



A Review on the Ethnobotany, Bioactive Compounds, and Biological Activities of *Triticum Aestivum*

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ABSTRACT

Wheatgrass is the freshest branch or young grass of the common wheat plant. It is also known as "green blood" due to its structural similarities to the haemoglobin molecule. This plant plays a larger role in the Ayurvedic medicinal system and is used to treat a variety of illnesses and conditions. It is used by people to treat anaemia and thalassemia patients as a haemoglobin replacement that increases RBCs and blood count. Because of the high concentration of chlorophyll in it, it is used to improve heart and lung function. Additionally, it has pharmacological properties that include those that are anti-arthritic, anti-bacterial, anti-microbial, anti-diabetic, antioxidant, and anti-thalassemia. Cancer can be treated with the largest quantity of vitamins, minerals, enzymes, amino acids, and antioxidants that can be found in diet.

Keywords: Wheatgrass, *Triticum aestivum*, Pharmacological activity, Secondary metabolites

Introduction:

Over evolutionary time periods, the natural products have been improved for the best interactions with biomolecules. Numerous important discoveries for contemporary medicine have come from pharmacological studies of conventional and herbal treatments. Researchers are very interested in finding novel medicines made from plants and other natural resources [Yuan and Piao, 2016; Calixto, 2019]. In rural and distant locations, herbal remedies are regarded as the primary source of healthcare worldwide. Since ancient times, medicinal plants have been used to cure a wide range of illnesses and ailments [Sen and Chakraborty, 2017]. Traditional medicine, especially herbal therapy, is regarded as a key source of healthcare worldwide, especially in rural and isolated places [Khan and Ahmad, 2019]. Ayurveda, Siddha, and Unani, three traditional Indian medical systems, have a very long history of success; contemporary science has also recognised the significance of such therapy [Pandey et al., 2013; Sen and Chakraborty, 2019]. A crucial source of novel drugs is also regarded as being traditional medicine or medicinal plants [Wu et al., 2021; Süntar, 2020]. Indian culture has been regarded as being inextricably linked to wheatgrass from ancient times. Since ancient times, wheatgrass has been utilised as a traditional medicinal plant to cure a variety of diseases [Kaur et al., 2022; Minocha et al., 2022]. The wheatgrass movement is credited to Dr. Charles. On the basis of his observations of both humans and animals, he recorded the usage of the wheat plant in a variety of health advantages [Bar-Sela et al., 2015; Al Bashir 3et al., 2020]. Wheatgrass is sometimes referred to as "living food" or "green blood" because it contains the largest concentration of chlorophyll, which accounts for 70% of the total chemical components [Padalia et al., 2010; CHOUDHARY et al., 2021]. Due to its ability to postpone the ageing process, promote health, and prevent chronic illnesses, wheatgrass is also regarded as a nutraceutical. The human body may benefit greatly from the minerals and vitamins found in wheat grass, a common weed. It contains significant amounts of active enzymes, vitamins, and other nutrients in the form of fresh juice [Mujoriya and Bodla, 2011; Sachin et al., 2013].

Botanical description of *T. aestivum*:

The *Triticum aestivum* Linn, a member of the Poaceae (Graminae) family, common wheat plant, produces wheatgrass as a shoot or young grass [Hattarki and Bogar, 2017; Shrivastav et al., 2013]. The term "wheatgrass" often refers to wheat that has been germination for 6 to 10 days. A genus of annual and biennial grasses is called *Triticum aestivum* [Suriyavathana et al., 2016; Balakrishnan, 2020]. The plant may grow as tall as 30–100 cm (12 to 40 inches). The plant has flat or slightly folded leaves, long, thin, somewhat flattened spikes, dorsally compressed rachis, tough spikelets, and hexaploid, far-flung spikelets with two to five flowers [Kumar et al., 2017; Rana et al., 2011]. The stem of the *T. aestivum* plant is heavily compressed, glabrous, hollow, 1.2 m tall, auricled, wraps around the stem, linear-lanceolate or narrow linear with length 20-38 cm and breadth up to 1.3 cm, and 1.2 m tall except at nodes or crown bearing leaves that are alternating, simple, and whole [Ashok, 2011; Mrunali et al., 2016].

