

Chapter 4

Source, Name of Marker Compounds and Their Chemical Nature, Medicinal Uses and Health Benefits of Following Used as Nutraceuticals/Functional Foods-II

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ABSTRACT

This section of Nutraceuticals-II explores the nutraceutical and functional food applications of Garlic, Broccoli, Ginkgo, and Flaxseeds, focusing on their source, marker compounds, chemical nature, medicinal uses, and health benefits. Garlic, derived from *Allium sativum*, is rich in allicin, a sulfur-containing compound with potent antioxidant and antimicrobial properties, known for its cardiovascular benefits, including lowering blood pressure and cholesterol levels. Broccoli, a cruciferous vegetable, contains sulforaphane, a sulfur-rich compound that supports detoxification processes and offers protective effects against cancer. Ginkgo, sourced from *Ginkgo biloba* leaves, is known for its flavonoid glycosides and terpenoids, which enhance cognitive function and improve blood circulation. Flaxseeds are high in alpha-linolenic acid (ALA), an omega-3 fatty acid, and lignans, both of which contribute to heart health, anti-inflammatory effects, and hormonal balance. This study provides a comprehensive understanding of how these natural substances contribute to overall health, emphasizing their importance in disease prevention and health promotion.

GARLIC

Garlic (*Allium sativum*) is a widely used culinary herb with a long history of medicinal use. It's known for its potential health benefits and is often included in functional foods and dietary supplements. Here's a detailed overview of garlic functional foods, including their source, marker compounds, medicinal uses, and health benefits:

1. Source

- a. **Source:** Garlic is a bulbous plant belonging to the Allium family, which also includes onions, leeks, and chives. It is cultivated globally and used in various cuisines for its distinctive flavor and medicinal properties. The medicinal part of the plant is the bulb, which is consumed raw, cooked, or in supplement form.

2. Marker Compounds and Their Chemical Nature

a. Allicin

- **Chemical Nature:** Allicin is a sulfur-containing compound formed from the enzyme alliinase acting on alliin, a sulfur-containing precursor in garlic. It is known for its strong aroma and biological activity.
- **Marker Compound:** Allicin is the primary active compound in garlic, contributing to its medicinal properties.

b. Alliin

- **Chemical Nature:** Alliin is a sulfur-containing compound that converts to allicin when garlic is crushed or chopped. It has antimicrobial and antioxidant properties.
- **Marker Compound:** Alliin is a key precursor to allicin.

c. Ajoene

- **Chemical Nature:** Ajoene is a sulfur compound derived from allicin through chemical reactions. It is known for its anti-platelet and anticoagulant effects.
- **Marker Compound:** Ajoene is significant for its cardiovascular benefits.

d. Diallyl Sulfide

- **Chemical Nature:** Diallyl sulfide is a sulfur compound with a pungent odor, contributing to garlic's health benefits.
- **Marker Compound:** It has antioxidant and anti-inflammatory properties.

e. S-Allylcysteine (SAC)

- **Chemical Nature:** S-Allylcysteine is a sulfur-containing amino acid derivative with antioxidant and anti-cancer properties.
- **Marker Compound:** SAC is notable for its potential role in cancer prevention and cellular protection.

f. Fructans

- **Chemical Nature:** Fructans are polysaccharides made up of fructose units. They act as prebiotics, promoting the growth of beneficial gut bacteria.
- **Marker Compound:** Fructans contribute to digestive health.

3. Medicinal Uses and Health Benefits

a. Cardiovascular Health

- **Benefit:** Garlic has been shown to lower blood pressure, reduce LDL cholesterol levels, and improve overall heart health. Allicin and diallyl sulfide are key compounds contributing to these effects by promoting vasodilation and reducing platelet aggregation.

b. Anti-Inflammatory Effects

- **Benefit:** Garlic's sulfur compounds, including allicin and ajoene, have anti-inflammatory properties that can help reduce inflammation in the body, potentially benefiting conditions like arthritis and asthma.

c. Antioxidant Properties

- **Benefit:** Garlic contains antioxidants such as diallyl sulfide and S-allylcysteine, which help protect cells from oxidative stress and free radical damage, thereby reducing the risk of chronic diseases.

