Wheatgrass (*Triticum aestivum* L.) – natural food supplement

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Abstract

Wheatgrass is used as food supplement in the form of fresh juice, powder or tablets. The main reasons for the use of wheatgrass as a food supplement are high quality chemical composition and a presence of numerous nutraceuticals. Wheatgrass is rich in chlorophyll, minerals, vitamins, proteins, enzymes and have high antioxidant potential. The aim of this paper was to give a short review of recent researches related to nutritional quality of wheatgrass.

Key words: functional food, wheatgrass juice, antioxidants, nutraceuticals

Introduction

Wheatgrass represents young shoots of the plant species from Triticum spp. Harvested prior to jointing stage, wheatgrass shoots can be used as a natural food supplement in the form of juice, powder or capsules. The idea of wheatgrass as dietary supplement started to develop in the 1930s, when agricultural chemist Charles F. Schnabel discovered that wheatgrass has high nutritional value. About the same time, C. Sounders published his paper "The Nutritional Value of Chlorophyll as Related to Hemoglobin Formation" that rises interest in research of chlorophyll role in a human health. The majority of researches on chlorophyll in that period were done on dehydrated wheatgrass. During his life, F. Schnabel advocated usage of dehydrated powder, produced from wheatgrass grown for 200 days during winter in the field (in his case glacial soils in northeastern Kansas, northern Missouri and central Iowa).

On the contrary, majority of wheatgrass produced today grows for 8 to 12 days in a glasshouse or other controlled environments. Although harvested at the same stage, according to Schnabel and other authors, wheatgrass grown for a short period is impoverished in nutritional quality in comparison to field grown wheatgrass. Supporter and promoter of raw food and usage of fresh wheatgrass juice, Ann Wigmore, popularized cultivation of wheatgrass in controlled conditions. She developed system for wheatgrass cultivation in shallow plates and introduced a usage of wheatgrass juicer.

Regardless of the way of cultivation, wheatgrass has a high antioxidative activity, high concentrations of chloroplast pigments, minerals, vitamins, bioflavonoids and essential amino acids. Due to its chemical composition, wheatgrass has a wide range of health benefits. Many researches have been done to examine specific action of substances within wheatgrass in certain illnesses. Until now, wheatgrass has been used in therapy of chronic illness (Chauhan, 2014; Sharma et al., 2013), but it can also be used to detoxify an organism, to improve blood by increase in haemoglobin level or to boost immunity (Polshettiwar and Khorate, 2016; Rana et al., 2011; Singhal et al., 2012). Besides, wheatgrass shown success in a cancer prevention as well as antiproliferative activity in some cancerogenic cell lines (Shikha Rana et al., 2017; Tandon and Arora, 2011). Due to its nutraceutical properties, wheatgrass is considered as functional food (Ogutu, 2017). Global dietary supplements market is on the rise, and it is expected to reach 220 billion US dollars in 2020 (https://www.statista.com/statistics/828514/total-dietary-supplements-market-size-globally/) High demand for dietary supplements opens opportunity for production and trade of natural food supplements, and wheatgrass is a prominent candidate for such usage.

The aim of this paper is to give an overview of nutritional benefits of wheatgrass in human nutrition with emphasis on mineral content, antioxidants properties and chlorophyll content – important properties of natural food supplement.

Mineral content and *in vitro* bioaccessibility of minerals in wheatgrass

Minerals are essential for proper functioning of a human organism. Depending on the required quantity, they are divided on micro and macro elements. A recommended daily intake of different minerals differs mostly in relation to gender, age and health status. Recommended daily intakes based on a 2000-calorie intake for people of four or more years of age are shown in Table 1 (https://www.lenntech.com/recommended-daily-intake.htm#ixzz5VUpylhJp). Available results of mineral content of wheatgrass are highly diverse. A main reason for that is in a non-uniform methodology of wheatgrass cultivation (different species or cultivars, different substrates, fertilization, light intensity, duration of cultivation, etc.), in different preparation of juice or powder and in different laboratory techniques used for determination of minerals. Furthermore, there is a high difference in mineral content regarding the material used for determination (wheatgrass juice, wheatgrass powder, wheatgrass shoots, etc.).

Table 1. Recommended daily intakes of minerals

Mineral	RDI[1]	Mineral	RDI[1]	Mineral	RDI[1]
Boron	< 20 mg	Iodine	150 µg	Phosphorus	1000 mg
Calcium	1000 mg	Iron	15 mg	Potassium	3500 mg
Chlorine	3400 mg[2]	Magnesium	350 mg	Selenium	35 µg
Chromium	120 µg	Manganese	5 mg	Sodium	2400 mg
Copper	2 mg	Molybdenum	75 µg	Vanadium	< 1.8 mg
Fluorine	3.5 mg	Nickel	< 1 mg	Zinc	15 mg

[1] Recommended daily intake; [2] in chloride form

Most commonly determined minerals in wheatgrass are minerals that have significant beneficial role in a human organism (table 2). Recommended dosage of wheatgrass juice is up to 30 ml daily. On the basis of mineral concentrations presented in Table 2, consumption of 30 ml of wheatgrass juice daily will cover 0.14 - 3.8% RDI for Mg, up to 4.3% RDI for Fe, 0.03 - 0.5% RDI for Zn and 0.4 - 1.8% RDI for Ca. (table 1 and table 2). In comparison to raw vegetables, average Mg content in the edible portion of raw fruits and vegetables was 15 mg/100 g (Cunningham et al., 2001) and 6 - 16 mg/100 g in cabbage and lettuce (Mayer, 1997). Accordingly, wheatgrass can contain three times more Mg (Reddy et al., 2008), than raw fruits and vegetables.