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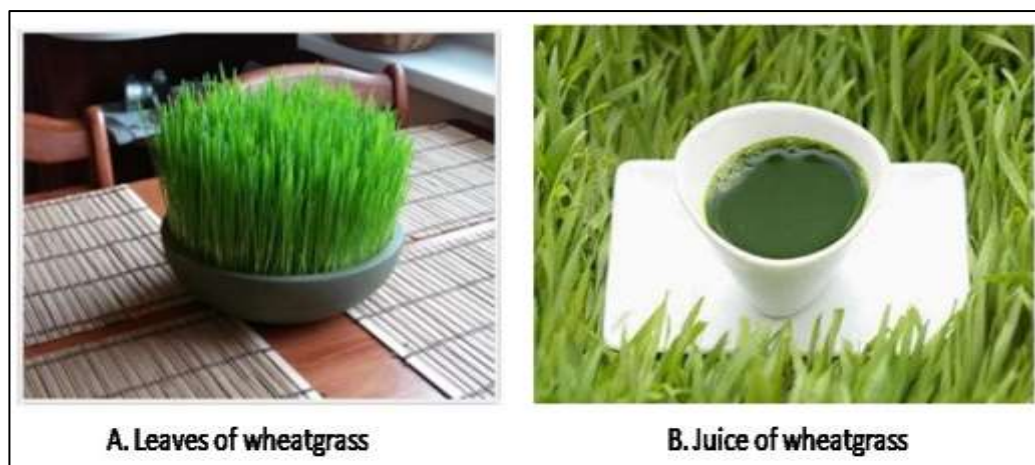


Fig.1: A. Leaves of Wheatgrass; B. Juice of wheatgrass [Mrunali et al., 2016]

Geographical distribution of *T. aestivum*:

The Levant area of the Near East is where the wheat plant first appeared [Singh et al., 2012]. The *T. aestivum* plant is mostly grown in temperate, wet to dry, heavy rainfall, warm, humid to dry, and cold climates [Sharma et al., 2019]. It was initially domesticated in the Mediterranean area and western Asia, following which it expanded and was grown all over the world. China was the world's top producer of wheat, making up around 30% of the total (112 to 120 million tons) [Lev-Yadun et al., 2000; Nanda et al., 2015].

There are around 15 to 20 different species of *T. aestivum* known to exist, eight of which are supposedly present in India [Chauhan, 2014]. Other types of wheatgrass include *Agropyrontrachycalam* (slender wheatgrass), *Elytrigia*, *Eremopyrum*, *Pascopyrum*, and *Pseudoroegneria*, which are all typically grown in temperate regions of North America and Europe. These varieties of wheatgrass are rich sources of antioxidants, vitamins, minerals, enzymes, and amino acids [Aydos et al., 2011].

Phytochemical constituents of wheatgrass:

Another name for wheatgrass is "green blood." This is due to the high chlorophyll concentration, which makes about 70% of all its chemical components and has a structure similar to haemoglobin. It helps the body produce more RBCs and encourages the growth of tissue cells in a healthy way [CHOUHDHARY et al., 2021; Ashok, 2011]. Nutrients including Vitamin A, Vitamin C, Vitamin E, and Vitamin B complex are abundant in wheatgrass. With the development of wheatgrass, the levels of ferulic acid, vanillic acid, beta-carotene (pro-vitamin A), vitamin C, and vitamin e increase. Phosphorus, calcium, magnesium, selenium, alkaline earth metals, boron, zinc, potassium, and molybdenum are among the minerals found. This plant contains a variety of phytochemicals, including as phenols, flavonoids, vitamins, proteins, minerals, etc [Lim and Lim, 2013] The primary active components identified from *Triticum aestivum* are rutin and gallic acid, which have been shown to have significant anti-cancer, anti-ulcer, anti-inflammatory, antioxidant, and anti-arthritis potential [Tirgar, 2011]. Amylase, protease, cytochrome oxidase, transhydrogenase, and superoxide dismutase are among the enzymes that are present. Glutamic acid, arginine, alanine, aspartic acid, and serine are among the many amino acids found in wheatgrass, but it also contains bioactive plant chemicals flavonoids and triterpenoids, which are said to affect lipid levels [Kothari et al., 2008; Ghumman et al., 2017]. Wheatgrass is also recognised as a nutraceutical because of its capacity to slow down the ageing process, enhance health, and lower the risk of illness. Alkaloids, flavonoids, tannins, phenolic compounds, glycosides, steroids, and terpenoids are among the large amounts of constituents found in wheatgrass. It contains both primary and secondary metabolites in abundance. More bioflavonoids, including luteolin, quercetin, apigenin, and indole components like laetrile (amygdalin) and choline, are present in wheatgrass [Mrunali et al., 2016; Stracke et al., 2009]. Some of constituents are shown in **Fig 2**.

