine.

Rapeseed is only rarely dehulled, however, rapeseed dehulling is a very attractive option in fat unit operations. Rape hulls contain around 6 % of the dark-coloured phenolic compounds and the antioxidant activity of some fractions prepared from water-acetone extracts of canola hulls is very promising [20]. The contents of soluble, SDS-extractable, and insoluble condensed tannins were determined in canola hulls [21]. The total amount of tannins ranged from 1913 to 6213 mg per 100 g of oil-free hulls and insoluble tannins predominated, comprising between 70 to 96 % of the total tannins present.

Sinapic acid is the main phenolic acid bound as esters in rapeseed hulls, while protocatechuic acid is the major phenolic acid in the residual kernel. Sinapic acid has trans stereochemistry, while *cis*-sinapic acid is produced by isomerization caused by light and/or UV radiation. Sinapic acid comprises between 70 % and 80 % of the free phenolic acids and 71–97 % of the esterified phenolic acids [22]. Minor phenolic acids include *cis*-sinapic, *p*-hydroxybenzoic, vanillic, gentisic, protocatechuic, syringic, *p*-coumaric, *o*-coumaric, ferulic, caffeic, cinnamic and salicylic acids, depending on seed ripeness and on the cultivar [23-25]. The content of phenolic compounds increases during the ripening of the seeds. The concentration of water-soluble phenols, including sinapine, is at its maximum between the final stage of green seeds and the beginning of seed browning [26].

Rapeseed cakes, obtained by expeller pressing, rapeseed-extracted meals and their fractions obtained by sieving the ground meal, manifested antioxidant activity in lard [27]. Ethanol extracts of rapeseed meals, added at a concentration of 0.05–0.10 % were more efficient as antioxidants in rapeseed oil than BHA, BHT and monoglyceride citrate added at a concentration of 0.02 % [17]. Similar efficiency was obtained in sunflower oil [28]. Furthermore, the methanol extract from rapeseed meal was active in a β-carotene/linoleic acid model system, and the butanol-soluble fraction of a methanol extract had stronger antioxidant activity than the respective water-soluble fraction [29]. Antioxidant activity of free phenolic acids, sinapic acid and sinapine, obtained from defatted rapeseed meal, was also observed in a β-carotene/linoleic acid system [30]. Sinapine possesses only very weak antioxidant activity, but sinapic acid and other free phenolic acids isolated from sinapine had pronounced activity.

In spite of the high content of phenolics, oil-extracted rapeseed meal would not be a suitable source of antioxidants as they are mostly bound in the inactive compound sinapine. The hydrolysis of sinapine and isolation of sinapic acid would be too expensive, and sinapic acid would hardly compete in its antioxidant efficiency with other phenolic antioxidants. Direct addition of rapeseed meal would be unacceptable because of the bitter taste, off-flavour and low social status of rapeseed meal.

Mustard seed

Mustard seed is used directly as a food flavouring and not as a source of oil in spite of the high oil content. Mustard seed from different species contains high amounts of phenolic acids, but they are mostly esterified, as in rapeseed. The methanol extract from defatted white mustard (*Sinapis alba* L.) flour contained 220 $mg.kg^{-1}$ free phenolic acids, 5769 $mg.kg^{-1}$ ester-bound phenolic acids, and 33 $mg.kg^{-1}$ insoluble phenolic acids. Hydroxybenzoic acid and sinapic acid were the dominant phenolic acids [23, 24]. The dry matter of defatted yellow mustard seeds contained 44 $mmol.kg^{-1}$ sinapine whereas brown seeds contained 26–33 $mmol.kg^{-1}$ sinapine [30]. Mustard seed powder exhibited strong antioxidant activity and acted as a synergist with tocopherols [1]. Moreover, defatted mustard flour and the respective methanol and ethanol extracts, as well as the seed powder, possessed strong antioxidant properties [31].

The content and the composition of the phenolic mixture is similar in mustard seed to that in rapeseed. However, as mustard seed is commonly used as a food condiment, both full-fat and defatted mustard preparations could be used both as flavouring agents and as moderately active antioxidants for developing some special foods, such as dressings and meat products.

