Chapter

Medicinal Herbs: Important Source of Bioactive Compounds for Food Industry

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Abstract

Medicinal herbs accompany people throughout life – from birth to the grave. Almost every day they come to our table as a part of food in various forms, many are used for technical and bioenergetics purposes, and there is also a large group of plants used in medicine, pharmacy and food industry. In the last decade, the consumption of herbs and spices has increased. They grow spontaneously and free of chemical additives, and some studies have shown higher nutritional value, often more significant compared to other common food plants. Medicinal herbs become increasingly important due to its potential beneficial health effects related to its nutritional composition, such as the presence of vitamins, phenolic, anthocyanins, flavonoids, tannins, among others. These raw materials are considered to be promising, economically and ecologically advantageous for the food industry. In this chapter will be describe selected medicinal herbs from *Lamiaceae* family – bioactive compounds and possibility for using in food industry.

Keywords: herbs, spices, food technology, bioactive compounds

1. Introduction

Medicinal herbs have been used for many centuries especially in traditional folk medicine. Plants are very good source of bioactive compounds for functions including activity to inhibit insects, antimicrobial and antifungal activity and positive effects for animals and humans. Several groups of phytochemicals with biological activity have been identified in medicinal plants – polyphenols, natural colorants, essential oils, mineral compounds, vitamins and many others [1]. Humans have a long tradition for using medicinal and aromatic plants in their lifestyle [2]. Culinary herbs are primarily used for enhancing the flavor of foods including meats, milk products, sauces, vegetables, cereal products and desserts. They can be used as a replacement for salt and sugars, colorants and flavorings agents [3].

The main bioactive compounds presented in medicinal and culinary herbs are polyphenols (especially phenolic acids and flavonoids). These compounds are well known for their biological activity such as anticancer, antioxidant, antimicrobial, neuroprotective, antidiabetic, cardio protective and many others positive effect to human body. It is important to determine their safe intake and dosage in health, gastronomy and food industry [3, 4].

The cooking methods in gastronomy include baking, frying, boiling, roasting, steaming and use of microwave ovens can enhance the textural and sensory properties of the food material but can cause chemical changing of natural phytochemicals especially polyphenols. The amount of phenolic compounds can decrease due to water-soluble phenols loosing during the cooking water and it can be visible also structural changes of these compounds that occurs during cooking process. In addition, thermal processes also produce new bioactive compounds by the Maillard and carbonyl-amine reactions [5].

Prevention of food products from chemical, physical and microbial damages has been a vital concern in the food industry. Nowadays, consumers are interesting for partial or complete substitution of chemical agents due to their possible negative health effects. These benefits has guide to an increasing consciousness in developing more friendly and natural label on processed foods. Incorporation of fresh, dried and powdered medicinal and culinary herbs to foods can enhanced sensory properties, technological properties and increase amount of bioactive compounds in these products [6].

In this chapter are summarized medicinal herbs (spices) as important source of bioactive compounds for food industry especially kinds from *Lamiaceae* family: oregano (*Origanum vulgare* L.), sage (*Salvia officinalis* L.), lavender (*Lavandula angustifolia* L.), mint (*Mentha piperita* L.), lemon balm (*Melissa officinalis* L.) and rosemary (*Rosmarinus officinalis* L.). The family of *Lamiaceae* consists of about 230 genera and 7100 species worldwide. Many species from this family are considered of high importance because of their uses in medicine, culinary, cosmetics, smoking, production of essential oils, repellents, fragrances and charm [7].

