

The medicinal properties and value of wheatgrass (*Triticum aestivum* L.)

A Literature Review

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The Medicinal Properties and Value of *Triticum aestivum* (wheatgrass juice)

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Introduction

The purpose of this review is to summarize the literature available on the extract known as wheatgrass derived from the plant *Triticum aestivum* L. The use of wheatgrass has a long history and is widely used as a health food supplement. The themes reviewed highlight the far reaching branches of study and application surrounding this broad subject. At first inspection the majority of information available is in the form of anecdotal literature, usually published by a company selling a wheatgrass product. This has been largely bypassed as it does not present validated scientific literature, which is at the centre of developments regarding wheatgrass and medicine.

Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Monocots
(unranked):	Commelinids
Order:	Poales
Family:	Poaceae
Subfamily:	Pooideae
Tribe:	Triticeae
Genus:	Triticum
Species:	T. aestivum
Binomial name:	Triticum aestivum

Wheatgrass juice (WGJ) is the pressed young shoots of the plant *Triticum aestivum*, a member of the Poaceae family. The majority of studies on the medicinal properties of wheatgrass use it in the form of the pressed juice, however, comparisons are made to its dried powder form also.

Herbal or 'alternative' medicine is gaining popularity and scientific research about wheatgrass as a "functional food" is becoming more available and popular as a research topic. It is found to be used as a treatment for minor ailments and serious life threatening issues as well as a preventative dietary supplement.

In a recent survey, more than half of Australian cancer patients reported using herbal medicine (MacLennan, Wilson & Taylor 2002)

However, not enough in-depth, controlled clinical trials have been conducted to study the therapeutic effect of wheatgrass. (Iyer,U *et al* 2010)

This review aims to focus on scientific trials with regard to the medicinal value of WGJ. Therefore, the majority of published literature was found in medical journals and the quality of the trials varied. Only a handful were in-vivo and none were multi-centre run or involved large enough groups to validate the data fully. But, they do present several cases for the feasibility of further research.

There is a plethora of books on wheatgrass that have not been included in this review simply because they represent the vast quantity of anecdotal literature and are therefore not the focus of this review.

Themes covered include specific qualities of wheatgrass as a treatment for cancer, chemotherapy, blood disease, digestive and bowel disease or disorder, with associated applications far reaching. This brings to light the literature on the most remarkable quality about wheatgrass and that is its high content of chlorophyll. The use of chlorophyll in trials offers a broad view of the potential for wheatgrass or wheatgrass derivatives. Another

interesting quality is the antioxidant potential of WGJ, in particular its superoxide dismutase (SOD) content. This enzyme has gained much attention in recent years with regard to its ability to inhibit cell mutation. Whilst there is much literature on SOD, its presence and availability in WGJ requires further development. (Forgionne.G, 2005)

History

The juice is sold either frozen or dried into tablet or powder form or as tray grown. Its availability as a health food supplement began in the 1930s after Charles F. Schnabel, an agricultural chemist, conducted experiments on his hens using wheatgrass to nurse them back to health. His experiment yielded positive results and so he carried out another experiment, which also proved positive. He found that when supplementing his ill hens diets with wheatgrass they doubled their egg production. Schnabel produced dried and powdered wheatgrass for him and his family to supplement their diets. Spreading the word of its benefits and promoting his findings the grass products were eventually noticed and invested in by large corporations Quaker Oats and American Dairies Inc.

Further research and development continued and has contributed a substantial product to the food supplements industry.

The use of wheatgrass, and particularly its fresh juice became popular again in the 1970s, when Ann Wigmore wrote '*The Wheatgrass Book*' and it became somewhat of a gospel amongst health supplement fanatics. The book itself is an homage to the applications of wheatgrass but does not make reference to whether the chosen applications offer valid scientific data or not. Ann Wigmore also established the famous Hippocrates Centre treating thousands of clients with herbal grasses and wheatgrass juice.

Self-styled 'Sproutman' Steve Meyerowitz published 'Wheatgrass; Natures finest medicine' in 1983. It is now in its 7th edition and has sold over 300,000 copies. It does contain 12 pages with references to selected studies. However, these date as far back to 1939 and the most recent in 2002. Whilst these findings are no less valuable now it does highlight the need for up to date investigation.

