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Review Article

Bioactive Profile and Health Claims of *Ginkgo biloba*

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ABSTRACT

Ginkgo biloba also known as 'maidenhair tree' is a therapeutic herbal medicine consumed by people around the globe and is commonly used to treat neurological and cardiovascular disorders as well as neurological illnesses such as Alzheimer's disease, dementia, and cognitive impairment. As it is rich in vitamins and has a number of bioactive compounds which are helpful in treating many health-related issues. This review aims to cover the beneficial side of *Ginkgo biloba* like its pharmacological effects, antidiabetic effects, anti-inflammatory effects, and its role in treating diseases.

INTRODUCTION

Herbal medicines have been utilized for over a thousand years and are one of the most promising sources of new pharmaceuticals. Ginkgo biloba is a living fossil and medicinal herbal medicine that has astounded scientists across the world with its vast array of bioactive chemicals. The name Ginkgo biloba comes from the Japanese word Yin-Kwo, which means silver fruit. The leaves of the Ginkgo biloba plant have a bilobed form, and the shape and veins of the leaves resemble those of the maidenhair fern, hence it's also known as maidenhair tree. The species is often used to treat central nervous system disorders like Alzheimer's disease, dementia, and cognitive impairment [1]. Ginkgo biloba is a living fossil and one of the oldest plants on the planet. The ginkgo tree thrived throughout the Mesozoic era 150 million years ago, and the Ginkgo biloba plant attained its greatest growth during the Jurassic and Cretaceous periods of history [2]. In Asia, Europe, North America, and Argentina, ginkgo trees are now widely planted. Ginkgo leaf extract has been widely utilised in herbal medicine products, food and dietary supplements, botanical and complementary therapies, and has a long history of use in Chinese medicine [3]. The Ginkgo biloba

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plant contains a variety of bioactive chemicals, including terpenoids (ginkgolides and bilobalides), flavonoids (quercetin, kaempferol, isorhamnetin), bioflavonoids (ginkgetin, isoginkgetin, sciadopitysin), and organic acids (ginkgolic acid). Vitamin C, riboflavin, carbs, and other nutrients are found in Ginkgo biloba seeds. Ginkgo nuts are a kind of nut that offers a variety of health advantages, including anti-cancer characteristics and impacts on neurological dysfunction [4]. Ginkgo biloba seeds are a classic delicacy that may be used in a variety of sweets, glazed fruits, and drinks. Using various cooking processes, ginkgo biloba seeds may be converted into hundreds of dishes and sweets. The most popular ginkgo recipes in China include ginkgo stewed chicken, ginkgo steamed egg, and boiled or roasted ginkgo. Because ginkgolic acids might trigger allergic responses, Ginkgo biloba seed nuts should not be consumed on a regular basis. To lessen the toxicity of Ginkgo biloba seed nut, many processing procedures are applied. Boiling, baking, and microwave processing can significantly minimize ginkgo seed nut toxicity [5]. Ginkgo biloba EGb761 extract is commonly used to treat neurological and cardiovascular problems [6]. Ginkgo biloba is the most commonly traded medicinal plant; it was originally grown mostly in China, Japan, and Korea, but it is now widely grown in Europe, America, and temperate New Zealand, Argentina, and India. The last wild Ginkgo biloba tree was discovered in Zhejiang, China, and according to the International Union for Conservation of Nature and Natural Resources, there are just a few wild types of Ginkgo biloba trees extant, making it a rare medicinal plant [7].

Morphology of *Ginkgo biloba* Plant:

The *Ginkgo biloba* plant is sporophytic, means this type of plants don't have chlorophyll and obtains food from dead and decay matter such as fungi. The configuration of *Ginkgo biloba* tree is in ex-current manner and can reach the heights of approximately 30 meters. The branches of Ginkgo biloba trees are unique in that they have both short and dwarf branches that develop at different rates. A dwarf sprout can be several years old and be 2-3 cm in length. Ginkgo biloba leaves are yellow, light, and dark green in hue. The Ginkgo biloba tree has long and short branches with different characteristics; the leaves grow alternately on the long branches and are fan-shaped, lathery, and smooth in appearance in the spring. The *Ginkgo biloba* tree is 30 to 40m long and it is columnar in shape, and the female *Ginkgo biloba* tree produces small oval shape fleshy fruit and its size resembles with small Chinese date, and when this small fruit matures its turns into pale color, and its outer covering is known as sarcotesta [8]. The mature Ginkgo biloba seeds are relatively large in size and immersed in the tissue of the female gametophyte, which is surrounded by a thick seed coat made up of three layers: the first layer is soft and fleshy and is also known as the outer layer, the middle layer is hard and stony, and the inner layer is thin and membranous. outer soft and fleshy layer is known as the ginkgo nut [9]. In comparison to Ginkgo biloba leaves, the ginkgo nut has been widely used for a longer time; It has been used as a food and medicinal all across the world since 1350, when it was first described in herbals [10]. Ginkgo nuts are used as a meal and offer a variety of health advantages, including anticancer characteristics and impacts on neurological dysfunction. Ginkgo biloba seeds are a classic delicacy that may be used in a variety of sweets, glazed fruits, and drinks. Using various cooking processes, ginkgo biloba seeds may be converted into hundreds of dishes and sweets.