2. Oregano (*Origanum vulgare* L.)

Oregano (*Origanum vulgare* L.) is an aromatic, perennial herb with hairy stem, creeping roots, branched woody stems, up to 50 cm high, oval leaves. The flowers are in corymbs with reddish bracts, a two-lipped pale purple corolla and a five-toothed calyx. It grows in arid, sunny meadows and rocky places, widely distributed in Europe and Asia, especially in the Mediterranean region. In moderate climates, the flowering period extends from late June to August. Each flower produces, when mature, four small seed-like structures. The foliage is dotted with small glands containing the volatile or essential oil that gives the plant its aroma and flavor [8, 9]. Oregano is rich for γ-terpinene, *p*-cymene, thymol and carvacrol methyl ethers, thymol and carvacrol acetates; also compounds such as *p*-cymenene, *p*-cymen-8-ol, *p*-cymen-7-ol; thymoquinone and thymohydroquinone are also present [9]. Oregano contains significant amounts of the vitamin E, especially $\alpha,\beta,\gamma,$ and δ-tocopherol, which are involved with the antioxidant capacity. In fresh leaves are presence 45 mg of vitamin C, 0.07 mg of thiamine, 0.81 mg carotene also higher values of B_6, riboflavin, niacin, folate panthotenate and biotin. From mineral compounds are dominant iron, copper, sulfur, iodine, selenium, calcium (310 mg in fresh leaves), magnesium (53 mg in fresh leaves), phosphor (39 mg in fresh leaves), zinc (0.9 mg in fresh leaves) and manganese (0.3 mg in fresh leaves). Amount of potassium is 33 times higher than sodium [10]. Flavonoids – apigenin, luteolin, quercetin, scutellarein and phenolic acids – mainly rosmarinic acid are the main types of phenolic compounds present in oregano [11].

Oregano has ability to increase appetite in human tomato dressing in a pasta meal seasoned with 0.27% of oregano increased the palatability and the intake of food compared with an unseasoned control food. But concentration of oregano is very important – doubling the amount reduced the food intake and eating rate [10].

The dried light green leaves are available whole, flaked or ground. Essential oil is obtained by steam distillation of the dried flowering herb. The oil is a yellow to dark-brown mobile liquid, yield 1–2%. Aroma of oregano is strongly, camphoraceous. Flavor is slightly bitter and pungent, musty, hay and minty notes [2]. Oregano as raw material as well as oregano essential oil is used in meat, sausages, salads, stewings, dressings, soups, alcoholic beverages, baked goods, meats and meat products, condiments and relishes, milk products, processed vegetables, snack foods, and fats and oils. It is the most common spice for pizza. Addition of 5% dry oregano powder increase antioxidant activity (DPPH method – 36.28 mg TEAC/g – TEAC Trolox equivalent antioxidant capacity), total polyphenol (288.46 mg GAE/g – GAE – gallic acid equivalent) and total ash content (0.77%) of Linz biscuits with compare to control variant without addition (DPPH – 3.10 mg TEAC/g; 86.01 mg GAE/g; 0.71%). These biscuits were also very good evaluated from sensory point of view [12]. Oregano is a common ingredient of dressings and a good substitute for table salt. It increases aroma of vegetable dishes as pea soup and other pea dishes, squash and stews made from mixed vegetables, mushrooms and asparagus. Oregano essential oil can be added into edible films in order to prolong the shelf-life of sliced bread and bakery products, due to the antimicrobial activity against some foodborne pathogenic and spoilage microorganism. The oregano essential oil could be used as supplementation on a lamb diet, improving the antioxidant activity which had influence on retarding the lipid meat oxidation during refrigerated and long-term frozen storage. This process could be explained by carvacrol and thymol action on the permeability off cell membrane and by the transformation of lipid and hydroxyl radicals into stable products [9, 13].

3. Sage (*Salvia officinalis* L.)

Sage *(Salvia officinalis* L.) is a plant from *Lamiaceae* family and can be found in Europe around the Mediterranean, in Southeast Asia, and Central and South America. This plant grows in the form of an outcrossing, perennial evergreen subshrub up to 80 cm high. The leaves are opposite silver oval, shiny, covered with fine hairs and large attractive violet flowers 2–4 mm long from the pedicel. They bloom from March to July depending on habitat and climatic condition [2, 14]. The major phenolic acids in sage are rosmarinic acid, caffeic acid and its derivatives, salvianolic acids, sagernic acid and lithospermic acids. From flavonoids are dominant hispidulin, luteolin 7-O-glucoside, apigenin, cirsimaritin, kaempferol and quercetin. The major constituent in essential oil are α-thujone (15–43%), β-thujone (3–9%), camphor (4–24%), 1,8-cineol (10%) camphene, α-pinene, β-pinene, limonene, α-humulene, β-caryophyllene and borneol. The oil is clear, colorless to pale yellow mobile liquid, with yield 2–3.6%. From mineral compounds are dominant in dry matter of sage leaves potassium (14.9 g/kg), calcium (10.1 g/kg), magnesium (4.1 g/kg), iron (885 ppm), zinc (145 ppm), sodium (91 ppm), manganese (52.7 ppm) and copper (6.9 ppm) [15]. The most abounding carbohydrates described in this plant are arabinose, galactose, glucose, mannose, xylose, uronic acids and rhamnose. One teaspoon (0.7 g) of ground sage contains 10% of the reference daily intake of vitamin K and 1.1% of vitamin B_6 [2, 16].