A study found in the book and frequently cited in published wheatgrass papers covers the treatment of active distal ulcerative colitis and the effect of wheatgrass on its activity when taken as a dietary supplement. The double-blind, randomized, placebo controlled trial describes significant reductions in overall disease activity ($P=0.031$) and rectal bleeding ($P=0.025$) a common and sometimes severe symptom of the disease. (Ben-Ayre.E,2002) Its frequent appearance as cited in many papers is testament to its thorough experiment design, even though only 19 patients completed the experiment. But, more importantly it highlights the lack of any other similar studies.

Many studies have been conducted about wheatgrass applications by G.O Kohler and this name also frequents the references of papers today. Kohlers own works range from 1939 into the late 1950s and cover many aspects of the use of wheatgrass, mainly as a treatment for chickens. Again, in an attempt to describe the current state of available literature the majority of cited papers are from within the last ten years.

Wheatgrass properties

Name of the Test	+(positive) – (negative)
Test for carbohydrates	
a) Molisch's test	+
b) Fehling's test	+
c) Benedict's test	+
Test for proteins	
a) Biuret test	+
b) Xantho protein test	+
c) Millons test	+
Test for Amino acids	
a) Ninhydrin test	+
Test for Alkaloids	
b) Dragendroff's test	+
c) Mayer's test	+
d) Hager's test	+
e) Wagner's test	+
Test for sterols	
a) Salkowski test	-
b) Liebermann reaction	-
Test for phenolics & tannins	
a) Ferric chloride test	-
b) Lead acetate test	-
c) Dil. HNO ₃ test	-
Tests fixed oils and fats	
a) Saponification test	-
b) Stain test	-
Test for triterpenoids	
a) Liebermann Burchard's Test	-
b) Salkowski test	-
Test for glycosides	
a) Keller-Killiani Test	-
b) Baljet's Test	-
Test for saponins	
a) Haemolytic test	+
b) Foam test	+

The table was presented by Ashok *et al* upon phytochemical and pharmacological screening of *T.aestivum* and describes the results of the tests carried out therein.

Wheatgrass juice is a rich source of Vitamins A, C, E and B complex, including B12. It contains a multitude of minerals like calcium, phosphorus, magnesium, alkaline earth metals, potassium, zinc, boron, and molybdenum. The various enzymes responsible for its pharmacological actions are protease, amylase, lipase, cytochrome oxidase, transhydrogenase and super oxide dismutase (SOD). The other notable feature of wheatgrass is its high proportion of amino acids such as aspartic acid, glutamic acid, arginine, alanine and serine. It also has a high content of bioflavonoids like apigenin, quercetin and luteolin. All of these enzymes contribute to its antioxidant activity.

This work also screened for the presence of antioxidants using a DPPH assay and found wheatgrass juice to have significant activity which was comparable to the standard drug ascorbic acid. It also confirmed the presence of chlorophyll as a component in its ability as an anti-diabetic agent.

Other compounds present, which make this grass therapeutically effective, are the indole compounds, choline and laetrile (amygdalin). (Swati Padalia2010)

Anti-diabetic activity is under further scrutiny in an evaluation using rats at the University of Health Sciences. The paper states from the World Health Organization expert committee on diabetes has listed as one of its recommendations that traditional methods of treatment for

diabetes should be further investigated. The paper aims to measure reaction in rats using fresh WGJ as a treatment for Diabetes mellitus and is yet to be published in 2012.

Chlorophyll

One of the most remarkable qualities *T.aestivum* has is its high chlorophyll content, often referred to as 'green blood'. Dried *T.aestivum* is said to contain 70% chlorophyll.

The analogy between chlorophyll and haemoglobin can be demonstrated with respect to the structure of their porphyrin heads. The structure of both the compounds depicts a striking similarity in having a tetra pyrrole ring structure, the only difference between the two being the nature of the central metal atom - magnesium (Mg) in chlorophyll and iron (Fe) in haemoglobin. The apparent resemblance between the two is thus considered to be responsible for the therapeutic effects shown by chlorophyll in conditions involving deficiency of haemoglobin. (Mishra et al 2011)

