

VITAMINS CONTENT IN WHEAT GRAIN

Muhammad Usman¹, Laiba Kuasar^{1*}, Maham Tariq¹, Rabia Zafar¹, Anam Jamil¹, Zulqarnain¹

¹Department of Human Nutrition and Dietetics (HND), The Islamia University of Bahawalpur (IUB), Pakistan

*Corresponding author e-mail: laibakosar918@gmail.com

ABSTRACT Wheat, an indispensable global staple food, boasts a diverse nutrient profile pivotal for human health. Its richness in carbohydrates, proteins, dietary fiber and vital vitamins, such as A, B complex, E, and K renders it a cornerstone in addressing nutritional deficiencies and supporting optimal bodily functions. The loss of B vitamins during milling and the intricate metabolism of fat-soluble vitamins underscore the significance of wheat in nourishing diets. Influenced by cultivation and processing, wheat's vitamin content serves as a target for strategies like bio-fortification to combat global under nourishment. As a significant calorie source, wheat offers not only energy but also essential nutrients and fiber, essential for a balanced diet. The intake of wheat fiber shows promises in potentially reducing colorectal cancer risk by positively impacting gut health. Moreover, the vitamins present in wheat contribute extensively by supporting bodily functions, acting as antioxidants, regulating genes, and aiding in disease prevention. In essence, the nutritional richness of wheat plays a critical role in enhancing overall health and mitigating disease risks. This comprehensive review provides an in-depth analysis of wheat's nutritional contributions and health benefits, encompassing a detailed examination of the nutritional composition of wheat grain to facilitate a better understanding. The emphasis is placed on elucidating the trace amounts of vitamins essential in wheat, delineating the precise quantities and types of vitamins attainable from wheat consumption.

Keywords: *Wheat; Nutrients; Vitamins; Diet; Bio-fortification*

INTRODUCTION

Wheat has consistently held a pivotal role as a foundational grain, serving as a fundamental dietary constituent for centuries. Beyond its primary recognition as a staple food, the complex constitution of wheat grain, particularly its vitamin composition, carries significant relevance for global health and overall well-being. Wheat can be considered the foremost staple crop across worldwide (Mir et al., 2014). The nutritional significance of wheat is highly crucial, given its prominent role as a staple food among a select number of extensively cultivated crop species. Wheat's significance primarily stems from its seeds, which can be processed into flour, semolina, and other derivatives, constituting fundamental components of bread, bakery goods, and pasta. Consequently, it stands as a primary nutrient source for a vast portion of the global population (Šramková et al., 2009).

The primary perception of wheat centers on its function as a pivotal energy source, primarily providing carbohydrates that indisputably carry substantial significance. However, wheat also encompasses noteworthy quantities of essential nutrients, including proteins, fiber, and minor constituents consisting of lipids, vitamins, minerals, and phytochemicals. These

constituents have the potential to contribute to a nourishing dietary regimen (Shewry et al., 2015). Antioxidants and vitamins play significant roles in the human nutrition (Granda et al., 2018). Vitamins are organic molecules with low molecular weight. The body either does not produce vitamins at all or synthesizes them in very little amount (Omonnazarova et al., 2022). Vitamins belong to a category of organic compounds crucial in small amounts for optimal physiological functions in the human body. Inadequate or unbalanced dietary intake, along with distinct cultural dietary habits, have been linked to certain health conditions due to deficiencies in these vital micronutrients. Such deficiencies can lead to identifiable disease patterns (Ball, 2008).

Nutritional Composition of Wheat Grain: Wheat is commonly known for its role as a predominant provider of energy in the form of carbohydrates, and indeed, it holds significant importance in this regard. Nevertheless, it comprises notable quantities of other essential nutrients, such as proteins, fiber, and various minor components encompassing lipids, vitamins, minerals, and phytochemicals. These additional elements have the potential to contribute substantially to a well-rounded and healthy diet (Shewry and Hey, 2015b). Globally, a vast number of people, reaching billions, heavily depend on wheat as a

significant part of their diet. This makes understanding the nutritional importance of wheat proteins crucial, especially in less developed regions where items like bread, noodles, bulgur, and couscous constitute a substantial portion of daily meals. Wheat contributes approximately 55% of carbohydrates and 20% of total food calories (Table 1). Its composition consists of

about 78.10% carbohydrates, 14.70% proteins, 2.10% fats, and 2.10% minerals. Moreover, it contains notable amounts of vitamins (such as thiamine and vitamin B) and minerals like zinc and iron. Additionally, wheat serves as a reliable source of trace minerals like selenium and magnesium, which are vital nutrients for maintaining good health (Kumar et al., 2011).