d. Immune System Support

- **Benefit:** Garlic boosts the immune system by enhancing the activity of immune cells and increasing the production of important immune compounds, such as cytokines and antibodies.

e. Antimicrobial and Antiviral Properties

- **Benefit:** Garlic exhibits antimicrobial and antiviral effects due to compounds like allicin, which can help combat infections and improve overall immune defense.

f. Cancer Prevention

- **Benefit:** Research suggests that garlic may reduce the risk of certain cancers, including stomach, colon, and prostate cancers. Its sulfur compounds may help inhibit cancer cell growth and induce apoptosis (programmed cell death).

g. Digestive Health

- **Benefit:** Garlic's prebiotic fructans support gut health by promoting the growth of beneficial gut bacteria, improving digestion, and enhancing overall gastrointestinal function.

h. Detoxification

- **Benefit:** Garlic aids in detoxifying the body by enhancing liver function and promoting the elimination of toxins and heavy metals.

i. Blood Sugar Regulation

- **Benefit:** Some studies suggest that garlic may help regulate blood sugar levels and improve insulin sensitivity, making it beneficial for managing diabetes.

4. Usage and Dosage

- a. Forms:** Garlic is available in various forms, including raw cloves, powdered supplements, garlic oil, and aged garlic extracts. Each form may have different levels of active compounds and health benefits.
- b. Typical Dosage:** For general health benefits, consuming 1-2 cloves of raw garlic per day or taking a garlic supplement (typically 600-1,200 mg of standardized garlic extract) is common. However, dosage can vary based on the form and individual health needs.

5. Safety and Considerations

- a. Safety:** Garlic is generally safe for most people when consumed in moderate amounts. However, it can cause gastrointestinal discomfort, bad breath, and allergic reactions in some individuals. High doses or concentrated supplements may interact with certain medications, such as blood thinners.

- b. Consultation:** It's advisable to consult with a healthcare provider before starting garlic supplements, especially for individuals with existing health conditions or those taking medications.

Garlic functional foods offer a wide range of potential health benefits due to their rich content of bioactive compounds. Incorporating garlic into your diet can support overall health and well-being while providing both culinary and medicinal advantages.

BROCCOLI

Broccoli (*Brassica oleracea var. italica*) is a cruciferous vegetable renowned for its nutritional and medicinal properties. It is a popular functional food due to its high content of bioactive compounds with potential health benefits. Here's a detailed overview of broccoli functional foods, including their source, marker compounds, medicinal uses, and health benefits:

1. Source

- a. Source:** Broccoli is a member of the Brassicaceae family, which includes other cruciferous vegetables like cabbage, cauliflower, and Brussels sprouts. It is cultivated worldwide and is consumed fresh, cooked, or as part of various processed foods and supplements.

2. Marker Compounds and Their Chemical Nature

a. Glucosinolates

- **Chemical Nature:** Glucosinolates are sulfur-containing compounds that can be converted into biologically active products upon enzymatic hydrolysis. They include several types, such as sulforaphane, indole-3-carbinol, and erucin.
- **Marker Compounds**
 - **Sulforaphane:** A potent isothiocyanate derived from glucoraphanin.
 - **Indole-3-Carbinol (I3C):** A product of the breakdown of glucobrassicin.

b. Sulforaphane

- **Chemical Nature:** Sulforaphane is an isothiocyanate formed from the glucosinolate glucoraphanin. It has strong antioxidant and anti-inflammatory properties.
- **Marker Compound:** Sulforaphane is noted for its role in detoxification and cancer prevention.

c. Indole-3-Carbinol (I3C)

- **Chemical Nature:** I3C is a compound formed from the breakdown of glucobrassicin. It has been studied for its effects on estrogen metabolism and cancer prevention.
- **Marker Compound:** I3C is significant for its potential role in hormone-related cancer prevention.

d. Vitamin C

- **Chemical Nature:** Vitamin C (ascorbic acid) is a water-soluble vitamin with antioxidant properties.
- **Marker Compound:** Vitamin C in broccoli supports immune function and acts as an antioxidant.

