

## A Brief Review on Pharmacological Potential of *Brassica oleracea* sprouts

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### ABSTRACT

Broccoli (*Brassica oleracea*) is an important vegetable crop of the family are essential to maintain quality. Glucosinolate levels mirror visual quality in broccoli as they generally decrease during post-harvest handling, with low temperatures (<4 °C) slowing the loss of both quality and glucosinolates. Glucosinolates content in broccoli florets declined by 82% after 5 days at 20 °C, but by only 31% at 4 °C. A high relative humidity (RH) of 98–100% is recommended to maintain post-harvest quality in broccoli. Controlled atmosphere (CA) storage is very effective in maintaining broccoli quality and can double post-harvest life. Ideal atmospheres to maintain quality were 1–2% O<sub>2</sub>; 5–10% CO<sub>2</sub> when temperatures were kept between 0 and 5 °C. Care needs to be taken that O<sub>2</sub> does not drop below 1% as this can cause the development of off-order. Broccoli is a vegetable with a high nutrient content in *Brassica oleracea*. It possesses a wide range of nutrients, including vitamins A and K, antioxidants, β-carotene, calcium, riboflavin, and iron, as well as phytochemicals such as phenols, flavonoids, glucosinolates, minerals, and selenium. The biological abilities of these defense-related secondary metabolites, such as their anti-diabetic, anti-carcinogenic, anti-inflammatory, and antioxidant activities, have been favorably connected. The anti-cancer and antioxidant properties of broccoli sprouts have drawn the most interest and have been the subject of substantial research in recent years.

**Key words:** Botanical description, Biological abilities, Controlled atmosphere storage, Chemical constituents, Phytochemical, Relative humidity.

About cauliflower, the history, and evolution of broccoli are examined, as well as how it has changed over time to include both annual and biennial varieties [1]. China and India produced the majority (19.7 million tonnes) of this vegetable in 2019, accounting for 73% of global output, while the United States, Spain, and Mexico each contributed about 1 million tonnes [2]. The bioactive chemicals found in broccoli are thought to be responsible for many of the vegetable's functional qualities. These include functions that regulate enzymes, cell cycles, apoptosis, antioxidant activity, and other processes [3].

Isothiocyanate, an organic phytochemical substance generated after glucosinolates were hydrolyzed by an enzyme, is one of broccoli's components that promotes health. In addition, broccoli contains minerals like iron,

zinc, and selenium, vitamins like ascorbic acid and tocopherol, and polyphenols like kaempferol and quercetin. These substances probably play a role in lowering the risk of degenerative illnesses including cancer and cardiovascular conditions [4, 5].

In addition to being a great source of fiber, broccoli also has a lot of other nutrients, including a lot of water (89%), carbs (6.27%), protein (2.57%), lipids (0.34%), ash (0.83%), and the aforementioned vitamins and minerals (1%). Despite the nutritional benefits of broccoli, people with developed palates prefer to consume it [6].

The sulfur-containing molecules are thought to produce a strong odor and unpleasant taste. However, these substances have demonstrated antitumor action [4]. Table 1 depicts the vernacular names of *Brassica oleracea* and Table 2 elaborates its taxonomical classification.

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**Table 1: Vernacular names of *Brassica oleracea* [7]**

Languages	Name
English	Broccoli
Sanskrit	Kapishank
Kannada	Kosugadde
Malayalam	Breakkeali
Hindi	Brokolee

**Table 2: Taxonomical classification of *Brassica oleracea* [7, 8]**

Kingdom	Plantae
Order	Brassicales
Family	Brassicaceae
Genus	Brassica
Species	<i>Brassica oleracea</i>

## HABITAT

*Brassica oleracea*, or broccoli, is a highly prized hardy biennial crop produced as a cool-season annual. Although broccoli may be grown in a variety of soil types, choosing the right soil unintentionally has an impact on how the plant grows. As porous and well-drained soil encourages higher root penetration, impacting broccoli development, sandy and silt loam soils with a pH range of 5.5–6.5 are often favoured for the growth of broccoli. A cool-weather crop, broccoli is ready for harvest before daily highs reach over 75°F [8]. The head is chopped with shears around 25 mm (1 in) from the tip. Broccoli should be plucked before the blossoms on the head bloom brilliant yellow [9].

