



Review Article



Nutritional and Health Promoting Attribute of Kidney Beans (*Phaseolus vulgaris* L.): A Review

Fatima Shabir* and Sajjad Ahmad Khan

School of Agricultural Sciences, Glocal University Saharanpur UP 247231, India

*Corresponding author e-mail: fatimashabir1415@gmail.com

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ABSTRACT

Red kidney bean (*Phaseolus vulgaris* L.) is nutritious and their consumption is associated with many health benefits that can fight against protein malnutrition. Starch, the most common carbohydrate reserve in plants, is present in legume seeds and has been associated with both cultural and nutritional advantages. Kidney bean seeds' main constituent is starch, which accounts for 25–45% of their dry matter. It also goes by the names Rajmash and common bean. Kidney bean starches are more soluble and have less swelling than cereal starches, which suggests that they have more functional qualities. Due to its properties and interactions with other ingredients, particularly water and lipids, which can greatly affect the final product's quality, starch is of interest to both the food industry and human nutrition as a macro-ingredient in many foods.

Keywords: Red kidney beans, protein, carbohydrates, vitamins, flavonoids

INTRODUCTION

Legumes are a good source of protein—two to three times that of cereal grains—as well as dietary fibre, vitamins, minerals, and starch. In many nations where protein energy malnutrition is a major problem, the different kinds of beans are a staple diet and an inexpensive source of protein. Recently, Kidney beans has been identified as a possible substitute for meat products and as a strong antioxidant. Its lower glycemic index makes it beneficial for those with diabetes, as well as for those with cardiovascular conditions, atherosclerosis, breast cancer, and increased satiation (Gutiérrez-Urbe, 2013). The scientific name for kidney beans is *Phaseolus vulgaris* L. These are popular legumes that are valued for their nutritious content and adaptability in the kitchen (Jones *et al.*, 2019; Uusiku *et al.*, 2013). They contribute to dietary diversity and general well-being by being an essential component of many different cuisines around the world. Because of their reddish-brown coloring and kidney-shaped form, kidney beans are also known as "common beans" or "red beans." From ancient times, kidney beans have been cultivated and consumed. Kidney beans came from Central and South America and were then traded through the Columbian Exchange to other regions of the world (Gepts *et al.*, 2008). Kidney beans are a staple food for many different kinds of people because they are grown across North and South America, Africa, and Asia nowadays. With their remarkable nutritional profile, kidney beans are a great complement to a balanced diet. They provide a harmonious combination of vital

micronutrients and macronutrients. The macronutrients consist of a little quantity of fat, proteins, and carbs. Minerals like iron, potassium, and magnesium are among the micronutrients included in kidney beans, along with vitamins like folate, thiamine, and vitamin K (Drewnowski, 2014; Tsai *et al.*, 2017). There are a number of health advantages linked to kidney bean eating. Kidney beans' high dietary fiber content helps to maintain regular bowel movements and the growth of good gut flora, both of which are helpful to digestive health (Pereira *et al.* 2013; Tosh *et al.* 2013). In addition to its ability to help control weight and glucose levels, this high-fiber legume may also lower the chance of developing chronic illnesses like heart disease and some forms of cancer (Bazzano *et al.*, 2013; Aune *et al.*, 2017). Kidney bean processing techniques have an effect on the nutrients they contain. Cooking techniques like steaming or boiling can assist kidney beans maintain their nutrients (Mudryj *et al.*, 2014).

Techniques including canning, freezing, and dehydration also help to retain some of the nutrients (Martínez *et al.*, 2019). Furthermore, kidney beans can have their levels of anti-nutritional factors decreased and their nutrient availability increased by soaking and sprouting (Aguilera *et al.* 2016; Yadav *et al.* 2020). Kidney beans are versatile enough to be used in the creation of goods with additional value. Dried kidney beans are ground to create kidney bean flour, which is becoming more and more well-liked for its numerous uses in baked goods, snacks, and gluten-free items (Bai *et al.*, 2018). In

response to consumer expectations for healthier options, convenience foods and snacks made from kidney beans are also being developed (Yang *et al.*, 2021).

Furthermore, the functional qualities of kidney bean protein isolates and extracts are being investigated for possible application in food formulations (Wang *et al.*, 2020). Kidney beans are important for maintaining good health and warding off many ailments. Because of their high fiber content and low glycemic index, kidney beans can assist diabetics control their blood sugar levels (Viguiliouk *et al.*, 2014; Bazzano *et al.*, 2013).