e. Vitamin K

- **Chemical Nature:** Vitamin K is a fat-soluble vitamin essential for blood clotting and bone health.
- **Marker Compound:** Vitamin K1 (phylloquinone) is found in high concentrations in broccoli.

f. Fiber

- **Chemical Nature:** Broccoli contains dietary fiber, including soluble and insoluble fibers that aid in digestion and overall gut health.
- **Marker Compound:** Dietary fiber in broccoli contributes to its health benefits.

g. Carotenoids

- **Chemical Nature:** Carotenoids are pigments with antioxidant properties. Key carotenoids in broccoli include lutein and zeaxanthin.
- **Marker Compounds:** Lutein and zeaxanthin are associated with eye health.

h. Flavonoids

- **Chemical Nature:** Flavonoids are polyphenolic compounds with antioxidant and anti-inflammatory effects.
- **Marker Compounds:** Quercetin and kaempferol are notable flavonoids in broccoli.

3. Medicinal Uses and Health Benefits

a. Cancer Prevention

- **Benefit:** Glucosinolates, particularly sulforaphane and indole-3-carbinol, have been shown to reduce the risk of various cancers by promoting detoxification, inhibiting cancer cell growth, and inducing apoptosis (programmed cell death).

b. Antioxidant Properties

- **Benefit:** Broccoli's high content of antioxidants, including sulforaphane, vitamin C, and carotenoids, helps neutralize free radicals, reducing oxidative stress and the risk of chronic diseases.

c. Anti-Inflammatory Effects

- **Benefit:** Sulforaphane and flavonoids in broccoli have anti-inflammatory properties, which can help reduce inflammation and may benefit conditions such as arthritis and cardiovascular disease.

d. Immune System Support

- **Benefit:** Vitamin C in broccoli supports immune function by enhancing the activity of immune cells and increasing the production of antibodies.

e. Digestive Health

- **Benefit:** The dietary fiber in broccoli promotes healthy digestion, supports regular bowel movements, and contributes to gut health.

f. Cardiovascular Health

- **Benefit:** Broccoli's fiber, antioxidants, and anti-inflammatory compounds contribute to heart health by improving blood vessel function, reducing blood pressure, and lowering cholesterol levels.

g. Bone Health

- **Benefit:** Vitamin K and calcium in broccoli support bone health by aiding in bone mineralization and reducing the risk of osteoporosis.

h. Eye Health

- **Benefit:** Carotenoids such as lutein and zeaxanthin in broccoli support eye health by protecting against age-related macular degeneration and cataracts.

i. Detoxification

- **Benefit:** Sulforaphane and other compounds in broccoli enhance liver function and promote the elimination of toxins from the body.

4. Usage and Dosage

- Forms:** Broccoli can be consumed fresh, steamed, boiled, or roasted. It is also available in powdered form as a dietary supplement.
- Typical Dosage:** Incorporating 1-2 servings of broccoli (approximately 1 cup of cooked broccoli) into the diet daily provides significant health benefits. For supplements, follow the recommended dosage on the product label or consult a healthcare provider.

5. Safety and Considerations

- Safety:** Broccoli is generally safe for most people when consumed as part of a balanced diet. However, excessive consumption of raw broccoli may cause digestive discomfort in some individuals due to its high fiber content.
- Consultation:** If you have specific health conditions or are on medication, consult with a healthcare provider to ensure that broccoli or broccoli supplements are appropriate for you.

Broccoli functional foods offer a wide range of health benefits due to their rich content of bioactive compounds. Regular consumption of broccoli can support overall health and well-being, providing both nutritional and therapeutic advantages.

GINGKO

Ginkgo biloba, commonly known as ginkgo, is one of the oldest living tree species and has been used in traditional medicine for centuries. Its leaves are the primary source of active compounds used in functional foods and supplements. Here's a detailed overview of ginkgo functional foods, including their source, marker compounds, medicinal uses, and health benefits:

1. Source

- a. **Source:** Ginkgo biloba is a deciduous tree native to China, with distinctive fan-shaped leaves. The medicinal parts used are the dried green leaves, which are processed to extract various active compounds for functional foods and supplements.