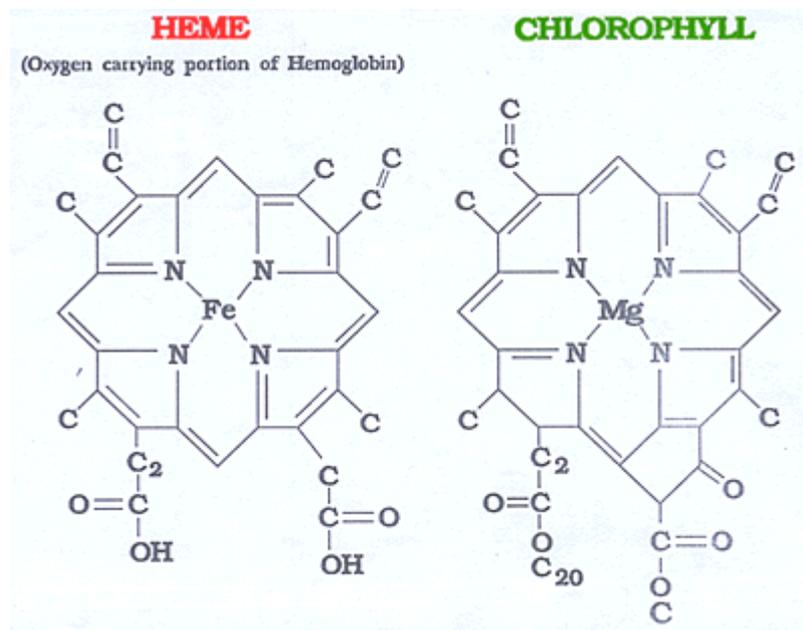


Fig.1 Haemoglobin and chlorophyll

The focus of this review is on the study of wheatgrass juice in medicine and the study of chlorophyll since it is in such high quantities that it is of interest. The isolation of properties in wheatgrass is becoming more prevalent. Superoxide dismutase is gaining interest as an antioxidant as is apigenin, both of which are present in wheatgrass. There is evidence to suggest that it is the combination of these properties which make wheatgrass activity potentially useful as a medical treatment. The protocol when discovering new potential uses of plant compounds is to isolate and purify that one mechanism so it can be synthesized and manufactured. Important to these studies and further investigation is the elemental concentrations of wheatgrass and how these may be of benefit.

Growing conditions and medicinal value

Instrumental neutron analysis has determined the concentrations of compounds in *T.aestivum*. The elemental concentration levels, their trends and concentration ratios of in shoot-to-root growth seem variable in differing growing conditions.(Kulkarni *et al* 2006)

Kulkarni *et al* conducted a study comparing the antioxidant levels (phenolic and flavonoid compounds) of water-based (i.e. wheatgrass juice) and alcohol-based extractions of wheatgrass measured from plants grown under different growing conditions over periods from 6 to 15 days. These conditions included tap water, tap water with nutrients, soil and tap water and soil with nutrients.

Results showed, in comparison with wheatgrass tablets, the alcohol extracted solution of wheatgrass to be up to 250% higher than in fresh wheatgrass juice and for antioxidant activity to be highest at the end of the growing period (15 days). It also showed antioxidant activity to be highest in soil with nutrients and higher than many natural extracts and vegetables. Wheatgrass tablets were shown to be significantly lower in antioxidants than both fresh juice and alcohol-extracted solutions. (Kulkarni et al 2006)

Glycoside molecules, which are also a powerful antioxidant, have also been isolated in a study of wheatgrass potential to inhibit DNA oxidative damage in-vitro.(Falcioni 2002)

Whether different growing conditions change the medicinal value of the final product has been further researched by Kulkarni *et al* in other published papers. One of which is concerned with the bioaccessibility of wheatgrass. **How do the properties of wheatgrass behave once ingested and are they active in metabolic processes?**

The trial measured the range of values determined by gastric digestion for fresh wheatgrass juice, wheatgrass tablets and wheat seeds which were 37–57%, 17–43% and 9–38% respectively. Corresponding bioaccessibility values determined by gastrointestinal digestion method were 39–60%, 34–55% and 15–23% respectively. These studies suggested that fresh wheatgrass grown in the laboratory is an effective source of minerals.