Table 1: Food composition in terms of the retail weight ("as purchased") in 100 grams

Cereals And Products	CALORIES (kcal)	PROTEIN (Grams)	FAT (Grams)
Wheat grain	334	12.2	2.3
Flour of Wheat	364	10.9	1.1
Bran of Wheat	213	12.1	3.1
Germ of Wheat	382	29.1	10.7
Wheat Starch	362	0.5	0.3
Wheat Gluten	380	95.0	0.0

Vitamins content in a wheat grain: Wheat contains nutrients essential for human health including carbohydrates, protein, vitamins, dietary fiber, and phytochemicals (Shewry and Hey, 2015b). Whole grain cereals are rich in water and fat soluble vitamins including A, B1, B2, B3, B5, B6, B9, E, and K, although some are not good sources of vitamins B12, C, and D.

Water soluble vitamins: Water soluble vitamins include B and C vitamins. Seed coat and germ contain B vitamins (Garg et al., 2021). Firstly, they were thought to be as a single compound. Researchers suggest that they are composed of eight components and are water soluble in nature (Shewry and Hey, 2015a). Cereals are good source of B vitamins excluding vitamin B12. Vitamin content of whole grain cereals is high as compared to milled (Garg et al., 2021).

Fat soluble vitamins: Fat-soluble vitamins encompass vitamin A, D, E, and K, crucial micronutrients essential for human growth and development. These vitamins, obtained from dietary sources, fall into two categories: water-soluble and fat-soluble. Water-soluble vitamins, consumed through diet, are excreted from the body in excess. In contrast, fat-soluble vitamins are stored in fatty tissues and the liver. Each fat-soluble vitamin further subdivides based on molecular structure. For instance, vitamin A comprises retinoids (like retinol, retinal, and retinyl esters) and carotenoids. Carotenoids, such as beta-carotene, found in plants, convert to vitamin A. Vitamin E divides into tocopherols and tocotrienols, each containing subgroups. Vitamin K segregates into phylloquinones and menaquinones. Vitamin D branches into vitamin D2 ergosterol and vitamin D3 cholecalciferol. The absorption and metabolism of fat-soluble vitamins involve intricate processes in the body. These vitamins are absorbed in the intestines through metabolic pathways in the presence of fat. They possess unique structures and necessitate carrier proteins or lipoproteins for transportation into circulation. Subsequently, they are transported to the liver or stored in adipose tissue for utilization. Deficiencies in fat-soluble vitamins can significantly impact various bodily systems, notably the immune system.

Vitamin A: Vitamin A is found in two forms: retinol (in animal) and provitamin A carotenoids (in plant tissue) (Čurná and Lacko-Bartošová, 2017). Carotenoids are synthesized by plants and are required for good human health thus taken through diet as are not synthesized in human body but carotenoid pigments are lost during milling, storage and processing (Hussain et al., 2015). The typical yellow corn possesses less than 2 micrograms per gram ($\mu\text{g/g}$) of provitamin A carotenoids and can contain up to 20 $\mu\text{g/g}$ of total carotenoids. In contrast, yellow durum wheat contains 3 $\mu\text{g/g}$ of total carotenoids (Ortiz-Monasterio et al., 2007)

Vitamin E: Plants contain vitamin E as tocopherols and tocotrienols. They are found in the oil-rich germ layer. Cooking also affects its content in food for example whole wheat bread contains 18% RDA/100 g of vitamin E which is lost in cooked white rice as 0% RDA. It is a fat soluble vitamin and is lost while losses milling from 80 to 85%. Cooking also reduces its content.