Soybeans and soybean flours

Soya (*Glycine max* L.) is a crop that is broadly used for human and animal nutrition. Beans are consumed as whole seeds, full-fat or defatted flours. Soybean powder and soybean extracts are among the oldest natural antioxidants for animal fats or meat products [32-34]. The antioxidants in soybeans, soybean flours and soya protein concentrates are mainly isoflavones and cinnamic acid derivatives [35]. The methanol extract from defatted soybean flour contained 46 $mg.kg^{-1}$ free phenolic acids, 161 $mg.kg^{-1}$ phenolic acid esters and 26 $mg.kg^{-1}$ phenolic acids bound in the insoluble residue [23]. Several acids were present in the ethanol extract, including syringic, vanillic, ferulic, salicylic, *p*-coumaric and *p*-hydroxybenzoic acids [35]. Chlorogenic, isochlorogenic, caffeic and sinapic acids were also found in soybeans [23, 24].

Defatted soybean flour is rich in flavonoids, mainly isoflavones, present at a level of 0.25 % [36]. Genistin and its aglycone, genistein, were isolated in 1941 [37], glycitein in 1973. Most isoflavones (up to 99 %) are present as 7-*O*-monoglucosides [38]. The saccharidic moiety increases the water solubility of the aglycone, and the high antioxidant activity of aqueous extracts from soybean flour is believed to be due to these glycosides [39, 40].

However, isoflavone aglycones are present in fermented soybeans and in soybean protein hydrolyzates and the high oxidative stability of fermented soybeans has been ascribed to the aglycones [41]. The antioxidants in fermented soybeans show synergistic antioxidant effects with phenolic compounds including tocopherols and their active reaction products, such as 5-(δ-tocopheroxy)-δ-tocopherol [42].

It is therefore clear that both full-fat and defatted soybean products could be consumed as antioxidant-rich foods. They might be added as ingredients to a variety of foods, including bakery products, cakes, crackers, snacks, meat products and even dairy product substitutes. The preparation of extracts is unnecessary. In addition to the antioxidant activity, soybeans would contribute to the improvement of many other properties, such as the nutritional value of the food.

Peanuts and peanut defatted meals

Peanuts or groundnuts (*Arachis hypogaea* L.) belong to the same *Leguminosae* or *Fabaceae* family as soybeans, but in chemical composition and food use, they resemble nuts rather than other beans. Defatted peanut flour contains about 1750 $mg.kg^{-1}$ phenolic acids [24]. These authors reported that a methanol extract from peanut flour contained 289 mg free phenolic acids, 327 mg esterified phenolic acids, and 20 mg phenolics in the insoluble residue from 1 kg defatted flour, and the extract showed antioxidant activity in a β-carotene/linoleic system. The major component was *p*-hydroxybenzoic acid, but *trans-p*-coumaric, syringic, *trans*-ferulic, and *trans*-caffeic acids were also present. Dihydroquercetin was identified as an active compound [43]. Peanut hulls are particularly rich sources of phenolics, containing concentrated tannins, procyanidins, catechin and epicatechin oligomers and other substances [44]. However, peanut hulls are bitter and they are not used as food, so the use of peanut hulls and hull extracts would need more research to overcome these problems.

As peanuts are commonly used as food, both full-fat and defatted peanut flour could be used as a food additive without further fractionation, especially in sweets, bakery products, cakes and snacks. Suitable recipes could be developed even for new meat and dairy foods, where peanut ingredients could substantially prolong the storage time.

Sunflower seeds and defatted meal

Sunflower (*Helianthus annuus* L.) belongs to the major oilseed crops. Roasted sunflower seeds are consumed in Eastern Europe, but, in other parts of the world, seeds are processed for the production of edible oil, and the extracted meal is used as feed. Defatted sunflower seed flour contains 3.0–3.5 $g.kg^{-1}$ of phenolics. Chlorogenic and caffeic acids constitute about 70 % of these compounds [45, 46], but chlorogenic acid is the major component. It can be bound to polypeptides with a molecular weight lower than 5000 Da and to oligonucleotides. Several other phenolic acids, including *p*-hydroxybenzoic, *p*-coumaric, cinnamic, *m*-hydroxybenzoic, vanillic and syringic acids were also identified in an aqueous extract of ground sunflower seeds [47].

The isolation of antioxidants from sunflower meal is unrealistic, as they are not present in high amounts, and the extraction would be expensive.

However, seeds, or perhaps even dehulled oil-extracted meals, could be used for the production of various foods as a substitute for nuts for wafers, crackers, or other fine bakery products.