Total mineral concentration is important, but from a nutritional point of view, it is more important to know what quantity of an ingested nutrient will be absorbed in an organism and will be available for physiological functions. That quantity represents nutrient bioavailability (Etcheverry et al., 2012). Nutrient bioavailability differs from nutrient bioaccessibility, that is the amount of ingested nutrient that is potentially available for absorption in an organism (Etcheverry et al., 2012). Bioavailability and bioaccessibility are most commonly determined by static *in vitro* digestion methods (Egger et al., 2016; Minekus et al., 2014; Kiers et al., 2000).

Table 2. Concentrations of micro and macro elements in wheatgrass

	Chauhan, 2014	Ghumman et al., 2017		Fortună et al., 2018	Reddy et al., 2008
	WGJ[1]	WGJP[2]	WGSP[3]	WGJ[1]	WGSP[3]
	mg 100 mL^{-1}	mg kg^{-1}	mg kg^{-1}	mg L^{-1}	mg 100 g^{-1}
K	57	308	303	44.59 – 92.90	
P	8.2	-	-	-	66.7
Ca	2.4	54	106	117.22 – 208.15	59.5
Na	1.42	-	-	55.19 – 78.88	-
Mg	1.7	16.37	21.35	5.61 – 14.59	44.2
Mn	-	0.045	0.060	3.19 – 10.19	0.34
Fe	0.02	0.07	0.32	0.27 – 0.33	2.13
Zn	-	0.14	0.74	-	0.21
Cu	-	0.02	0.30	-	-

[1] wheatgrass juice; [2] wheatgrass juice powder; [3] wheatgrass shoot powder;

Static in vitro digestion methods are fast and relatively cheap, but not as accurate as in vivo methods, so they should be used for screening purposes only (Etcheverry et al., 2012).

Bioaccessibility of micro and macro elements from wheatgrass were usually obtained by in vitro gastric and gastro-intestinal digestion methods. Currently, there is no standardized in vitro digestion method, but only a proposal of standardized method (Minekus et al., 2014). That is why available results on bioaccessibility of micro and macro elements were obtained by various in vitro digestion methods. In addition, the concentration of minerals was measured by different techniques, making it difficult to make comparison. There are only few published papers regarding mineral bioaccessibility from wheatgrass. In general, concentrations and bioaccessibilities of minerals are higher in wheatgrass grown on soil in comparison to cultivation without soil (Kulkarni et al., 2007). Besides, duration of cultivation also affects bioaccessibility of minerals (Kulkarni et al., 2009). Regarding the bioaccessibility of K, Mn, Zn, Fe and Na higher percentages were obtained after gastro-intestinal digestion compared to gastric digestion (Kulkarni et al., 2007).

Antioxidant activity and chlorophyll content of wheatgrass

Wheatgrass contains antioxidant enzymes (superoxide dismutase and cytochrome oxidase) that have the potential to convert reactive oxygen species (ROS) to the hydrogen peroxide and an oxygen molecule. Different researches reported high antioxidant activity (Kulkarni et al., 2006; Rana et al., 2017) and anti cancerogenic effect (Alitheen et al., 2011; Rana et al., 2017) of wheatgrass. In comparison of free radical scavenging activity in different wheatgrass extracts, crude ethanolic extract showed highest free radical scavenging activity (Kulkarni et al., 2006; Tandon and Arora, 2011). In fact, ethanolic extract of wheatgrass showed higher free radical scavenging activity than ascorbic acid (Tandon and Arora, 2011). Antioxidant activity of wheatgrass is changed during the shoot growth, and maximum antioxidant potential is reached after 7 days of plant growth (Chauhan, 2014). Wheatgrass growing conditions (temperature, light), method of preparation and storage as well as duration of storage affects the antioxidant activity and chlorophyll content of wheatgrass juice (Skoczylas et al., 2018).

Recent researches revealed that wheatgrass contained high amounts of chlorophyll (Sharma et al., 2013). In comparison to broccoli (6.73 ± 0.67), a field grown wheatgrass juice had 9.4 and 4.7 fold higher concentration of Chl a and Chl b, respectively. A tray grown wheatgrass juice also had 2.2 and 1.7 fold higher Chl a and Chl b concentration, respectively, in comparison to broccoli (Wakeham, 2013). Due to similarity to haemoglobin in chemical structure, chlorophyll showed success in treatment of blood diseases, especially in treating anaemia (Ogutu, 2017). Besides it is assumed that wheatgrass has disease – protective role (Chauhan, 2014), reduces the risk of breast cancer an provide beneficial effects in liver, colon, stomach and gastrointestinal cancer (Singh et al., 2012).

Conclusions

Wheatgrass contains all-important minerals, have high concentration of chlorophyll and high antioxidative potential. These characteristics make the wheatgrass a valuable dietary supplement. Based on available literature, we can conclude that the technology of wheatgrass cultivation as well as preparation and preservation of wheatgrass juice or powder are very diverse. In addition, determination of nutrients in wheatgrass has been carried out by various methods. In view of this, it would be good to harmonize methodology in order to make the results more comparable.

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Pšenična trava (*Triticum aestivum* L.) – prirodni dodatak prehrani

Sažetak

Pšenična trava se koristi kao dodatak prehrani u obliku svježeg soka, praha ili tableta. Kvalitetan kemijski sastav i visok sadržaj nutraceutika glavni su razlozi korištenja pšenične trave kao dodatka prehrani. Pšenična trava sadrži visoke koncentracije klorofila, minerala, vitamina, proteina i enzima te ima visoku antioksidativnu aktivnost. Cilj ovog rada je dati kratak osvrt na najnovija istraživanja hranidbene vrijednosti pšenične trave.

Ključne riječi: funkcionalna hrana, sok pšenične trave, antioksidant, nutraceutik