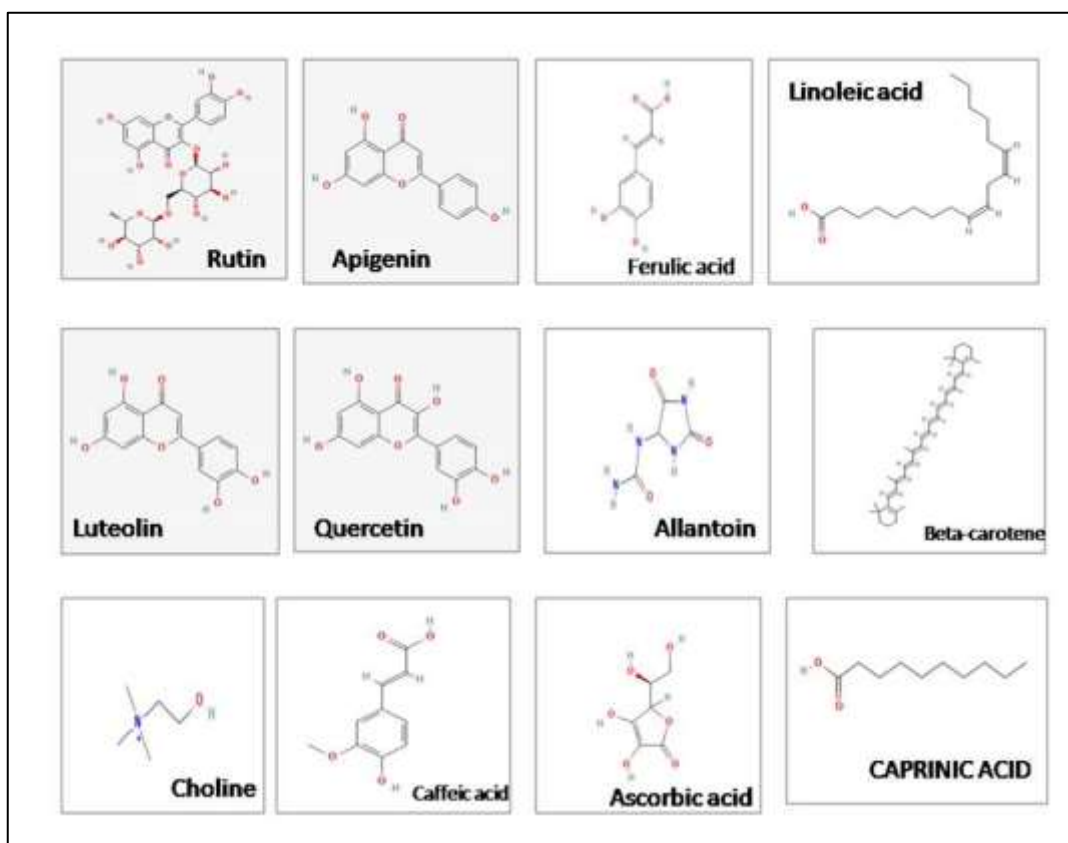


Fig. 2: Chemical constituents of wheatgrass

Since wheatgrass germination produces a larger concentration of phenolic compounds such as flavonoids, vitamins, and minerals, wheatgrass juice is primarily used in medicine for its antioxidant properties [Suriyavathana et al., 2016]. Wheatgrass, which is frequently offered in many health food stores as fresh plant, tablets, frozen juice, and powder, is one of the most well-known supplemental health foods [Vijayalakshmi et al., 2020]. It is an important herbal plant that has been used for centuries to cure a wide range of illnesses and conditions, including high blood pressure, obesity, cancer, diabetes, gastritis, ulcers, pancreatitis, tiredness, anaemia, asthma, haemorrhoids, halitosis, skin issues, and constipation [Tufail et al., 2019]. Ayurveda also makes reference to the wheatgrass plant as a natural remedy for treating various ailments. Wheatgrass juice is mostly used in medicine due to its antioxidant properties [Parit et al., 2018; Durairaj et al., 2014]. In the Ayurvedic medical system, it is also used to treat acidity, colitis, renal problems, and swollen wounds [Rimple et al., 2016]. Treatments for thalassemia, hemolytic anaemia, cancer, asthma, allergies, and inflammatory bowel disease all benefit from the use of wheatgrass [Mutha et al., 2018; Singh et al., 2004; Gore et al., 2017; Dixit and Ali, 2010].