## Distribution

Beginning in the northern Mediterranean region in the sixth century BC, land-race Brassica crops were crossed to produce broccoli. The Roman Empire produced early varieties of broccoli, which were later enhanced by artificial selection in Sicily or the southern Italian Peninsula. By the 18th century, broccoli had reached northern Europe, and Italian immigrants had brought it to North America in the previous century. The most widely used cultivars since then are "Premium Crop," "Pack-man," and "Marathon," which were created via the breeding of American and Japanese F1 hybrids during World War II to boost yields, quality, growth speed, and geographical adaptability [10, 11].

**Botanical Description:** The cabbage family's (family Brassicaceae, genus Brassica) enormous blooming head, stalk, and little accompanying leaves are all consumed as vegetables in the form of broccoli. Large, typically dark-green flower heads on a thick, typically light-green stalk are the distinguishing feature of broccoli. These flower heads are

arranged in a tree-like structure. Leafy bushes around the multitude of flower heads [12].

**Broccoli Buds:** The vegetable broccoli is a flower. A crown of broccoli has several small flower buds that have not yet blossomed or opened out. A bud is each of the little, green pieces of the crown. Before it blooms, broccoli is picked so that the little buds can be eaten. The adorable buds will eventually bloom into little yellow flowers [13].

**Broccoli Crown:** Broccoli develops on a sturdy, medium-height stem. It is cut at the base of the stalk when taken from fields or gardens. The portion that is left over is known as the broccoli's head or crown. The tops (heads) of the broccoli stem, which are made up of the florets, stem, and other components, are known as broccoli crowns. In essence, it is the entire stalk, excluding the actual stalk [13].

**Broccoli Florets:** It is a short segment of broccoli buds that have been cut off from the crown [13].

**Broccoli Leaf:** Compared to a typical head of broccoli, Broccolini or broccoli rabe often have more leaves. Broccoli leaves are the plant's most delicate and brittle component [13].

**Broccoli Stalk:** The stem of a plant is called a stalk. Also, the stem of a broccoli plant is referred to as the stalk. The area between the stem and the florets with broccoli bud-filled florets is called the stalk [13].

**Broccoli Stem:** The component of the broccoli plant that sprouts from the soil is the stem. It is substantial and ultimately divides into distinct stalks that emerge from the stem's base. As the stem is rough, most people chop it off and don't eat it [13].

**Chemical Constituents:** The typical broccoli phytochemical is sulfur-containing compounds, including glucosinolates, hydroxycinnamic acids (sinapic and caffeoyl-quinic acid derivatives), minerals (Calcium, phosphorus, potassium, sodium), vitamins (B, C, E, K), Fibers, indoles, Flavonoids (kaempferol), glucoraphanin, S-methyl cysteine, sulfoxide isothiocyanates, and indole-3-carbinol, etc [14].

## PHARMACOLOGICAL ACTIVITIES

**Anti-amnesic activity:** Researchers tested amyloid beta [A]-induced neurotoxicity in vitro and in vivo to determine the anti-amnesic properties of broccoli [*Brassica oleracea var. italica*] leaves. A notable neuronal cell-protective effect and acetylcholinesterase [AChE] inhibition were demonstrated by the broccoli leaf chloroform fraction (CBL). The Y-maze,

passive avoidance, and Morris water maze tests were used to assess the ameliorating impact of CBL on A1-42-induced learning and memory deficits. The findings showed that the CBL group's cognitive performance was improving. As a result, our research suggests that CBL may be exploited as a natural resource to treat learning and memory problems brought on by A1-42 [15].

**Anti-oxidant activity:** Samples made from fresh broccoli sprouts using freeze-drying or water distillation were tested for antioxidant activity. Antioxidant activity that was dosage dependent was present in all samples. The maximum DPPH radical scavenging activity was found in the broccoli methanol extract. Both samples of dichloromethane extract from broccoli sprout water distillate and freeze-dried broccoli sprouts had a strong antioxidant activity that was equivalent to BHT. It is well known that these isothiocyanates have antioxidant qualities. The compounds 4-(1-methyl propyl) phenol (0.012 g/g), 4-methyl phenol (0.159 g/g), and 2-methoxy-4-vinylphenol (0.009 g/g) may be phenolic antioxidants. The current study shows that broccoli sprouts are an excellent source of natural antioxidants [16].

