

Food, Industrial, Nutraceutical, and Pharmaceutical Uses of Sesame Genetic Resources

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INTRODUCTION

Sesame (*Sesamum indicum* L., Pedaliaceae) is a very old cultivated crop and thought to have originated in Africa (Ram et al. 1990). However, Oplinger et al. (1990) have indicated it to be a highly prized oil crop of Babylon and Assyria about 4,000 years ago. The Chinese burned sesame oil for light and to make soot for their ink blocks. African slaves brought sesame seeds, which they called benne seeds to America where sesame became a popular ingredient in Southern recipes. The English term sesame traces back to the Arabic *simsim*, Coptic *semsem*, and early Egyptian *semsent* (Home Cooking 1998).

Sesame is an annual self pollinating plant with an erect, pubescent, branching stem, and 0.60 to 1.20 m tall. The leaves are ovate to lanceolate or oblong while the lower leaves are trilobed and sometimes ternate and the upper leaves are undivided, irregularly serrate and pointed (Felter and Lloyd 1898). The older cultivars have smooth and flat leaves while the nonshattering cultivars have cupped leaves with leaflike outgrowths on their lower side. Some cultivars have many branches, while others are relatively unbranched (Kinman and Martin 1954). The flowers are tubular, pendulant, bell shaped, and two lipped with a pale purple or rose to white color and 1.9–2.5 cm (0.75–1") long (Martin and Leonard 1967). In addition, the flowers are borne on short glandular pedicels (Felter and Lloyd 1898). One flower is produced at each leaf axil and the lower flowers usually bloom 2 to 3 months after planting with continuous blooming until the uppermost flowers are open (Martin and Leonard 1967). The fruit is an oblong, mucronate, pubescent capsule containing numerous small, oval, and yellow, white, red, brown, or black seeds (Felter and Lloyd 1898; McCormick Sesame Seed 2001).

Japan uses sesame seed as a health food and leads the world in sesame seed imports followed by Europe and the US. About 70% of the world's sesame seed is processed into oil and meal. White sesame seed is imported from Mexico, Guatemala, and El Salvador while black sesame seed comes from China and Thailand. Total annual consumption is about 65% for oil extraction and 35% for food. The food segment includes about 42% roasted sesame, 12% ground sesame, 36% washed sesame, and 10% roasted sesame seed with salt. People generally consume more than twice as much white sesame as black sesame (International Trade Center 1993). Sesame oil is also referred to as teal oil or benne oil and is a pale yellow, oily liquid, and almost odorless with a bland taste. The oil consists of glycerides with about 43% oleic and linoleic each, 9% palmitic, and 4% stearic fatty acids. Sesame genetic resources conserved at the USDA, ARS, Plant Genetic Resources Conservation Unit represents 869 available accessions from countries worldwide (Table 1).

FOOD AND INDUSTRIAL USES

There are many foods in which sesame is an ingredient (Table 2). Europeans sometimes use it as a substitute for olive oil. Sesame oil is an excellent salad oil and is used by the Japanese for cooking fish (The Nut Factory 1999). Aqua hulled sesame seeds undergo a special hulling process which produces a clear white seed. These seeds are then double washed, dried, and used on hamburger buns. This special process allows the seed to stick to the bun while maintaining a white color after baking. About one-third of the imported crop from Mexico is purchased by McDonalds for their sesame seed buns (The Nut Factory 1999). The seeds are also used on bread and then eaten in Sicily. Sesame seed has a nutty taste when the seed is roasted. Bread, breadsticks, cookies, chocolate, and ice cream are ideal products for roasted natural sesame seed. In Greece seeds are used in cakes, while in Togo, Africa seeds are a main soup ingredient. Mechanically hulled sesame seed enriches bakery and candies plus it is also the basis for the creamy, sweet wholesome tahini. Tahini is rich in protein and a very good energy source. Sesame flour is an edible, creamy and light brown powder from sesame seeds. Sesame flour has high protein, high levels of methionine and tryptophan, and 10% to 12% sesame oil (Dipasa). Sesame seeds contain three times more calcium than a comparable measure of milk (Home Cooking 1998).

Table 1. Sesame genetic resources conserved for research use at the PGRCU.

Number of accessions	Country of origin	Number of accessions	Country of origin	Number of accessions	Country of origin
15	Afghanistan	3	Italy	1	Somalia
5	Angola	16	Japan	1	South America
8	Argentina	2	Jordan	1	Sri Lanka
2	Cameroon	2	Korea	4	Sudan
52	China	1	Liberia	2	Syria
14	Egypt	3	Libya	5	Taiwan
2	Ethiopia	29	Mexico	1	Tanzania
51	Former Soviet Union	11	Mozambique	163	Turkey
14	Greece	9	Myanmar	119	United States
3	Guatemala	12	Nepal	28	Venezuela
154	India	1	Nicaragua	1	Virgin Islands
26	Iran	4	Nigeria	1	Yugoslavia
9	Iraq	17	Pakistan	5	Zaire
26	Israel	1	Philippines		

Refined sesame oil is a fine oil because of its antioxidant properties allowing for greater shelf life plus improving its flavor and taste for use in the food industry. Roasted sesame oil resists rancidity due to the antioxidants formed during seed roasting and the particular roasted sesame flavor improves taste of fried products. African countries use the seeds as spice, seed oil, frying vegetables and meat, eaten raw or fried, and used in confections such as candy and baking. Sesame honey bits are made by combining hulled sesame seed with honey from a cactus flower in Mexico (Dipasa). Additional products sold in US grocery and health food stores with sesame seed as an ingredient include sesame crackers, honey puffed kashi seven whole grains and sesame cereal, sesame blues chips, unhulled sesame seed, and sesame seed candy. Many recipes contain sesame seeds as an ingredient such as sesame seed sprouts, sesame spread, tangerine and sesame, sesame seed cookies, hummus, sesame seed bagels, sesame granola, sesame broccoli rice, sesame mustard sauce, ginger sesame chicken, sesame pastry, sesame seed sauce, and sesame green beans (Home Cooking 1998). Sesame meal is excellent feed for poultry and livestock (Oplinger et al. 1990).