Wheatgrass has been demonstrating a variety of actions such as anti-inflammatory, anti-fungal, anti-malarial, anticancer, detoxifying, anti-ulcer, and anti-arthritic [Jain and Argal, 2014; Dixit and Ali, 2010; Wasonga and Osoro, 2017]. Wheatgrass is a powerful tonic that helps with pyorrhea, arthritis, skin allergies, hair loss or greying, weakness, kidney stones, impaired vision, and weariness [Sareen, 2014]. Drinking wheatgrass juice is a quick and effective approach to rid your body of environmental toxins [Balakrishnan, 2020]. The liver is detoxified, poisonous heavy metals are removed from the blood stream, the body is cleansed of waste products, and the ageing process is slowed down thanks to its high amounts of enzymes and amino acids, which act as a natural cleaner [Dégraff, 2011].

Wheatgrass's secondary metabolites are used to treat a variety of diseases and have a wide range of medicinal properties. Inorganic extracts of T.A. grass in hexane, chloroform, and methanol were found to contain rutin, chlorogenic acid, tocopherol, and gallic acid. It is antibacterial in nature [Afroz et al., 2012]. *Staphylococcus aureus*, *Vibrio cholerae*, and *Salmonella typhi* were all resistant to plant-based organic extracts. The amounts of carotenoids (lutein and zeaxanthin) and phenolic acids in whole wheat from the Titlis and Runal cultivars have been assessed over a long period of time utilising both conventional and organic production techniques [Moshawih et al., 2022]. Bioflavonoids found in wheatgrass have antiviral and antibacterial properties [Jeong et al., 2010]. Wheatgrass juice contains unprocessed chlorophyll that has no hazardous side effects either given orally or as a colon implant. The healing properties of chlorophyll make it useful both within and outside the body. Wheatgrass' chlorophyll helps to repair the bloodstream. Chlorophyll has not been shown to cause any harmful reactions in studies on a variety of animals [Baral, 2019].



Fig.3: Pharmacological activities of wheatgrass

Antiulcer activity:

From a number of published trials, it was discovered that wheatgrass juice was successful in treating active distal ulcerative colitis. Water-soluble proteins and water-soluble organic compounds shown strong anti-stomach ulcer action in the investigation that was carried out on rats. Chlorophyll was tested against cutaneous wounds in another study done on guinea pigs, and it was found to be effective in healing clinical burns, surgical wounds, and ulcers in human patients. It was discovered that the use of chlorophyll ointment and aqueous solution in the treatment of skin ulcers [CHOUDHARY et al., 2021; Chauhan, 2014].

Anti-microbial activity of wheatgrass:

Many different secondary metabolites, including tannins, terpenoids, alkaloids, and flavonoids, have been found to have antimicrobial properties which are present in wheatgrass. When tested on *E. coli* and *Staphylococcus aureus*, the wheatgrass juice (green blood) demonstrated antibacterial action [Saha et al., 2018; Sundaresan et al., 2015]. When tested against *E. coli* and *Staphylococcus aureus*, wheatgrass juice (often referred to as "green blood") was discovered to possess antibacterial qualities. Many secondary metabolites found in wheatgrass have been demonstrated to have advantageous effects on the human body. It is commonly known that wheat grass juice has antimicrobial properties. Wheatgrass extracts were tested against Gram-positive microorganisms such as *Staphylococcus aureus*, *Bacillus subtilis*, and Gram-negative *Escherichia coli* using Amoxicillin as the reference drug by Pallavi et al (2011). In comparison to *Staphylococcus aureus* and *E. coli*, several extracts demonstrated a considerable amount of activity against *Bacillus subtilis*. The substantial bioflavonoid content of wheat grass extract may help explain its potential antibacterial effects. When wheatgrass extracts in N-hexane and chloroform are compared for antibacterial activity, N-hexane extract exhibits more antimicrobial activity than chloroform extract against a variety of bacteria, including *K. pneumoniae*, *E. coli*, *S. aureus*, and *B. Subtilis* [Roy et al., 2018; Dholi, 2018].