Nutritional aspects

The most significant food legume for human consumption worldwide is *Phaseolus*. Its seeds are a good source of protein and nitrogen, but they are mostly composed of carbohydrates. In addition, it has sulphur, copper, iron, zinc, manganese, magnesium, potassium, phosphorus, and calcium. This legume is full of bioactive substances that play metabolic roles in both humans and animals, including lectins, phytates, oligosaccharides, and phenolics. *Phaseolus* has a protective effect against cardiovascular diseases because of its biological activities, which include the capacity for antioxidants, the reduction of cholesterol, and the reduction of low-density lipoproteins. Because of its phenolics, lectins, and protease inhibitors' anti-mutagenic and anti-proliferative qualities, it has also demonstrated positive effects against cancer. Because of its resistant starch and α -amylase inhibitor content, it has also demonstrated effects on diabetes and obesity. An overview of the health benefits of beans as a nutraceutical food is provided here. (Bhatty, 2016).

Antioxidant profile

According to Lima *et al.* (2016), antioxidants are substances that shield animal, human, and other cell types from the damaging effects of free radicals. Plants naturally produce flavonoids and phenolic acids, which are natural sources of antioxidants. According to Dai and Mumper (2010), they are more effective antioxidant sources than vitamins C, E, and carotenoids. The capacity of phenolic and flavonoid compounds to modulate antioxidant defence by scavenging radical species is what gives rise to their antioxidant properties (Cotelle, 2017). The number of free hydroxyl groups in the molecular structure determines the reduction property of phenolic compounds (Ghasemzadeh and Ghasemzadeh, 2011), whereas the position of hydroxyl groups and other features in the chemical structure determine the antioxidant potential of flavonoids (Saxena *et al.*, 2012).

Manganese, a trace mineral that is vital for many enzymes involved in energy production and antioxidant defences, can be found in kidney beans. Manganese, for instance, is necessary for the essential oxidative enzyme superoxide dismutase, which neutralizes free radicals created in the mitochondria, our cells' factories for producing energy in (Pilbeanu *et al.*, 2017).

Amino acids profile

Excellent amino acid profile is exhibited by red kidney beans, which are primarily high in arginine, leucine, aspartic acid, glutamic acid, and lysine. When combined with cereals and other products that contain sulphur, beans offer the ideal amount of essential amino acids (Boye *et al.*, 2010a). Aspartic and glutamic acids are primarily acidic substances found in both raw and processed beans. The FAO/WHO amino acid requirements for teenagers are met by both raw and processed red kidney beans, with the exception of cysteine, methionine, and tryptophan. According to Audu and Aremu (2011), 10.2g of glutamic acid, 9.5g of aspartic acid, 1.2g of cysteine, 1.7g of methionine, 3g of histidine, 4.4g of alanine, 5.2g of glycine, 3.4g of threonine, 3.3g of proline, 3.7g of isoleucine, 3.1g of tyrosine, 4.6g of phenylalanine, 4.1g valine, 3.1g of serine, 6.9g of arginine, 7g lysine, and 7.2g of leucine are supplied by red kidney beans per 100g. Legumes high in methionine and threonine are cowpeas. It also contains two non-essential amino acids, glutamic acid and aspartic acid. According to Iqbal *et al.* (2006), lentils are high in non-essential amino acids but cowpeas have a higher concentration of essential amino acids. The limiting amino acids for broad beans are cysteine and methionine. Though they are less common than eggs, most other EAAs nevertheless meet people's needs (Mortuza *et al.*, 2009).

Dietary fiber

According to Zhang *et al.* (2011), dietary fibre can be categorized as soluble or insoluble, and each class has unique physiological effects (Ajila and Rao, 2013). For nutritional and functional qualities, the proportion of two classes of dietary fibre matters (Liu *et al.*, 2021). The GIT is the site of bacterial fermentation that soluble dietary fibre encounters, impacting the metabolism of fats and carbohydrates. On the other hand, insoluble fraction prevents the growth of rectal cancer and lowers the incidence of constipation by shortening the gastrointestinal transit time (Bingham *et al.*, 2018). Dietetic fibre is a diverse range of non-digestible substances, including resistant starch, soluble and insoluble fibre, and oligosaccharides like mullein, raffinose, and estachyose. According to Cruz-Bravo *et al.* (2011), the common bean (*Phaseolus vulgaris* L.), which is primarily consumed in Latin America, has a high fibre content. Rats fed a pancreatin-resistant fraction made from *Phaseolus vulgaris* beans (Kintoki beans) exhibited significantly higher levels of Cholesterol 7- α -hydroxylase when compared to rats fed a cellulose diet. In the small intestine, it also reduced bile acid absorption and raised intestinal content viscosity (Han *et al.*, 2004). Long-term bean consumption has been demonstrated to lower serum levels of low-density lipoprotein (LDL) and cholesterol in humans, suggesting that beans may provide some protection against cardiovascular diseases (Bazzano *et al.*, 2013). *Phaseolus mungo* fibre was isolated, and it revealed a neutral detergent residue (NDR). It significantly reduces

cholesterol and increases the excretion of bile acid in faeces (Rebello *et al.*, 2014).