Salvia has long been known for its culinary values, and it also has the potential to be used as a natural preservative in food applications. Leaves are strongly aromatic, sweet, herbaceous, and spicy. The taste is bitter, fragrant warm and astringent. The young leaves and flowers can be eaten raw, boiled, pickled or used in sandwiches. The flowers can also be sprinkled on salads to add color and fragrance. Yang leaves are eaten fresh in salads and cooked in omelets, fritters, soups, yeast breads and

rolls, marinades, sausages, meat pies, and poultry stuffing. They are also used in cooking with liver, beef, pork, veal, lamb, fish, poultry, duck, goose, artichokes, tomatoes, asparagus, carrots, squash, corn, potatoes, eggplant, beans, leeks, onions, cabbage and lentils. Sage tea is made from the fresh or dried leaves, it is said to improve the digestion. An essential oil obtained from the plant is used commercially to flavor ice cream, sweets, and bakery products [2, 17]. Addition of 5% dry sage powder increase antioxidant activity (DPPH method – 38.16 mg TEAC/g – TEAC Trolox equivalent antioxidant capacity), total polyphenol (250.29 mg GAE/g – GAE – gallic acid equivalent) and total ash content (0.76%) of Linz biscuits with compare to control variant without addition (DPPH – 3.10 mg TEAC/g; 86.01 mg GAE/g; 0.71%). These biscuits were also very good evaluated from sensory point of view, especially spicy-bitter taste and aftertaste [12]. Several researches have shown that sage efficacy is comparable to that of synthetic preservatives and can thus be used in as a natural preservative. Consequently, sage have potential to be as antioxidants and against spoilage microorganisms such as *Pseudomonas aeruginosa* and *Bacillus cereus* strains. Sage essential oil (0.05–0.1 μL/g) exhibited activity against microbial growth in fresh pork sausages to improve the safety of the meat product during storage. The addition of this essential oil reduced the microbial growth in fresh pork sausages and it had no negative effect on sensory properties of this meat product at 0.05 μL/g [17]. The whey protein concentrate coating incorporated with 4000 ppm of sage extracts on pistachio kernels inhibited *Aspargillus flavus* growth totally [18]. Due to antioxidant and antibacterial properties sage essential oil and sage ethanol extracts may be recommended as an auxiliary factor to prolong the storage stability of frozen, vacuum-packed low-pressure mechanically separated meat from chickens [19].

4. Lavender (*Lavandula angustifolia* L.)

Lavender (*Lavandula angustifolia*, L.), is an evergreen perennial plant native to the Mediterranean region but grown in many other countries of the world, including Slovakia. Lavender grows to a height of 40–60 cm and forms compact, regular clumps. The lower part of stem is woody, while the upper part is green, leaves are linear or lanceolate with curled edges and a highly branched fibrous root system. Silver-green lavender leaves are covered with tomentum, which protects them from strong sunshine, wind, and excessive water loss. The pale violet flowers grow in spikes, arranged in circles (3–5 flowers per circle) in the top part of the stem [2, 20]. Lavender contains anthocyanins, phytosterols, sugars, coumaric acid, glycolic acid, valeric acid, ursolic acid, herniarin, coumarin and tannins (5–10%). Essential oil (1–3%) containing more than 100 constituents including linalyl acetate, linalool, *cis*- and *trans*-β-ocimene, terpinen-4-ol, lavandulol, lavandulyl acetate, 1,8-cineole, limonene. From mineral compounds is possible to find in dry matter of lavender leaves potassium (17.7–23.9 g/kg), calcium (2.13–10.5 g/kg), magnesium (1.40–3.60 g/kg), sodium (0.11–0.15 g/kg), zinc (23–106.27 mg/kg), copper (7.2–11.1 mg/kg) and manganese (9.6–18 mg/kg) [2, 20, 21].