2. Marker Compounds and Their Chemical Nature

a. Ginkgo Flavonoid Glycosides

- **Chemical Nature:** Flavonoid glycosides are plant-derived compounds with antioxidant properties. They include various flavonoid aglycones linked to sugar moieties.
- **Marker Compounds:** Key flavonoid glycosides in ginkgo include quercetin, kaempferol, and isorhamnetin.

b. Ginkgolides

- **Chemical Nature:** Ginkgolides are unique diterpene lactones found in ginkgo leaves. They have anti-inflammatory and neuroprotective properties.
- **Marker Compounds:** Notable ginkgolides include ginkgolide A, B, C, and J.

c. Bilobalide

- **Chemical Nature:** Bilobalide is a sesquiterpene lactone found in ginkgo that has neuroprotective and antioxidant effects.
- **Marker Compound:** Bilobalide is significant for its role in cognitive health and protection against oxidative stress.

3. Medicinal Uses and Health Benefits

a. Cognitive Function and Memory

- **Benefit:** Ginkgo is widely used to enhance cognitive function and improve memory, particularly in older adults. Ginkgo flavonoid glycosides and ginkgolides are believed to improve blood flow to the brain, support neuronal health, and enhance cognitive performance.

b. Circulatory Health

- **Benefit:** Ginkgo can improve circulation by dilating blood vessels and reducing blood viscosity. This can help with conditions like peripheral artery disease and improve overall cardiovascular health.

c. Antioxidant Properties

- **Benefit:** The flavonoid glycosides and bilobalide in ginkgo have strong antioxidant effects, helping to neutralize free radicals and reduce oxidative stress, which may protect against chronic diseases.

d. Anti-Inflammatory Effects

- **Benefit:** Ginkgolides and other compounds in ginkgo have anti-inflammatory properties that may help reduce inflammation and support conditions such as arthritis and other inflammatory diseases.

e. Anxiety and Depression

- **Benefit:** Some studies suggest that ginkgo may help alleviate symptoms of anxiety and depression by improving brain function and reducing oxidative stress.

f. Tinnitus and Vertigo

- **Benefit:** Ginkgo may be used to manage tinnitus (ringing in the ears) and vertigo (dizziness) by improving blood flow to the inner ear and brain, which can help alleviate these symptoms.

g. Eye Health

- **Benefit:** Ginkgo's antioxidant and circulatory benefits may support eye health by improving blood flow to the eyes and reducing the risk of age-related macular degeneration and glaucoma.

h. Mental Alertness

- **Benefit:** Ginkgo is often used to support overall mental alertness and reduce cognitive decline associated with aging.

4. Usage and Dosage

- a. Forms:** Ginkgo is available in various forms, including dried leaf extracts, capsules, tablets, teas, and tinctures.
- b. Typical Dosage:** For general cognitive support and circulatory benefits, a common dosage is 120-240 mg of standardized ginkgo extract per day, usually divided into two or three doses. The extract should be standardized to contain 24% ginkgo flavonoid glycosides and 6% ginkgolides.

5. Safety and Considerations

- a. Safety:** Ginkgo is generally considered safe when used at recommended dosages. However, it can cause side effects such as gastrointestinal discomfort, headaches, and allergic skin reactions. High doses may increase the risk of bleeding, especially if taken with anticoagulant medications.
- b. Consultation:** It is advisable to consult with a healthcare provider before starting ginkgo supplements, particularly if you have a bleeding disorder, are on blood-thinning medications, or have other health conditions.

Ginkgo functional foods offer a range of potential health benefits due to their unique combination of bioactive compounds. Regular consumption of ginkgo can support cognitive function, cardiovascular health, and overall well-being.

FLAXSEEDS

Flaxseeds (*Linum usitatissimum*) are highly valued for their nutritional content and health benefits. They are a rich source of omega-3 fatty acids, fiber, and various bioactive compounds. Here's a detailed overview of flaxseeds functional foods, including their source, marker compounds, medicinal uses, and health benefits:

1. Source

- a. **Source:** Flaxseeds come from the flax plant, which is cultivated primarily in regions with temperate climates. The seeds are harvested from the plant's fruit and can be consumed whole, ground, or in oil form.