Gluten-free

A gluten-free diet is recommended for those with celiac disease, as gluten is a protein present in many grain products. Their diet has to change to exclude these products, which raises the possibility of deficiencies in various B-vitamins and other nutrients that are normally present in grains (Niewinski *et al.*, 2008). In addition to having many of the same vitamins and minerals—such as thiamin, riboflavin, folate, iron, and fiber—that are frequently found in enriched grain products, beans are naturally gluten-free. Because bean flour can be combined with other gluten-free flour (like rice or tapioca flour) they may be especially helpful for people on gluten-free diets (Bai *et al.*, 2018).

Health benefits of kidney beans

Kidney beans and cancer

One term for cancer is a multi-step disease. Cancer develops as a result of a variety of direct and indirect factors, including genetic, physical, chemical, metabolic, and environmental factors (Aparicio-Fernández *et al.*, 2017). Cancer is thought to be caused by aberrant cells that divide cellularly and replicate their DNA on their own. This results in the formation of cancerous tumours, which destroy surrounding tissue and the lymphatic system. Red kidney beans are said to contain phenolic acids with anticancer properties (Nyau, 2014; Gibson *et al.*, 2017). They have the ability to function as an inhibitor and prevent tumours from growing once they have started. According to Scalbert *et al.* (2015), they can also inhibit cell proliferation *in vitro*. More proof of a negative correlation between bean consumption and the development of cancer has come from epidemiological and preclinical research assessing prostate and colon cancer (Thompson *et al.*, 2012). In developed nations, colorectal cancer ranks as the second most common cause of cancer-related deaths. Studies aimed at detecting it have not reduced the disease's incidence or mortality, so efforts to prevent it have centered on lifestyle modifications (Derry, Raina, Agarwal, & Agarwal, 2013). Dietary fibre may be protective against colorectal cancer, according to epidemiological data. According to a study (Reynos-Camacho *et al.*, 2007), rats given pinto, black, and white beans while they were being treated for colon cancer had four times fewer tumours grow.

Kidney beans and diabetes mellitus

The major goal of managing diabetes is controlling blood glucose levels. A key component of type 2 diabetes management is glycaemic control. By slowing down and reducing the absorption of glucose from the intestine, the soluble fibre fraction can regulate the glycemic (Ricardo-da-Silva *et al.*, 2019)). Studies pertaining to individuals with diabetes have demonstrated that diets with lower GI ratings and higher fibre content result in better levels of glycated proteins, which can help regulate the glycaemic index (Kendall *et al.*, 2016). According to Eshak *et al.* (2010), they can decrease the

incidence of type 2 diabetes by decreasing the rate at which macronutrients are absorbed and digested, as well as the duration of time that the intestinal lumen is in contact with carcinogens (Raninen *et al.*, 2011). Water soluble fibres enter the small intestine, thickening its contents and modifying the process of digestion by decreasing the time that nutrients diffuse for absorption and the interaction between food and digestive enzymes. A higher frequency of atherosclerotic plaques, endothelial dysfunction, and an increase in intima-media thickness are all correlated with hyperglycemia in type 2 diabetes mellitus (DM2). This is connected to a rise in oxidative stress brought on by thrombin synthesis, low-density lipoprotein oxidation, and platelet activation, all of which raise the risk of DM2-related cardiovascular illnesses (Barrett and Udani, 2011). The reduction of tiobarbituric acid and hydroperoxide reactive substances was observed in streptozotocin-induced diabetic rats after an oral administration of an ethanolic extract from *Phaseolus vulgaris* (200 mg/kg body weight) for 45 days. In the liver and kidneys, the extract significantly increased reduced glutathione, superoxide dismutase, catalase, glutathione peroxidase, and glutathione-S-transferase. According to Venkateswaran and Pari (2012), the extract was superior to glibenclamide in its ability to lower blood glucose levels.

According to Feregrino-Pérez *et al.* (2008), the starch in beans is slowly absorbed and reduces the postprandial response to insulin. In order to combat obesity and diabetes in humans, the α -amylase inhibitor isoform 1 (α -AI1) has been extracted and utilised in a variety of commercial products (Barrett and Udani, 2011, Zhang, and Jiang, 2008). Eating beans has been associated in epidemiological studies with a lower risk of obesity and overweight. Bean eaters in the US had a 23% lower chance of obesity and a lower systolic blood pressure in adults. According to research conducted on adult Brazilians, eating beans on a regular basis lowers the risk of obesity and overweight in both men (-13%) and women (-14%), (Nilsson, Johansson, Ekström, and Björck, 2013). Furthermore, studies have shown that a bean extract taken by people reduces body weight, fat percentage, and hip and waist circumference (Preuss, 2019).