It was found that bioaccessibilities of Mn, Zn and Fe were higher from wheatgrass as compared to wheat grain during both the digestions. This indicates that minerals from fresh wheatgrass are more easily bioaccessible when grown over a period of 8–10 days even in the simple growth conditions such as tap water and ordinary soil without addition of fertilizers. (Kulkarni *et al*, 2007)

Again, Kulkarni determines root-to-shoot elemental concentrations in wheatgrass grown in differing conditions. The antioxidant value is in question in this paper where FRAP, DPPH and ABTS assays determine levels of antioxidants in samples of varying growing conditions and both, final, aqueous and ethanol extracts. The ORAC values of aqueous and ethanol extracts of day 10 with condition 4 were found to be 39.9 and 48.2, respectively, being higher than those reported for many natural extracts or vegetables. (Kulkarni *et al*, 2006)

Chlorophyll vs. chlorophyllin

Chlorophyllins are molecule analogs of chlorophyll studied for cancer prevention in-vitro and in-vivo because they may mimic the effects of chlorophyll. Hydrolysis produces the chlorophyllin molecule which varies from chlorophyll in that magnesium in the centre is replaced by sodium copper and the removal of the phytol tail.

One trial from 2005 used the controlled diet of rats to determine results. One group was fed heme, which mimics red meat which is known to contribute to cytotoxic cell proliferation in the colon. The second group were fed heme with addition of sodium copper chlorophyllin and the third group was fed heme with the addition of natural chlorophyll. Results showed that group 1 experienced an almost 100% increase in proliferation. Adding chlorophyllin in group 2 did not inhibit the heme-induced proliferation of colonic cells, but group 3 showed an inhibition similar to control values. **The study concludes that dietary protection against the increased risk of colon cancer due to high consumption of red meat can be offered only by consumption of green vegetables, containing natural chlorophyll and not by chlorophyllin. (de Vogels, J, 2005) This presents obvious applications for the high chlorophyll content of wheatgrass.**

Natural chlorophyll has not been shown to cause any side effects or detrimental damage, except mild nausea in some cases. Of course, different dosages or isolated and purified extracts potentially alter that. The role of dosage is important in the context of medicinal value and therefore presents another realm of potential research.

The use of chlorophyll as a blood builder has been studied and one case in particular describes effects of varying dosage. Howell Hughes.J & Latner A.L (1936) demonstrated effects of varying doses of pure chlorophyll, large doses of crude, unrefined chlorophyll and one with a magnesium free derivative, (which later came to commercial use as chlorophyllin.) Results showed that pure, refined chlorophyll in large doses has no effect on the speed of haemoglobin regeneration, very small doses markedly increases regeneration. Crude, unrefined chlorophyll is effective, even in large doses and magnesium-free chlorophyll was shown to also aid regeneration when given in large doses. The haemoglobin levels in anaemic rabbits showed recovery after 12 days of a large dose of crude, unrefined chlorophyll.

Crude drugs may be less efficient than modern medicines, but they are relatively free from side effects which is a desirable quality. Often the limitation of the application of modern medicine is their adverse side effects. Therefore, there is an ever increasing need for efficacious, economic, safer medicinal agents producing permanent cure in recent times (Ashok, 2011)

Again, further investigation, especially in-vivo, is required to confirm its real potential as a safe treatment. Natural versus synthetic will be an important debate in the world of medicine in the future.

Synthetic antioxidants are widely used in the food, cosmetics, and therapeutic industry. However, some physical properties of these compounds such as their high volatility and instability at elevated temperature, strict legislation on the use of synthetic food additives, carcinogenic nature of some synthetic antioxidants, and consumer preferences have shifted the attention of manufacturers from synthetic to natural antioxidants. In view of increasing risk factors of human to various deadly diseases, there has been a global trend toward the use of natural substances present in medicinal plants and dietary plants as therapeutic antioxidants. **It has been reported that there is an inverse relationship between the dietary intake of antioxidant-rich food and medicinal plants and incidence of human diseases. The use of natural antioxidants in food, cosmetic, and therapeutic industry would be promising alternative for synthetic antioxidants in respect of low cost, highly compatible with dietary intake and no harmful effects inside the human body. Many antioxidant compounds, naturally occurring in plant sources have been identified as free radical or active oxygen scavengers (Lobo,V *et al* 2010)**

Chemopreventive

This scavenging potential applies to the potential of wheatgrass as a chemopreventive. Cancer is a serious threat to people the world over and research is relentlessly evolving. Any suggestion of WGJ efficacy in relation to treating or preventing cancer deserves investigation.