Nutritional Profile of Ginkgo Biloba Seeds:

Ginkgo biloba contains many bioactive compounds and constituents but according to different analysis these contents differs slightly.

Ginkgo biloba seeds include nutrients and bioactive substances.	Ginkgo biloba seeds contain what percentage of nutrients and bioactive compounds
Carbohydrates,	Dry weight 35 to 72.6%
Protein,	9 to 13%
Fat	2.4%

Table 1: shows proximate analysis of ginkgo biloba seeds [11, 12]

The most prevalent carbohydrate in Ginkgo biloba seeds is starch. Carbohydrate content in Ginkgo biloba seeds ranges from 35 to 72.6 percent. Ginkgo biloba starch is a resistant starch that takes a long time to breakdown. The proportions of amylose and pectin in different Ginkgo biloba cultivars vary. Standard commercial maize starch is more resistant to pancreatic amylase hydrolysis and acid hydrolysis than starch isolated from ripe Ginkgo biloba seeds [13]. The size of starch granules extracted from ginkgo seed nuts vary depending on harvesting conditions and time. The protein composition of Ginkgo biloba seeds ranges from 9 to 13 percent dry mass, with albumin protein, globulin protein, and salt-soluble protein accounting for the bulk of the protein content, with prolamin, alkali soluble protein, and complex protein accounting for the remainder. Many researches have been undertaken in attempt to modify these proteins' favorable health effects [14] Ginkgo biloba seeds also contain a 13-kDa antifungal protein [15] that inhibits the growth of various fungi, including Candida albicans, Trichoderma reesei, and Fusarium oxysporum, but not Escherichia coli [16]. Antifungal protein from Ginkgo biloba seeds is a high-quality protein with good antioxidant characteristics [17]. Ginkgo biloba seed proteins globulin and albumin have anti-oxidant properties [18]. The antioxidant potential of these proteins is

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influenced by the amino acid residue species, such as sulfhydryl content or antioxidase enzyme activity. G4b protein, a new protein isolated from Ginkgo biloba seeds, has high antioxidant properties and contains sulphur and aromatic amino acids, both of which have antioxidant action [19]. When an amino acid polypeptide chain is enzymatically digested, the protein takes on a variety of biological functions [20]. The enzymes alkali protease and pepsin are used to hydrolyze these antioxidant peptides from Ginkgo biloba seed. These antioxidant peptides have strong free radical scavenging properties and also reduce linoleic acid autooxidation. The bioactivity of ginkgo seed protein has been demonstrated to be good, suggesting that it might be employed as a food additive. Ginkgo biloba seeds also contain Polysaccharides, but according to various reports, these Polysaccharides are uncommon. Ginkgo biloba seeds contain roughly 0.9 percent polysaccharides, which have a molecular weight of about 186kDa and are fully made up of single sugar class D mannose [21]. In 2006, Fan et al. [22] used ultrasonic processing to improve the technology of extracting Polysaccharides from Ginkgo biloba seeds. The Polysaccharides ratio increased 2.0 percent, and the purity rose to 88.7%, using this method. Ginkgo seed polysaccharides have the capacity to induce apoptosis in SMMC-7721 cells. The microvilli of this cell become thinner and the number of microvilli rises after treatment with Ginkgo seed polysaccharide s, and apoptotic bodies form on these spherical cells.

Ginkgo seed oil	Unsaturated fatty acids
Linoleic acid	40.4 to 42.9%
Oleicacid	35 to 36.9%
Palmitic acid	5.7 to 6.7%
Palmitoleic acid	3.2 to 3.9%
Linolenic acid	1.7 to 5.5%
Stearic acid	0.9 to 1.3%

Table 2: Ginkgo seed oil also has a lot of unsaturated fatty acids in it.[23].

Flavonoids present in *Ginkgo biloba* seeds:

Flavonoids are bioactive chemicals found in ginkgo that have anti-inflammatory, anti-tumor, anti-fungal, and neuroprotective effects. When compared to Ginkgo biloba seeds, Gingko biloba leaf extract generally has a flavonoid content of more than 24 percent [24]. Over 70 flavonoids have been discovered to date [26]. Flavonoids have low bioavailability because of low absorption and quick elimination from the body, Flavonoids in glycosidic form is inadequately absorbed in the intestine only in the form of aglycone they are directly absorbed in the intestine [27]. Flavonoids are absorbed and then transported to the liver where they are to conjugated derivatives [28]. Although several investigations have been done on flavonol glycosides from Ginkgo a few studies have proved it may be extracted from the seeds using ultrasonic and flash extractors. [29, 30]. 0.07 percent to 0.2 percent. Biflavones have a variety of medicinal characteristics, including neuroprotective, anticancer, and anti-inflammatory activities [31-34], The neuroprotective effects of biflavonoids on cell death in brain cells caused by oxidative stress and amyloid peptide were examined. Ginkgetin, amentoflavone, and isoginkgetin, all contained in Ginkgo biloba seeds, were found to have a substantial neuroprotective impact against cytotoxic shocks in a study of nine bioflavonoids.