Several industrial uses have been identified in sesame (Table 3). African people have used sesame to prepare perfumes (The Nut factory 1999) and cologne has been made from sesame flowers. Myristic acid (C14:0) is used as an ingredient in cosmetics. Sesamin has bactericide and insecticide activities plus it also acts as an antioxidant which can inhibit the absorption of cholesterol and the production of cholesterol in the liver (Home Cooking 1998). Sesamolin also has insecticidal properties (Beckstrom-Sternberg and Duke 1994) and is used as a synergist for pyrethrum insecticides (Simon et al. 1984). Sesame oil is used as a solvent, oleaginous vehicle for drugs, skin softener, and used in the manufacture of margarine and soap (Dark 1998). Chlorosessamone obtained from roots of sesame has antifungal activity (Begum et al. 2000).

NUTRACEUTICAL AND PHARMACEUTICAL USES

Many nutraceutical uses have been discovered from sesame (Table 3). Sesame lignans have antioxidant and health promoting activities (Kato et al. 1998). High amounts of both sesamin and sesamolin have been identified in sesame (Sirato-Yasumoto et al. 2001). Both

Table 2. Sesame food uses.

Food	Country
Sesame cakes, wine, and brandy	Biblical Babylon
Bread stick, cracker	Worldwide
Salad and cooking oil	Worldwide
Roasted seed	India
Substitute for olive oil	Europe
On bread	Sicily
Cakes	Greece
Soup, spice, seed oil	Africa
Salad and fish oil	Japan
Confectionery	China
Sesame seed buns, chips	United States

sesamin and sesamolin were reported to increase both the hepatic mitochondrial and the peroxisomal fatty acid oxidation rate. Sesame seed consumption appears to increase plasma gamma-tocopherol and enhanced vitamin E activity which are believed to prevent cancer and heart disease (Cooney et al. 2001). Sesamin remained at 90% of the original level after roasting (Abe et al. 2001). Cephalin from sesame seed has hemostat activity and ranges from 133,168 to 233,856 ppm (Beckstrom-Sternberg et al. 1994a). Historically, fiber is used as an antidiabetic, anti-tumor, antiulcer, cancer preventive, cardioprotective, and laxative. Fiber ranges from 27,100 ppm to 67,000 ppm in the seed with up to 166,000 ppm in the leaf. (Beckstrom-Sternberg et al. 1994a). Sesame seed contains lecithin which has antioxidant and hepatoprotective activity and ranges from 58 ppm to 395 ppm (Beckstrom-Sternberg et al. 1994a). Lecithin is also likely effective for reducing hepatic steatosis in long term parenteral nutrition patients and a successful treatment for dermatitis and dry skin (Jellin et al. 2000).

Several pharmaceutical uses have been identified from sesame (Table 3). Myristic acid also has cancer preventive capability and is found in sesame seed ranging from 328 to 1,728 ppm (Beckstrom-Sternberg et al. 1994a).

Sesame oil is a pharmaceutical aid used as a solvent for intramuscular injections and has nutritive, demulcent, and emollient properties (Tyler et al. 1976) and has been used as a laxative (Dark 1998). The oil was used during the 4th century by the Chinese as a remedy for toothaches and gum disease. Sesame oil is known to reduce cholesterol due to the high polyunsaturated fat content in the oil. Other uses include the treatment of blurred vision, dizziness, and headaches. The Indians have used sesame oil as an antibacterial mouthwash, to relieve anxiety and insomnia (Annussek 2001). A recent clinical trial proved that sesame oil was significantly more effective for treating nasal mucosa dryness due to a dry winter climate than isotonic sodium chloride solution (Johnson et al. 2001). In addition, sesame oil contains large amounts of linoleate in triglyceride

Table 3. Sesame industrial, nutraceutical, and pharmaceutical uses.

Use	Phytochemical
Industrial	
Antifungal	Chlorosesamone
Bactericide, insecticide	Sesamin, sesamolin
Cosmetics	Myristic acid
Solvent, soap	
Nutraceutical	
Antioxidant, hepatoprotective	Lecithin
Cancer preventive	Myristic acid
Cancer preventive, cardioprotective	Fiber
Fatty acid oxidation, antioxidant	Sesamin, sesamolin
Prevent heart disease	Sesame oil
Skin softener	
Pharmaceutical uses	
Drug vehicle and laxative	Sesame oil
Hypoglycaemic activity	Flavonoids
Inhibit malignant melanoma	Linoleate in triglyceride form

Table 4. Sesame ethnobotanical uses.

Use	Country
Cancer	Germany
Cold	Dominican Republic
Colic	Haiti
Constipation, head cold, impotency, laxative, tonic, malaria, cold preventive, cancer, diarrhea, sore, venereal, wart	China
Cough	Venezuela
Dysentery, laxative	Turkey
Laxative	Mexico
Tonic	Malaya
Tumor	India

form which selectively inhibited malignant melanoma growth (Smith and Salerno 2001). See Table 4 for additional ethnobotanical uses (Beckstrom-Sternberg et al. 1994).

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