The purpose of cancer prevention is to cause delay in onset of cancer, its progression from precancerous lesion or recurrence after treatment. Therefore the ultimate goal of cancer prevention is preferably to live without cancer or with cancer without suffering from symptoms until the natural termination of life. (Priyanka,A., Madhu,K, 2011)

Chemoprevention by natural chlorophyll was investigated by Simonich.M.T *et al* (2007) in a rat multi-organ carcinogenesis model. Aflatoxin B₁ is a major cause of hepatocellular carcinoma in Asia and sub-Saharan Africa. The trials measured efficacy of chlorophyll (Chl) and fabricated chlorophyllin (CHL) as chemopreventives on hepatic AFB₁ DNA adduction in rats. **Results detailed that both Chl and CHL were both potent agents against biomarkers of AFB₁ in the rat liver and colon.** Further experiments are suggested to determine the precise mechanism of the inhibition in post-initiation models. **The results support the idea that consumption of green foods, high in chlorophyll, may substantially lower cancer rates among human populations at high risk from AFB₁ exposure. (Simonich.M.T *et al*, 2007)**

Chemotherapy, although an effective treatment for cancer, can, in some cases, produce life threatening side effects of its own. Breast cancer treated with chemotherapy has been known to induce myelotoxicity in patients. According to non-established data, wheat grass juice (WGJ) may prevent myelotoxicity when applied with chemotherapy. (Bar-Sela,G *et al* 2007) This pilot study was in-vivo and involved 60 patients assigned to either an intervention or a control arm.

The paper concludes that it was found that WGJ taken during FAC chemotherapy may reduce myelotoxicity, dose reductions, and need for G-CSF support, without diminishing efficacy of chemotherapy.

Chemoprevention depends on the use of non-toxic chemical substances to block, reverse or retard the process of carcinogenesis. Plant-based diets is regarded one of the potential chemopreventive agents. (Boivin, D.,et al, 2007)

Wheatgrass has also shown to be effective for inhibiting proliferation of leukaemia cells and to induce apoptosis, programmed cell death, thus providing a novel therapeutic approach for treatment of CML (Chronic Myelogenous Leukaemia). The study concludes that further investigation on a cellular or molecular level is necessary. (Aydos, O.S,et al, 2010)

Blood disease

Another in-vivo study on patients with the recessive blood disease *Thalassemia major* also pilots treatment with WGJ. *T.major* modern treatment involves blood transfusion on a regular basis, which is not only a considerable burden on the patient and their family but also on institutional resources. **It was found that the addition of WGJ into the diets of the patients at 100ml of fresh juice daily reduced transfusion requirements in 50% of patients. Reduction in the amount of blood transfused in the WGJ period as compared to the pre-WGJ period, by 25% or more without any concomitant fall in the mean pre-transfusion haemoglobin.**

Although showing beneficial results for those WGJ consumers the study does point out how it could be recognized to have a bias towards 'responders' when a significant proportion of cases were rendered 'inevaluable' for failing to adhere to the criteria in the study protocol. Again, further evidence and in-vivo studies on a larger scale are necessary. This leads the authors to conclude that WGJ has the potential to lower transfusion rates in thalasseemics but they do not wish to speculate on the mechanism of the beneficial action.(RK Marwaha, 2004)

Conclusion

After reviewing the literature available surrounding this subject the most apparent gap in knowledge is the lack of substantial in-vivo clinical trials in regard to its medicinal use. The clinical application of chlorophyll extracted from WGJ provides scope for further investigation. Antioxidant activity is a potential avenue, especially since resistance build up is an impending evolution in the clinical sciences and novel or new methods to apply useful properties to modern medicine should be regarded as worthy of investigation. Although the anecdotal literature does seem to provide enough evidence for its use to be fairly widespread, a reliable evidence based approach can explore its future potential as a treatment for serious illness on its own or in conjunction with modern medicine. The applications are extensive and further investigation into the compounds that are concentrated in wheatgrass. The question of bioaccessibility certainly shows gaps in knowledge that can only really be explored with further in-vivo trials.

Further study on natural chlorophyll in comparison with synthetic substances could provide treatment with fewer or no side effects. These kinds of applications are not feasible until the gap in sufficient in-vivo clinical trials are conducted. Wheatgrass is well established as a

“functional food” and future research could substantiate this claim as well as provide new and validated ones.