**Anti-diabetic activity:** After 28 days of therapy, type 2 diabetic HFD-STZ rats with the plant's ethanolic extracts of *Brassica oleracea var. Italica* showed clear antihyperglycemic capabilities. These effects were tested in STZ-induced type 2 diabetic SD rats at dosages of 800 mg/kg [17].

**Anti-cancer activity:** In addition to being effective in treating other diseases, broccoli plays a significant and advantageous role in treating cancer in its various forms that can occur in various parts of the body. Uncontrolled cell division is the end consequence of a multi-step process called cancer. The primary active components of many cruciferous vegetables, isothiocyanates, inhibit the development of tumors by producing reactive oxygen species or by causing cycle arrest that results in cell apoptosis. Broccoli sprouts with added selenium are superior to regular broccoli sprouts in that they cause prostate cancer cells to die, restrict cell growth, and secrete less prostate-specific antigens. Phytochemicals offer significant promise for preventing cancer given their degree of safety, cost, and oral absorption [18].

**Anti-obesity activity:** Obesity has emerged as a major global health issue and is a precursor to harmful metabolic illnesses including type 2 diabetes and cardiovascular disease. According to a few studies, broccoli sprouts reduce obesity by modulating lipid metabolism. In double-blind clinical research, the use of broccoli sprout powder as adjunctive therapy in type 2 diabetes patients may have positive effects on lipid profiles and the OX-LDL/LDL ratio,

risk factors for obesity, and cardiovascular disease. Based on a recent study, glucoraphanin from broccoli sprouts can boost Nrf2 activation and reduce lipid build-up. It results in the expression of several genes involved in gluconeogenesis and lipogenesis being down regulated, which reduces obesity [19].

**Anti-microbial activity:** According to a study, broccoli sprouts high in gallic acid, esculetin, ferulic acid, and myricetin have antibacterial activity against foodborne pathogens like *Salmonella typhimurium* and *Escherichia coli* as well as Gram-positive and Gram-negative bacteria with minimum inhibition concentrations (MIC) ranging from 390 to 1560 g/mL. Similar to previously reported findings from other plant extracts, this study found that Gram-positive bacteria were more susceptible to broccoli sprout extract than Gram-negative bacteria. These findings indicate that broccoli sprout extracts might serve as a potential source of antimicrobial agents in the food and pharmaceutical industry [20].

**Anti-inflammatory activity:** Several studies proved that broccoli sprouts and their bioactive components possess anti-inflammatory activity. Using broccoli sprouts and microgreens might help prevent and cure inflammatory bowel conditions including Crohn's disease and ulcerative colitis. The main anti-inflammatory effects of broccoli sprouts have been demonstrated in both in vitro and in vivo studies as well as clinical trials. These studies found that broccoli sprouts had high concentrations of sulforaphane and a group of phenolic compounds, such as anthocyanins, isoquercitrin, chlorogenic, and cinnamic acids, which inhibited inflammatory mediators like nitric oxide (NO), decreased levels of proinflammatory cytokines. Moreover, type 2 diabetes individuals' blood levels of high-sensitive C reactive protein (hs-CRP), IL-6, and TNF- were shown to be lower after eating broccoli sprouts rich in sulforaphane [21].

**Hepatoprotective activity:** In-depth research has been done on the preventative and therapeutic benefits of broccoli extracts on paracetamol-induced liver injury in rats. According to histological research and the measurement of biochemical indicators, broccoli extracts exhibit protective effects against liver injury. Three chemicals, obturcarbamate, N-(4-hydroxy phenyl) acetamide, and p-hydroxy benzoic acid, were isolated by phytochemical analysis of an 80% ethanolic extract and are suitable candidates for the prevention of liver damage brought on by paracetamol [22].

## CONCLUSION

*Brassica oleracea* belonging to the family Brassicaceae is widely accepted for its traditional medicinal uses and pharmacological potential. Various parts of *Brassica oleracea* have reported the presence of several

phytochemicals such as glucosinolates, dithiolthiones, indoles, glucoraphanin, s-methyl cysteine sulfoxide, isothiocyanates, indole-3-carbinol, and other constituents. *Brassica oleracea* revealed various pharmacological activities such as anti-microbial, anti-inflammatory, anti-diabetic, anti-oxidant, anti-cancer, anti-obesity, and hepatoprotective activity. Every part of the broccoli plant possesses medicinal and nutritional value, with numerous other applications. Further scientific investigation on different parts of *Brassica oleracea* must be undertaken to unveil additional pharmacological properties.

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