Lavender has a very floral fruity and herbaceous aroma. It has a sweet, floral refreshing, pleasant balsamic-woody undertone. Lavender flowers in the food industry are used as a natural flavoring for beverages, ice cream, candy, chocolates, bakery products, vinegars, sparingly in salads, syrup and jellies. They are used in baked goods, soft candy, gelatin, frozen dairy, pudding, and alcoholic and nonalcoholic beverages. Lavender essential oil could be used as a growth promoter in broiler nutrition with potential improvements in breast meat quality [2, 22]. Addition of lavender in amount 0.1–1% prolonged shelf life of hamsi kaygana (traditional

food in the Black Sea Region of Turkey), and confirmed that this products can be transported to wider markets, by increasing its durability and longer-term preservation and easy transportation with different packaging techniques [23]. Addition of 5% dry lavender powder increase antioxidant activity (DPPH method – 19.33 mg TEAC/g – TEAC Trolox equivalent antioxidant capacity), total polyphenol (146.35 mg GAE/g – GAE – gallic acid equivalent) and total ash content (1.17%) of Linz biscuits with compare to control variant without addition (DPPH – 3.10 mg TEAC/g; 86.01 mg GAE/g; 0.71%). These biscuits were also very good evaluated from sensory point of view, especially flower taste and aftertaste [12].

5. Mint (*Mentha piperita* L.)

Mentha is a genus belonging to the family of *Lamiaceae*, whose plants are among the most aromatic and spread in diverse environments worldwide. The plant is indigenous to Europe and widespread in cultivation throughout all regions of the world. It is found wild occasionally with its parent species. It is an invasive species in Australia, the Galapagos Islands, New Zealand and United State. Mint has simple, characteristic leaves with pleasant scent. Mint is a perennial hardy branched plant with bright green, lance shaped sharply toothed leaves, quickly spreading underground runners and white flowers clustered in the form of spikes. Leaves are sessile, lanceolate, or ovate-lanceolate, smooth above and glandular below. The flowers are sharply pointed, long and narrow. The plant is from 25 to 75 cm high [2, 23, 24]. Mint contains menthyl acetate (2–11%), isomenthone (2–8%), essential oils (yield 1–3%) composed of menthol (33–60%), menthone (15–32%), eucalyptol (5–13%), menthofuran (1–10%), limonene (1–7%), menthyl acetate (5%), isomenthone, menthofuran and piperitone. The oil is pale yellow to pale olive-green mobile liquid. Leaves contain 19–23% of polyphenols, which include iriocitrin and rosmarinic acid (59–67%), luteolin 7-orutinoside (7–12%), hesperidin (6–10%), rutin, caffeic, chlorogenic acid; betaine, choline, tannins, α- and γ-tocopherols and α- and β-carotenes [2, 25]. From mineral compounds is dominant calcium (255 ppm), sodium (147 ppm), potassium (15.56 ppm), magnesium (3.9 ppm), iron (2.03 ppm), copper (0.88 ppm), zinc (0.79 ppm), selenium (0.26 ppm), and cobalt (0.25 ppm) [26]. In 100 g of fresh leaf is present approximately 31.8 mg of vitamin C, 0.129 mg of vitamin B6 and 212 μg_RAE (retinol activity equivalents) [2].

Mint has strongly mentholic, herbaceous, very aromatic and cooling aroma. Taste is spicy, minty cool, sweet, fragrant and slightly pungent. Aftertaste is herbaceous, minty and cooling. The presence of essential oils in the leaves and other parts of the plants gives it a very appealing aroma. It is the most widely used herb. Mint is a popular flavor found in desserts, beverages, baked goods, ice cream, liquors, sauces, confectionary, candies, and after dinner mints. The crushed leaves can be used in jellies, beverages, sherbets, soups, sauces, stew, meat fish and vegetables. The oil is used to flavor chewing gum, candy, and mints [2, 27]. The mint leaves can be used as an effective novel nutritional bio-agent up to 15 g/kg to improve the performance of broiler chicks, mainly due to its active component [28]. Replacement of 50% of nitrite with mint essential oil is a good approach in order to put down harmful effects of nitrite in sausage and to enhance functionality of the product [29]. Mint may be used to modify microbial fermentation of milk with the intention of producing dairy products with higher antioxidant and enhanced anti-ACE activities (angiotensin-1 converting enzyme) [30].