Evening primrose seeds

Evening primrose (*Oenothera biennis* L.) is not a typical oilseed crop, but the seeds contain large quantities of oil rich in polyunsaturated fatty acids - 70–79 % linoleic acid and 8–13 % γ-linolenic acid [48], and the oil is used for special dietetic purposes due to its nutritional effects. Extracted seed meal is now available in modest amounts on the market. In comparison with many other oilseed meals, evening primrose meal contains high amounts of antioxidants, mostly phenolic compounds [49]. The methanol extract of defatted evening primrose meal contained 862.2 $g.kg^{-1}$ phenolics, compared to only 79.7 $g.kg^{-1}$ in the analogous extract from defatted rapeseed meal. The evening primrose extract contained mostly flavanols and proanthocyanidins. The main phenolic acids were gallic and vanillic acids [50]. TLC analysis showed that the following compounds were also present: epicatechin, catechin, proanthocyanidin, proanthocyanidin gallate, polymerized polyphenols and isoflavones [16, 51].

The crude acetone extract of evening primrose meal was separated using a Sephadex LH-20 column [52]. Evidence from TLC, HPLC, NMR and electron impact mass spectrometry was sufficient to identify the low molecular weight phenolic antioxidants as (+)-catechin, (-)-epicatechin, and gallic acid. These compounds accounted for about 10.5 % of the dry mass of the crude extracts and about 1.7 % of the dry mass of the meal, respectively.

Extracts were prepared from defatted evening primrose seeds using 60 % aqueous acetone, ethyl acetate, ethanol, and water. All extracts acted as antioxidants in a β-carotene/linoleic acid model system. Ethanol and 60 % acetone extracts were particularly active [16], while ethyl acetate and ethanol-ethyl acetate extracts had the highest activity in sunflower and rapeseed oils [53]. The antioxidant activity of defatted evening primrose seed extracts was similar to that of rosemary extract, and better than the activities of green tea, rapeseed and legume extracts [54].

Extracts from evening primrose seeds were found to be relatively active as antioxidants, but as neither seeds nor extracted meals have been used as food, further research would be necessary to ascertain, whether they would be safe as food components. Once safety is confirmed, the application of evening primrose seeds and extracts could be considered, at least for special purposes, where high price is not a limiting factor. Application in cosmetic or pharmaceutical products is, of course, open even now.

Linseed (Flax seed) and defatted meal

Cultivated flaxseeds (*Linum usitatissimum* L.) have been used as a source of oil for several thousands of years. Seeds have been proposed as a food additive, but extracted meals are used only as feed. The phenolic acid content is lower than in other oilseed meals. Methanol extracts from defatted linseed flour (1 kg) contained 224 mg free phenolic acids, 320 mg phenolic acid esters and 66 mg of phenolic acids bound in insoluble residues. Sinapic, *p*-hydroxybenzoic, coumaric and ferulic acids were the main phenolic components in linseed meal [23, 24]. The ethanol extract was separated into four fractions by column chromatography. Fraction I, containing four phenolic acids, possessed the strongest antioxidant activity in a β-carotene/linoleic acid medium [55].

Linseed meal is a rich source of two lignans, secoisolariciresinol and matriresinol. The former occurs in the form of an unknown chemical structure [56-58]. The secoisolariciresinol diglucoside content varied between 11.7 $g.kg^{-1}$ and 24.1 $g.kg^{-1}$ defatted linseed flour and between 6.1 $g.kg^{-1}$ and 13.3 $g.kg^{-1}$ of whole seeds [58].

Linseed phenolics require further study, especially the antioxidant activity of lignans, but the application of extracted meal for edible purposes would not be acceptable at the present state of knowledge, except for some speciality dietetic products.

Cottonseed and defatted meal

Cottonseed is used for the production of edible oil. The defatted meal from traditional cultivars was unacceptable even as feed because of the presence of gossypol, a complex phenolic compound with two aldehydic groups, showing high antioxidant activity, but also relatively high toxicity. In the past, it was used as a male contraceptive for humans, and it may also cause temporary male infertility in livestock [59]. Several pigments of similar structures were shown to be present together with gossypol.

Modern glandless cultivars (gossypol was located in special glands) are gossypol-free, but still contain phenolic components. The methanol extract from 1 kg defatted cottonseed flour contained 143 mg free phenolic acids, 317 mg esterified phenolic acids and 27 mg phenolic acid in the insoluble residue. Sinapic, ferulic and *p*-hydroxybenzoic acids are the major phenolic acids present [23, 24]. Quercetin and rutin are the main flavonoids, and the high antioxidant activity of the methanol extract is mainly due to quercetin [60].

Glandless cottonseed meal inhibited lipid oxidation in minced meat, but the activity was not related to the content of residual gossypol, which was present at trace levels below the permitted limits [61].