Vitamin K: There are three primary forms of vitamin K, namely K1 (phylloquinone), K2 (menaquinones), and K3 (menadiones) (29). Cereals do not serve as a significant provider of vitamin K. (Ortiz-Monasterio et al., 2007). Whole wheat bread contains about 7% RDA of vitamin K which is lost while cooking (Garg et al., 2021).

Factors Affecting Vitamin Levels in Wheat Grain: Wheat contains a diverse array of B vitamins (Table 2) that are water soluble in nature. These water-soluble molecules exert pivotal functions in metabolic processes occurring in the body. Researches indicate noteworthy disparities in B vitamin concentrations, primarily attributed to varietal differences, geographical cultivation conditions (notably for thiamine and riboflavin), soil composition, and annual variations (particularly for thiamine and pyridoxine) (Batifoulier et al., 2006). In the context of a review paper, it is noteworthy that manure application generally results in an elevation of thiamine concentration, whereas herbicide usage tends to diminish it. Conversely, the utilization of fertilizers or herbicides does not exhibit a discernible impact on riboflavin concentration. Storage conditions, milling procedures, and the bread-making process

represent influential factors capable of affecting B-vitamin concentrations in grain flour and bread, respectively (Batifoulie et al., 2006). Accumulating scientific evidence suggests a correlation between the decline in cereal consumption and the

simultaneous rise in the intake of more refined products with the manifestation of marginal deficiencies in micronutrients, particularly thiamine (Batifoulie et al., 2006).

Table 2: The concentration of loss of B vitamins in whole and milled wheat grains

Vitamins	Whole	Milled	Losses (%)
Vitamin B1	0.38	0.12	68
Vitamin B2	0.11	0.04	64
Vitamin B3	4.38	1.25	71
Vitamin B5	0.95	0.43	55
Vitamin B6	0.36	0.36	80
Vitamin B9	0.56	0.56	66

Source- USDA Food data central (Granda et al., 2018).

Health Implication and Nutritional Significance: Almost half of the global calorie intake originates from wheat consumption. Wheat serves as a notable reservoir of essential nutrients, including proteins like gluten, a variety of minerals, both fat-soluble and water-soluble vitamins, as well as dietary fiber and various advantageous bioactive elements such as phytochemicals (Khalid et al., 2023, Shewry et al., 2011). These items serve as valuable providers of nutrients crucial for optimal growth and proper functioning of the body. This means they contain essential elements necessary for the body's development and its ability to perform various functions effectively. (Garg et al., 2021). Wheat is commonly recognized as a significant calorie source because of its substantial starch content, constituting approximately 60-70% of the whole grain and 65-75% of white flour (Shewry, 2009). Despite being a calorie provider, it's crucial to complement wheat consumption with other nutrient-dense foods for a comprehensive and balanced diet. The significance of wheat proteins in terms of nutrition should not be undervalued, especially in regions with less developed food resources where staples like bread, noodles, and various products such as bulgur and couscous contribute significantly to the dietary intake (Shewry, 2009). Studies indicate that the consumption of wheat fiber can lead to increased bowel movements, reduced gut transit time, and a potential decrease in the risk of colorectal cancer. The fermentation of non-digestible carbohydrates in the colon may bring about favorable changes in the gut's microflora, resulting in increased production of beneficial compounds like short-chain fatty acids (Dalton et al., 2012).

CONCLUSION

Vitamins play crucial roles as antioxidants, supporting the body's defense mechanisms against oxidative stress. Additionally, they participate in genetic regulation, cellular integrity, and various metabolic processes, which are fundamental for optimal physiological functions. Moreover, the presence of vitamins in wheat contributes to disease prevention, ranging from common ailments to more severe conditions. The vitamins' collective action supports immune function, aids in neurological health,

promotes skin health, and has been associated with a reduced risk of certain cancers and gastrointestinal disorders. Understanding the nutritional content of wheat, especially its rich vitamin profile, emphasizes the need to incorporate this staple into daily diets. However, it's essential to highlight the importance of consuming a diverse range of nutrient-rich foods alongside wheat to achieve a well-balanced and comprehensive nutritional intake.

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