Kidney beans and cardiovascular disease

Reducing the risk of stroke and cardiovascular disease as well as maintaining healthy blood pressure levels benefits heart health. Diets rich in fruits, vegetables, legumes, whole grains, fish, poultry, seeds, unsalted nuts, and low-fat or fat-free dairy products all lower blood pressure than the control diet, which was based on the average American diet, according to the D.A.S.H. (Dietary Approaches to Stop Hypertension) study. Aune *et al.*, 2017 Potassium is naturally found in many of the food groups that make up the D.A.S.H. eating plan, including beans.

According to Marinangeli *et al.*, 2017, people who ate legumes at least four times a week had a 22% lower risk of heart disease compared to people who ate them less

frequently. Consistent lower risks of heart disease have also been noted in epidemiological studies where the consumption of legumes as part of a healthier diet plan has been observed. Within the Health Specialists Men who followed a more "prudent" diet consisting of more whole grains, legumes, fish, and poultry had a 30% lower risk of heart disease, according to the Follow-up Study. On the other hand, people who ate a more "Western" diet—one that included more red meat, refined grains, sweets, French fries, and high-fat desserts—were at risk of developing heart disease (Hu, (2015). Corresponding patterns were observed in the Nurses' Health Study. The risk of heart disease was halved for those who regularly followed the "prudent" diet as opposed to those who mostly followed the "Western" diet. (Fung, 2011) Legumes have been shown in epidemiologic studies to have heart-protective properties when included in a balanced diet. One study in particular looked at the connection between the incidence of cardiovascular disease (CVD) and bean consumption; it found that consuming one serving (1/2 cup) of beans daily was linked to a 38% lower risk of myocardial infarction (Kabagambe, 2005). According to a second study, people who ate legumes at least four times a week had a 22% lower risk of heart disease compared to people who ate them less frequently (Marinangeli *et al.*, 2017).

Kidney beans and degenerative diseases

Plant metabolites called polyphenols have strong antioxidant qualities that help lessen the effects of oxidative stress-related diseases. The data showed that because dietary polyphenols may help prevent degenerative diseases in people, there is a growing body of research investigating their potential benefits. The potential health benefits of polyphenols are contingent upon their consumption by humans and their bioavailability. *Phaseolus vulgaris* L., or common beans, are a better source of polyphenolic compounds, which have a variety of health-promoting qualities. The health benefits of dry common beans rich in polyphenols include their anti-oxidant, anti-diabetic, anti-obesity, anti-inflammatory, anti-mutagenic, and anti-carcinogenic qualities. In light of the research, the current thorough review seeks to offer current knowledge on the nutritional profiles and health-promoting properties of common beans high in polyphenols. This will aid in the exploration of these beans' potential therapeutic uses in light of future clinical investigations (Abd El-Hack *et al.*, 2021).

Kidney beans and heart health

The majority of beans, including kidney beans, are excellent sources of fibre that lowers cholesterol. Kidney beans are a particularly good option for people with diabetes, insulin resistance, or hypoglycemia because of their high fibre content, which also lowers cholesterol and prevents blood sugar levels from rising too quickly after meals. Kidney beans are an almost fat-free source of high-quality protein when they are combined with whole grains like rice. However, kidney beans are far more beneficial than this. As a necessary component of

the enzyme sulfite oxidase, which is in charge of detoxifying sulfites, kidney beans are a great source of the trace mineral molybdenum. A common type of preservative added to prepared foods like salad bars and delicatessen salads is sulfites. If sulfites are inadvertently ingested by someone who is sensitive to them, they may experience a fast heartbeat, headaches, or disorientation. You may not have enough molybdenum in your stores to properly detoxify sulfites if you have ever reacted to them (Abd El-Hack *et al.*, 2021).

The consumption of foods high in calories density is increased by modern lifestyles, which leads to changes in eating habits. Diets high in fat and high glycemic index, primarily derived from processed and simple sugar-derived goods, raise the risk of developing chronic illnesses. The past few years have seen a decline in the consumption of pulses, especially beans. Research demonstrates that the significance of this vegetable food group lies not only in its nutritional value but also in its association with a decreased risk of serious chronic non-transmissible diseases. *Phaseolus* has a number of advantageous biological activities for humans, including effects on obesity, diabetes, and cardiovascular disease as well as lowering cholesterol and low-density lipoprotein and having anti-mutagenic and anticancer properties. It's critical to work towards increasing bean consumption in order to reap the benefits. Conversely, beans may provide a good source of nutraceuticals for human supplementation; these are primarily compounds that lose their biological activity when cooked (Ros *et al.*, 2019)

CONCLUSIONS

Red kidney beans can help treat a wide range of chronic illnesses that affect people all over the world. Red kidney beans have a very promising future as functional foods and nutraceuticals. Increased use of improved varieties and scientific farm management techniques can result in a significant increase in red kidney bean yields.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

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