The evaluation of cottonseed meal is similar to that of linseed meal. It possesses antioxidant activity, but the direct application in food is unlikely, at least in Europe. The situation is different in developing countries where cottonseed flour was suggested as a protein source for the fortification of low-protein diets. In those countries, cottonseed flour would be acceptable and consequently the phenolic acid content of such edible flours would be worth further study.

Sesame seed and defatted meal

Sesame seeds are traditional food components in Oriental countries, and more recently, they have been consumed in Europe, too. Sesame oil is also extracted and used as an edible oil. The unsaponifiable matter from sesame oil contains several compounds with antioxidant activity some of which are formed from lignans during the roasting of sesame seeds before processing. Sesamin was the first crystalline compound isolated from sesame oil unsaponifiables, and sesamol, sesamolin, sesaminol as well as sesamin have subsequently been isolated and identified [15, 62]. Sesamol and sesaminol have free radical-quenching activity [63]. Both of these compounds are formed from sesamolin during the roasting process. Sesamolin (1.68–3.50 $g.kg^{-1}$ oil) is thought to be the antioxidant precursor [63, 64].

Sesame seed acetone extract contains, besides sesaminol and sesamolinal, also trans-ferulic acid [64]. The methanol extract from 1 kg defatted sesame flour contained 41 mg free phenolic acids, 352 mg esterified phenolic acids and 14 mg insoluble phenolic acids remained in the residue. Coumaric, ferulic, vanillic and sinapic acids were the main phenolic components [23, 24]. The high oxidation stability of roasted sesame oil was assigned to the synergistic action of γ-tocopherol, sesamol and products of Maillard reactions. Tocopherol decomposition was slower when sesaminol was present [63]. The antioxidant activity of sesamin, sesamolin and synthetic sesamol was examined in lard, refined peanut, cottonseed and sesame oils. Sesamol was very effective in lard and in vegetable oils, particularly in sesame oil [65].

Sesame seeds and defatted sesame meal would be applicable for stabilization of cakes, crackers, other bakery products, and also for meat products. Their utilization should be studied in more detail, and the optimum conditions for the formation of lignan decomposition products have yet to be identified. Sesame oil and sesame meal could be combined in the stabilization of food products.

Olive fruits and cakes

Olive fruits have always been consumed in the Mediterranean area, and have become a common food in most countries around the world. Essentially, they are not fruits, but the pericarp of the fruit; the kernels are removed and processed to olive kernel oil. Olive oil is the preferred oil in the Mediterranean despite its high price. As it is produced by cold extraction, the residual cake is still relatively rich in residual oil. The cake contains antioxidants, which are also present in virgin olive oil. In addition to simple phenols (hydroxytyrosol and tyrosol), secoiridoids (oleuropein, its aglycone, the aglycone of ligstroside, and their respective decarboxylated dialdehyde derivatives), flavonoids (rutin and luteolin 7-glucoside) and lignans (acetoxypinoresinol and pinoresinol) are present. Many of the phenolic classes have potent antioxidant properties [13].

Olive fruits are expensive to be used as food antioxidants, but the cakes of olive fruits, pomace, salsa, are much cheaper and so they could be used for preparation of food products requiring increased stability against oxidation. They could be applied without further fractionation, requiring only thermal inactivation of enzymes and microbial contaminants. They would be particularly suitable for use in animal foods, but they might also be useful in salad dressings and sauces. More research is needed to identify the range of applications.

Palm fruit and defatted meal

Oil palm (*Elaeis guineensis* L.) yields a seed, which is processed to yield palm kernel oil, and the fruit pericarp, which contains palm oil. The oil has a high content of tocopherols and tocotrienols [66, 67]. Carotenoids are also present, contributing to the antioxidant activity not only of the oil, but also of defatted residues after crude oil extraction. Although palm oil has been extensively studied, little is known about the composition and antioxidant properties of the residual extracted meal. It would be desirable to investigate the composition of phenolics in the meal, and to investigate the application of meals in food production.

Rice bran and defatted meal

Rice bran is not as rich in oil as oilseeds, but it is still economically advantageous to process the bran to produce oil, which has good flavour and stability against oxidation. Vitamin E and oryzanol are the main antioxidants in rice bran, but the content of oryzanol is about 10 times higher than that of vitamin E. γ -Oryzanol is a mixture of several closely related substances, consisting of steryl ferulates, cycloartenyl ferulate, 24-methylenecycloartenyl ferulate and campesteryl ferulate [68], the first compound being the major component. The oryzanol content is substantially higher in outer bran layers than in inner layers [69]. Oryzanol was found to be an active radical-scavenging antioxidant when tested with 2,2'-azobis(2-methylpropionamidine) dihydrochloride method [68]. The oryzanol content decreased less than the tocopherol content on irradiation at intensities of 10–15 kGy, while lower levels of radiation had only a minor effect [70].