Anti-diabetic activity:

The high fibre content of wheatgrass aids in controlling blood sugar levels. Wheatgrass' abundance of natural fibre regulates blood sugar levels. The existence of chlorophyll, which is thought to be the pharmacologically active component in wheatgrass and acts as an anti-diabetic drug, was verified by instrumental characterization of wheatgrass (spray dried powder of juice). In diabetic Male Wistar strain albino rats, WG therapy improved glycaemic control, and its impact was nearly identical to that of the common medication, glibenclamide [KARASHAHİN and ARGON, 2017; Shakya et al., 2016]. Additionally, wheatgrass has a component called chlorophyll that has anti-diabetic properties [Hattarki and Bogar, 2017]. In streptozotocin-induced diabetic rats, wheatgrass ethanol extract has anti-diabetic action when given at 100 mg/kg body weight [Mohan et al., 2013; Al-Awaida et al., 2020]. Wheatgrass exhibits hypoglycemic action in diabetic rats produced by alloxan [Singh and Mavai, 2018].

Wheatgrass in thalassemia major:

A hereditary condition known as beta-thalassemia is brought on by either decreased or absent beta-globin chains [Kukreja et al., 2013]. Utilizing a cellular experiment, it has been documented that ingestion of wheatgrass increases HbF production [Singhal et al., 2012]. The structure of the wheatgrass chlorophyll molecule is comparable to that of the human haemoglobin molecule. The sole distinction is in the main component; magnesium is present in chlorophyll whereas iron is present in haemoglobin. It has been claimed that consuming chlorophyll derivatives raises the concentration of RBCs and

haemoglobin by up to 70–83% over the course of 16 days. 38 individuals with serious thalassemia received 100 ml of wheatgrass juice daily for six months as part of a research on thalassemia patients. In 50% of the patients, it produced positive benefits. Another study involved 40 patients with thalassemia major who received wheatgrass tablets divided into 2-3 tablets per day and given, respectively, to children aged 1-3 years and 4–8 years. The results showed that the wheatgrass tablets increased haemoglobin levels, lengthened the time between blood transfusions, and reduced the amount of blood transfused [Singh et al., 2018; Mutha et al., 2018].

Detoxifying activity:

To identify its detoxifying properties, the chemical component of the wheatgrass plant was tested against the liver. It has been discovered that choline, when combined with a diet high in cholesterol, prevents fat from depositing in the liver of experimental animals. Additionally, phase I and phase II xenobiotic metabolic enzyme activity in the liver and intestinal mucosa was shown to be enhanced by the indole component. Consequently, indole molecules wheatgrass may contribute to the deactivation of carcinogens [Padalia et al., 2010]. In addition to the stimulating and regenerating qualities of chlorophyll the therapeutic value of wheatgrass juice is due to its high mineral content and other ingredients like choline. In a research to examine the impact of choline on the liver, it was discovered that when experimental animals were fed a diet high in cholesterol, choline prevented the liver from accumulating fat [Irak et al., 2016].

Wheatgrass in haemolytic anaemia:

The effects of wheatgrass juice treatment in hemolytic anaemia may result from the red blood cell-damaging actions of natural antioxidants (RBC). Various tests have demonstrated the anti-oxidant and anti-haemolytic properties of wheatgrass. When Sonia Johri and Neha Khan tested various extracts of wheatgrass (petroleum ether, ethyl acetate, n-butanol, aqueous) for anti-haemolytic activity/ membrane stabilizing activity using Hypotonic solution-induced haemolysis test and H₂O₂ induced haemolysis then n-butanol extract shows maximum activity among other extracts [Johri and Khan, 2017].

Wheatgrass in inflammatory bowel disease:

To test the anti-inflammatory effects of wheatgrass juice, Nalini, G. K., et al. employed rat models of resin pellet-induced granuloma, carrageenin-induced rat hind paw edoema, and formalin-induced rat hind paw edoema. The outcomes were compared with diclofenac sodium, a reference medication and control. Wheatgrass significantly reduced inflammation in chronic animals model. The impact of wheatgrass was greater than diclofenac sodium in the resin pellet model. Wheat grass had a less significant impact than diclofenac sodium in the model of rat hind paw edoema caused by formalin. Juice from wheatgrass has anti-inflammatory effects on chronic inflammation [Nalini et al., 2011; Dasari et al., 2021].

Antioxidant activity of wheatgrass:

Wheatgrass extract was found to have antioxidant action at several different levels of defence, including primary and secondary radical scavenging and prevention of free radical caused membrane damage. Based on its chemical composition, this may be explained [Parit et al., 2018]. Wheatgrass extracts have been reported to contain large concentrations of phenolic chemicals, including flavonoids. Several researches shown that wheatgrass water extracts are an excellent source of antioxidants [Zendeabad et al., 2014]. Wheatgrass extracts can be utilised as a dietary supplement for antioxidant substances like polyphenols and flavonoids due to its antioxidant properties and simplicity of home-growing under controlled climatic conditions [Devi et al., 2019; Kulkarni et al., 2006; Sun et al., 2015].