***Ginkgo biloba* phytoconstituents and their potential characteristics**: *Gingko biloba* seed nut contains several bioactive compounds and phytochemicals that exerts beneficial effect on health. These includes terpenoids (ginkgolide and bilobalide), alkyl salicylicacid derivatives (alkyl phenols or alkyl phenolic acids), flavonoids (apigenin, quercetin and kaempferol), ginkgotoxins, plant hormones such as cytokine like components, asparagine and gibberellin [35]. The principal ingredients are ginkgolide A, B, and C, as well as bilobalides. Ginkgolide may be categorised into five forms (Ginkgolide A, B, C, J, and M), all of which have the same molecular geometrical structure but differ in the location of the hydroxyl group [36]. Ginkgolide A, B, and C, as well as bilobalide, have been shown to increase circulatory perfusion, inhibit platelet activating factor, offer neuroprotection, and stimulate cognition. Flavone glycosides may have antioxidant capabilities as well as anti-platelet aggregation properties [37]. The EGb761 is a standardised Ginkgo biloba leaf extract that includes 24 percent flavanol glycosides, 6 percent terpenoids, 5 to 10% organic acids, and other beneficial components for general health. In addition, the Ginkgo leaf contains 6% lactones and 24% flavonoids. Ginkgo biloba's main bioactive ingredients include allylphenols, bioflavonoids, and ginkgolic acids. Ginkgo also includes Ginkgotoxin, which is structurally similar to vitamin B6 [38] Ginkgo toxins are also known as vitamin B6 analogues [39], with 4-pyridoxic acid, pyridoxamine, pyridoxal, pyridoxin (vitamin B6), methyl pyridoxine 5phosphate, and methyl pyridoxine 5 glycosides among the analogues. When the levels of various Ginkgo biloba seeds were measured, it was shown that methyl pyridoxine 5 glycosides are the major component in Ginkgo biloba seeds, accounting for nearly 94 percent of the total vitamin B6 analogues. Ginkgo biloba contains 170 to 404 parts per million of methyl pyridoxine [40]. All of the phyto-constituents found in Ginkgo biloba seed have numerous beneficial properties. They are powerful antioxidants with

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the ability to scavenge free radicals, protecting body organs from oxidative damage and cancer. They are also antifungal, antimicrobial, and anti-inflammatory, protecting organs from harmful microorganisms [41].

Pharmacological Significance of *Gingko biloba:*

Ginkgo biloba has shown to increase the blood circulation specifically in the cerebral area of the brain, it also maintains vascular permeability, improves venous tone, provides relaxation to vascular smooth muscles and prevents them from constriction and thus improve vascular muscle function and blood flow, reduce blood clotting and also maintains blood pressure and decreases the secretion of stress hormones such as cortisol and corticotrophin [42,43]. All of these clinical effects of *Ginkgo biloba* are due to presence several bioactive compounds in it.

Antidiabetic effect of *Ginkgo biloba:* In diabetic mice there is accumulation of free radicals in the body because of increased oxidative stress which can cause oxidative stress and tissue damage *Ginkgo biloba* supplement is both anti-inflammatory and antioxidant abilities [44]. And the diabetic mice fed *Ginkgo biloba* supplement in addition to diet the level of inflammatory factors such as TNFα, interleukin-6, P65 decreases significantly in them this illustrate that the *Ginkgo biloba* supplements have radical scavenging and inflammation reducing properties [45]. The inflammatory factor secretion is important in insulin resistance because of the over secretion of these inflammatory factor TNFα, interleukin-6, P65 this inhibits the insulin receptor tyrosine kinase activity and causes insulin resistance, interleukin-6 is associated with glucose intolerance and type 2 diabetes mellitus [46].

CONCLUSION

Plant-based foods and supplements, botanicals and alternative medicine, cosmetics, and other goods are becoming increasingly popular throughout the world. Ginkgo biloba, sometimes referred to as a living fossil, is used in the three "cals," or cosmetics, nutraceuticals, and medicines (CNP). This tree is described as a "wonder tree with varied purposes" based on its stated uses and medicinal potential. The existence of ginkgolides and other bioactive substances in the tree, particularly its leaves, has demonstrated its efficiency in neuroprotection, cardio protection, and cancer protection; however, long-term usage and negative effects have yet to be studied. As a result, studying the long-term usage of these bioactive, particularly ginkgolides, will be beneficial in determining their mechanisms of protection and, if any, adverse effects. Because the number of Alzheimer's patients is rising, as is the number of patients with other brain disorders, using G. biloba to combat these health issues will be quite beneficial. However, its wild distribution is minimal, and only professionally cultivated trees are accessible. In such cases, it is critical to reintroduce the species to its original environment in order to assure its conservation while still allowing for its beneficial use.

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