2. Marker Compounds and Their Chemical Nature

a. Alpha-Linolenic Acid (ALA)

- **Chemical Nature:** ALA is an omega-3 fatty acid that is essential for human health. It is a polyunsaturated fat with a chemical structure consisting of 18 carbon atoms and 3 double bonds.
- **Marker Compound:** ALA is one of the primary bioactive compounds in flaxseeds and contributes to their cardiovascular and anti-inflammatory benefits.

b. Lignans

- **Chemical Nature:** Lignans are a group of polyphenolic compounds that have antioxidant and estrogenic properties. They are metabolized by gut bacteria into enterolignans.
- **Marker Compounds:** Notable lignans in flaxseeds include secoisolariciresinol diglucoside (SDG) and its metabolites, enterodiol and enterolactone.

c. Fiber

- **Chemical Nature:** Flaxseeds are rich in both soluble and insoluble dietary fiber. Soluble fiber forms gels in the digestive tract, while insoluble fiber aids in bowel regularity.
- **Marker Compounds:** The fiber content contributes to digestive health and helps in regulating blood sugar levels.

d. Protein

- **Chemical Nature:** Flaxseeds contain high-quality plant protein with a balanced amino acid profile.
- **Marker Compounds:** Flaxseed protein supports muscle health and overall nutritional balance.

e. Phytosterols

- **Chemical Nature:** Phytosterols are plant-derived sterols that resemble cholesterol and help reduce cholesterol absorption in the gut.
- **Marker Compounds:** Includes beta-sitosterol, campesterol, and stigmasterol.

3. Medicinal Uses and Health Benefits

a. Cardiovascular Health

- **Benefit:** ALA, the omega-3 fatty acid in flaxseeds, helps reduce inflammation, lower blood pressure, and improve lipid profiles. It contributes to reduced risk of cardiovascular diseases such as heart attack and stroke.

b. Digestive Health

- **Benefit:** The high fiber content in flaxseeds promotes regular bowel movements, helps prevent constipation, and supports overall gastrointestinal health.

c. Anti-Inflammatory Effects

- **Benefit:** ALA and lignans have anti-inflammatory properties that can help manage chronic inflammatory conditions such as arthritis and inflammatory bowel disease.

d. Hormonal Balance

- **Benefit:** Lignans have estrogenic effects and may help balance hormones, potentially reducing symptoms of menopause and lowering the risk of hormone-related cancers like breast and prostate cancer.

e. Cancer Prevention

- **Benefit:** Lignans and ALA are associated with protective effects against certain types of cancer. They may help inhibit cancer cell growth and reduce the risk of developing cancer.

f. Blood Sugar Regulation

- **Benefit:** Flaxseeds may help regulate blood sugar levels and improve insulin sensitivity, making them beneficial for individuals with diabetes or those at risk of developing diabetes.

g. Skin Health

- **Benefit:** The omega-3 fatty acids and antioxidants in flaxseeds contribute to healthy skin by reducing inflammation and improving skin hydration and elasticity.

h. Weight Management

- **Benefit:** The fiber and protein content in flaxseeds can aid in weight management by promoting satiety and reducing overall calorie intake.

4. Usage and Dosage

a. **Forms:** Flaxseeds can be consumed in various forms, including whole seeds, ground flaxseed (flaxseed meal), flaxseed oil, and flaxseed supplements. Ground flaxseeds are more easily digested and provide better nutrient absorption compared to whole seeds.

b. **Typical Dosage:** A common dosage is 1-2 tablespoons of ground flaxseeds per day, or 1-2 teaspoons of flaxseed oil. The dosage may vary based on individual health needs and specific products.

5. Safety and Considerations

- a. Safety:** Flaxseeds are generally safe for most people when consumed in moderate amounts as part of a balanced diet. However, excessive consumption of flaxseeds or flaxseed oil may lead to gastrointestinal issues, such as bloating or diarrhea.
- b. Consultation:** Individuals with certain health conditions, particularly those with hormone-sensitive cancers or those on medications that affect blood clotting, should consult with a healthcare provider before incorporating large amounts of flaxseeds into their diet.

Flaxseeds are a versatile functional food with a range of potential health benefits due to their rich content of bioactive compounds. Including flaxseeds in your diet can support cardiovascular health, digestive function, hormonal balance, and overall well-being.