Kulkarni, Sunil D., et al. studied the antioxidant activity of aqueous and ethanol extract as aqueous extract is similar to those that people consume as herbal juice or drink and most of bioactive compounds are soluble in ethanol solvent. In study they studied the antioxidant activity of extracts using different assays like ability to inhibit radical formation assay (AIRB), radical scavenging assay (DPPH assay), ferric reducing antioxidant power (FRAP), capacity to inhibit lipid peroxidation in rat liver mitochondria and oxygen radical absorbance capacity (ORAC) assay [Tilak et al., 2006].

Wheatgrass in cancer treatment:

Apoptosis induction has been noted as a mechanism of wheatgrass' anti-cancer efficacy in several tests. The apoptosis of MCF-7 breast cancer cells was discovered to be induced by wheatgrass extract [Hussain et al., 2014]. On cancer cells, wheatgrass ethanolic extract has an anti-proliferative and apoptotic impact. An excellent solvent extract that demonstrated a favourable link between total phenolic, flavonoids, and other phytochemical ingredients and the antioxidant capabilities was discovered to be methanol extract. Additionally, it has been discovered to stop the growth of Hep2 cells, possibly via causing apoptotic-like nuclear fragmentation and chromatin condensation. Nine bioactive components were found in wheatgrass powder, according to a GC-MS analysis, and they all had plenty of double bonds and free hydroxyl groups. Therefore, we propose that phenolic and flavonoids, in addition to the nine distinct bioactive components, may be responsible for the antioxidant and anti-proliferative action of the wheatgrass methanol extract. Thus, it was determined by the current study that wheatgrass is a significant source of natural antioxidants. Because of this, consuming it may be crucial in lowering oxidative stress and avoiding cancer and other degenerative illnesses. Since wheatgrass is a natural substance with high antioxidant and cytotoxic properties, it may be a viable choice for both cancer prevention and therapy [Karadag et al., 2007]. Wheatgrass contains the anticancer elements selenium and laetrile. The time-dependent inhibition of leukaemia cell growth is mediated by the aqueous and ethanol extracts of wheatgrass. It was discovered that the wheatgrass plant's aqueous extract has an anti-proliferative action. The plant's ethanolic extract has the strongest anti-proliferative effects. Another in vitro investigation revealed that wheat sprout extract limits the metabolic activation of carcinogens and reduces their capacity to cause cancer by up to 99% [Chiu et al., 2005].

Wheatgrass in rheumatoid arthritis:

Rheumatoid arthritis primarily affects younger people, and girls are three times more likely to get it than males. It can linger into old life, gradually becoming increasingly incapacitating. Redness, swelling, and joint pain are early indications. Joints are frequently symmetrically damaged, for example, either wrists or both knees. Other joints may also have pain and stiffness, which would impact the entire body. Rheumatoid arthritis sufferers frequently assert that a customised diet or the simple removal of particular ingredients from their free-choice diet reduces their symptoms. With regards to issues with the bones and joints, its anti-inflammatory effects help by easing discomfort and swelling [Rana et al., 2011; Mujoriya and Bodla, 2011].

Conclusion

Comprehensive data from several research have shown that wheatgrass provides a wide range of health benefits, including those for thalassemia, hemolytic anaemia, cancer, asthma, allergies, inflammatory bowel disease, and detoxification. Given that haemoglobin and chlorophyll have a similar structural make-up, it is possible that chlorophyll serves a blood-building purpose in a number of clinical conditions that call for a deficiency in haemoglobin, thus the phrase "green blood." In conclusion, additional research is necessary to ascertain how wheatgrass may be utilised to treat a range of disorders. Wheatgrass looks to be a highly promising herbal therapy. Wheatgrass has a number of health benefits, including the ability to reduce fatigue, enhance sleep, increase strength, naturally control blood pressure and blood sugar, support weight loss, enhance digestion and elimination, support the health of our heart, lungs, and reproductive organs, heal ulcers and skin sores, slow cellular ageing, enhance mental function, and be helpful in treating arthritis and muscle cramps. It has been shown to be helpful for a number of ailments, including anaemia, diabetes, cancer, eczema, constipation, kidney enlargement, and the common cold. It should thus be incorporated into a regular diet in order to get its full advantages.

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