Addition of 5% dry mint powder increase antioxidant activity (DPPH method – 54.51 mg TEAC/g – TEAC Trolox equivalent antioxidant capacity), total polyphenol (258.20 mg GAE/g – GAE – gallic acid equivalent) and total ash

content (0.8%) of Linz biscuits with compare to control variant without addition (DPPH – 3.10 mg TEAC/g; 86.01 mg GAE/g; 0.71%). These biscuits were also very good evaluated from sensory point of view, especially minty cool taste and aftertaste [12].

6. Lemon balm (*Melissa officinalis* L.)

Lemon balm, member of the family *Lamiaceae* is a perennial bushy plant and is upright, reaching a height of about 1 m with square stems. The soft, hairy leaves are 2 to 8 cm long and either heart-shaped. The leaf surface is coarse and deeply veined, and the leaf edge is scalloped or toothed. The flowers, white or yellowish are in loose; small bunches from the axils of the leaves and bloom from June to October. The flower consists of five fused sepals, five petals, two or four stamens, and four lobed ovaries. The seeds are very small, ovate, dark brown, or black in color. The plant dies down in winter, but the root is perennial [2, 31, 32]. The leaf of *Melissa officinalis* contains flavonoids (quercitrin, rhamnocitrin, luteolin), polyphenolic compounds (rosmarinic acid, caffeic acid and protocatechuic acid), monoterpenoid aldehyde, monoterpene glycosides, triterpenes (ursolic and oleanolic acids), sesquiterpenes, tannins, resin and essential oils (0.1 average, with citral-geraniol and neral, linalool, eugenol, citronellal, geraniol) [12].

Lemon balm has a sweet, lemon, fresh aroma, fresh lemony, sweet taste with a slightly mint hint. The oil has a very pleasant fresh sweet lemony aroma. The aromatic balm leaves are often used in beverages and as a seasoning in salads, dressings and sauces, as well as in cooked foods, in soups and stews. The leaves goes well with teas, vinegars, stewed fruits, jellies, puddings, and custards. It can be added to fish, poultry, eggs [2, 27]. Addition of 5% dry lemon balm powder increase antioxidant activity (DPPH method – 48.24 mg TEAC/g – TEAC Trolox equivalent antioxidant capacity), total polyphenol (227.39 mg GAE/g – GAE – gallic acid equivalent) and total ash content (1.16%) of Linz biscuits with compare to control variant without addition (DPPH – 3.10 mg TEAC/g; 86.01 mg GAE/g; 0.71%). These biscuits were also very good evaluated from sensory point of view, especially lemon taste, aroma and aftertaste [12]. Lemon balm powder (0.1, 0.5 and 1% addition) had positive effects on sensory evaluation of hamburger patties. The pH of all patties decreased with longer storage period. The 2-thiobarbituric acid value, volatile basic nitrogen content, and the total microbial counts of hamburger patties with 1% of lemon balm powder addition were lower, compared to those of the control group without addition of lemon balm powder. Lemon balm powder in hamburger patties had significantly delayed lipid peroxidation [33]. The beer enriched with lemon balm had a pleasant appealing and harmonious flavor and aroma [34]. The pig's diet with 100 ml of lemon balm per day for 10 days before slaughter had significant influence of lemon balm extract on drip loss 24 h post mortem in comparison with control pigs was observed. This extract also improved significantly lightness and yellowness of fresh pork (24 h). The extract improved significantly antioxidative stability in 5-days stored pork [35].

7. Rosemary (*Rosmarinus officinalis* L.)

Rosmarinus officinalis L. is a medicinal plant that belongs to the *Lamiaceae* family and is commonly known as rosemary. Besides the culinary uses due to the characteristic aroma, this plant is also widely employed by indigenous populations,