Steam-treated rice bran is a substrate deserving attention as a source of antioxidants. It could be applied in cakes, snacks, breakfast cereals and different bakery products. Because of the presence of oryzanol and other antioxidants, bran could be used as a constituent of functional foods [71], such as special breakfast cereals.

Grapeseed and defatted meal

Grape (*Vitis vinifera* L.) seeds, by-products of wine production, are rich in oil, but they are not very important for edible oil production. The seed is a good source of monomeric phenolic compounds, including (+)-catechin, (-)-epicatechin, (-)-epicatechin-3-*O*-gallate, and dimeric, trimeric and tetrameric procyanidins [72]. The main compounds present are hexamers, but only the structures of some dimeric and trimeric procyanidins and their acylated derivatives have been elucidated. All acylated procyanidins of grape seeds are gallic acid esters. Teresa [73] reported 17 constituents with antioxidant activity in grape seeds. The major compounds were (+)-catechin, (-)-epicatechin, 3-*O*-gallate-(4β-8)-catechin(B1-3-*O*-gallate) and (-)-epicatechin-3-*O*-gallate. Similarly, Fuleki and Ricardo [74] reported monomeric (+)-catechin, (-)-epicatechin-3-*O*-gallate, 14 dimeric, 11 trimeric procyanidins and one tetrameric procyanidin. Substantial quantities of highly polymerized procyanidins are also present in grape seeds, as 55 % procyanidins consist of more than five monomer units.

Extracts of grape seeds with various solvents including acetone, ethyl acetate, methanol, and water, showed antioxidant activity both in a β-carotene-linoleate model experiment and when asssessed by the linoleic acid peroxidation method. Mixtures of ethyl acetate and water at different ratios yielded extracts with higher activity, which was confirmed by the potassium ferricyanate method. Following these findings, grape extracts were suggested for the preservation of food products as well as for health supplements and nutraceuticals [75].

Ground seeds are unlikely to be used as food additives due to their hard grainy texture, but extracts could be considered as sources of antioxidants. More research is needed to optimize food applications, and the costs of the application of extracts should be evaluated.

Conclusions

Oilseeds represent a very promising source of natural antioxidants, being usually mixtures of several compounds in variable ratios. The antioxidant activity of fractions obtained by extraction with different solvents could help in evaluating the contributions of individual antioxidants present in the mixture. Some oilseeds are consumed directly, and oil-extracted meals in some cases are already used or could be used as food. The oil-extracted meals after processing contain mainly phenolic acids and their derivatives, lignan decomposition products, flavonoids and similar compounds. Both oils and meals can be used as sources of antioxidants for the stabilization of fats and oils and other lipid foods against oxidative damage. The optimum application of oilseeds is the use of oilseeds or oil-extracted meals directly in foods or to prepare blends of stable oils with less stable oils or lipid foods. The application of extracts is more expensive, and the safety of concentrated materials as food components needs to be tested.

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Olejnaté semená - zdroj antioxidantov

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SÚHRN. Olejnaté semená a plody obsahujú nielen v oleji rozpustné antioxidanty, ale aj rôzne polárne látky s antioxidačnou aktivitou. Najjednoduchšou cestou na ich použitie v potravinách je začlenenie oleja alebo semien priamo do výrobku, čím sa zvýši jeho odolnosť voči oxidácii. Počas spracovania olejnatých semien prechádzajú lipofilné antioxidanty do olejov a prispievajú k ich vyššej oxidačnej stabilite. Takéto oleje sa môžu pridávať priamo do potravín alebo zmiešať s menej stabilnými na zlepšenie odolnosti. Semipolárne antioxidanty ostávajú najmä v extrakčných šrotoch, ktoré sú využiteľné na úpravu stability potravín. Pridávanie niektorých šrotov do potravín však nie je prijateľné vzhľadom na nepriaznivé ovplyvnenie organoleptických vlastností potravín. Získavanie extraktov zo šrotov bohatých na antioxidanty je nákladné a ich aplikácia do potravín je spojená so zdravotnými rizikami, preto je podmienená úradným schválením na báze toxikologického posúdenia. Niektoré extrakčné šroty sú potenciálnymi zdrojmi rastlinných antioxidantov, pred ich uplatnením je však potrebný dôkladný výskum.

KĽÚČOVÉ SLOVÁ: antioxidanty; jedlé tuky a oleje; extrakčné šroty; oxidácia