where it grows wild. Rosemary is woody, evergreen perennial small shrub up to 2 m high. It has branched, and narrow leaves that are bright green above, with rolled-in margins and densely hairy below. The branches are rigid and the stem is square, woody, and brown. The flowers are small, pale purple or bluish and appear in cymose inflorescence. This is herb originates from Mediterrean region [2, 36]. The active constituents include essential oil up to 2.5%. Composition of oils is as follows: *alph*a-pinene 12%, *beta*-pinene, camphene 22%, mycrene 1.5%, *alpha*-phellandrene, limonene 0.5–1%, *alpha*- and *y*-terpinene, paracyme-ne 2%, *bet*a-caryophyllene 3%, linalool 0.5–1% terpine-1ol-4, a-terpineol 1.5%, borneol 3–5%, isoborneol, *cis*-thuy-anol-4, *trans*-thuyanol-4, *p*-cymene-8-ol, bornyl-actate, a-phenchyl-actate, 1,8-cineol 30%, caryophylline-ox-ide, humulene-epoxide I and II, 3-hexanon, methyl-heptenon, camphor 30%, verbenon, carvon 0.4%. The oil is clear, colorless to pale yellow mobile liquid. In leaves are phenolic acids (rosmarinic, chlorogenic and caffeic), bitter diterpenes (carnosol, carnosic acid, rosmanol), triterpens (oleanic and ursolic acid), triterpene alcohols (α-amyrin, β-amyrin, betulin), as well as several flavonoids and their glycosides (diosmetin, luteolin, genkwanin) [2, 37]. In 100 g of dried rosemary is possible to find 1280 mg of calcium, 61.2 mg of vitamin C, 1.74 mg of vitamin B_6 and 156 μg RAE (retinol activity equivalents) [2].

Rosemary has sweet and fresh, fragrant, slightly eucalyptus-like aroma and is slightly camphoraceous, minty, balsamic undertones and fresh, bittersweet flavor. The taste is somewhat peppery, spicy, warming and herbaceous with bitter and camphoraceous aftertaste. Rosemary is a popular flavoring for meat and meat products, baked goods and Mediterranean recipes. Fresh or dried leaves can be used for special accent with cream soups made of leafy greens, poultry, stew, and sauces. The leaves and flowering tops are used in lamb roast, mutton preparations, fish dishes, marinades, bouquet garni, with baked fish, rice, salads, occasionally with eggs preparations, dumplings, apples, summer wine cups, and fruit cordials, and in vinegar and oil. Dries leaves and extractives are used to season fried chicken, salad croutons, baked products, confections, and nonalcoholic beverages [2, 27]. Rosemary extract (350 ppm) was very effective antioxidant on quality and stability of ground chicken meat and comparable to the other commercial antioxidants, so can be a good substitution to many synthetic antioxidants used in meat industry [38]. Results showed that tri-methylamine-nitrogen value of rosemary extract and vitamin E treated samples of fried fillets of Nile tilapia were significantly lower than those of the control samples without rosemary extract [39]. Results revealed that rosemary extract retarded oxidative changes in chilling and frozen fried fillets of Nile tilapia whereas rosemary extract 0.1%, 0.2% and vitamin E 0.1% were not as effective as rosemary extract 0.3% on oxidative stability. The modeling results showed that soluble phenolic content in yogurt increased with increasing the concentration of rosemary extract mixed with skim milk and strongly correlated with antioxidant activity and decreased over the same time period. Apparent viscosity does not affect as concentration supplemented. The use of rosemary extract as a natural antioxidant could increase the shelf life of dairy products by inhibiting oxidation. A more thorough understanding of the mechanisms of lipid auto-oxidation in milk may lead to a better understanding of how added natural antioxidants, such as rosemary oleoresin, can help inhibit such oxidation and sensory changes in milk and dairy products. Rosemary antioxidants are in most applications more effective than vitamin E (synthetic), BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene), TBHQ (tertiary butylhydroquinone) and others. A new application for rosemary-derived antioxidant, extend the shelf life of milk powder and other dairy products [40, 41].

8. Conclusions

Medicinal herbs are most often defined as any part of a plant that is used in the diet for its aromatic properties. Recently, however, herbs have also been identified as sources of various phytochemicals, many of which possess important biological activity which is interesting for different kind of industry; nowadays very important and big interest of medicinal herbs can be visible in food technology. In this chapter are summarized selected kinds of medicinal herbs especially from Lamiaceae family (oregano, sage, lavender, mint, lemon balm and rosemary). Chapter described botanical characteristics, bioactive compounds, sensory properties (aroma, taste), using in gastronomy as well as food industry especially for producing food with added value. Development of food products enriched by medicinal herbs will continue to grow through the 21st century as consumer demand for healthful products.

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Conflict of interest

The author declares no conflicts of interest.

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