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REVIEW ON NUTRITIONAL AND HEALTH PERSPECTIVES OF DRY BEANS: A LEADING NUTRACEUTICAL SOURCE

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ABSTRACT

Beans (*Phaseolus vulgaris* L.) are the most important food legumes for intake by human beings all over the world. The nutrient composition and physiochemical characteristics of dry beans make them preferably suitable to meet two major dietary recommendations to maintain a good health – increase in consumption of starches and complex carbohydrates and decrease in fat intake. Dry beans provide protein, complex carbohydrate, fibre, essential vitamins and minerals in the diet, yet are lower in fat and have no cholesterol. Both protective and therapeutic effects have been recognized. The anti-nutritional effects of dry beans, while minor, are of interest to nutrition professionals. Dry beans excellently enhance the dietary fibre intake. Inclusion of dry beans in health promoting diet is important particularly to meet the major dietary recommendations to decrease the risk for chronic diseases such as coronary heart disease, diabetes, obesity and cancer.

KEYWORDS: Beans, cancer, cardiovascular disease, diabetes, obesity.

INTRODUCTION

Dry beans are edible such as pinto, navy, kidney, pink and black beans (Figure A and Figure B). They belong to the legume family.[1] They are grown worldwide due to the crop's high environmental flexibility.[2] Dry beans are distributed in multiple forms such as whole unprocessed seeds, canned products and gluten-free wheat flour substitute. As a result, 50% of the grain legumes consumed all over the world are dry beans as a human food source. The seed color of beans is determined by the presence and concentration of flavonol, glycosides, anthocyanins, and condensed tannins (proanthocyanidins). Newly, common bean is gaining

interest as a functional or nutraceutical food. It contains a variety of phytochemicals with potential health benefits such as fibre, polyphenolic compounds, lectins, unsaturated fatty acids, trypsin inhibitors and phytic acid. Main biological activities have been described for fibre, polyphenolic compounds, lectins, trypsin inhibitor and phytic acid from common beans like enhancement of the bifidogenic, antioxidant, antimutagenic, anticarcinogenic as well as an antiproliferative effect on transformed cells.[3]

Figure A: Seeds of Dry Beans.

Figure B: Common Green Beans.

Therefore, the objective of this review is to provide information on dry beans as an important crop due to its several health benefits and its therapeutic potential to be used as a nutraceutical food in human diet.

Climatic Requirements

Dry beans flourishes in a warm climate at an optimal temperature of about 18ºC to 24^{0}C. During the flowering stage, temperature exceeding to 30^{0}C can result in yield loss. Delaying

in maturity of beans can also occur if day temperature is below 20^0C. During the growing season, the crop requires a minimum of 400 to 500 mm of rain to flourish whereas the annual total of 600 to 650 mm rain is considered as ideal.

Soil Requirements

Sandy loam, sandy clay loam or clay loam soil with clay content of about 15- 35% is considered suitable for the plantation of dry beans. Sometimes low fertility and nematode damage problem can be seen with sandy soil. Dry beans are not nurtured well in compacted, alkaline and poorly drained soil.

Bioactive Compounds of Dry Beans

Polyphenols

Polyphenolic compounds are present in dry beans. The main polyphenolic compounds are flavonoids such as flavonol, glycosides, anthocyanins and tannins.[4]

Lectins

Lectins are major part of bioactive proteins found in almost all organisms, including plants, vertebrates, invertebrates, bacteria and virus with important biological activity.[5] Lectins are present in legumes in the range of 5% to 20%.[6]

Antioxidant Activity of Common Beans

Antioxidants are vital compounds that save from diseases which caused by free radical reactions.

They offer this protective function by getting oxidized themselves. Free radicals are generated through normal body metabolism, environmental factors such as pollution, radiation, pesticides and cigarette smoke in which oxygen participates in the reaction. Extreme amount of free radicals attack cellular components such as DNA, lipids and proteins which is thought to be an initiating factor for a number of chronic diseases.[7] Dietary antioxidants can prevent these cellular components from oxidative damage therefore it helps to reduce the risk of age related diseases.[8] According to the studies on the antioxidant activity of more than 100 food items using the Oxygen Radical Absorbance Capacity (ORAC) assay, it was reported that common beans (navy, black, pinto, red kidney and small red) have the highest antioxidant activity among the food items.[9]

Chemical Composition

Dry beans are a good source of protein (20– 30%). One portion (90 g or a ½ cup of cooked beans) provides 7 to 8 g of protein.[10] Beans mostly contain carbohydrates (55–65% on dry weight). Of these, the polysaccharide derivative and non-derivative of starch (dietary fibre) are the primary components.[6] Calcium and potassium are the major minerals in common beans. There is greater availability of calcium than magnesium and potassium. Average mineral concentrations of copper, iron, manganese, zinc and sulphur are higher in wild genotypes of beans. However, although some studies have shown considerable variation between wild beans and modern cultivars, it seems that domestication does not affect the concentration of iron and zinc in the seed.[10] Both iron and zinc are found in common beans that are important for the population.[11] Nutrient composition of dry beans has been mentioned (Table 1).

Table 1: Nutrient composition of dry beans.

Nutrients	Amount
Energy (kcal/100 g)	308
Protein (g/100 g)	20.8
Fat (g/100 g)	1.3
Ash (g/100 g)	3.0
Carbohydrate (g/100 g)	56.9
Fibre (g/100 g)	17.3
Calcium (mg/100 g)	105.7
Iron (mg/100 g)	6.2
Magnesium (mg/100 g)	145.4
Phosphorous ((mg/100 g)	332.1
Potassium (mg/100 g)	1076.8
Sodium (mg/100 g)	43.6
Zinc (mg/100 g)	2.2
Copper (mg/100 g)	0.6
Manganese (mg/100 g)	1.1
Selenium (mg/100 g)	3.9
Vitamin C (mg/100 g)	8.9
Thiamine (mg/100 g)	0.5
Riboflavin (mg/100 g)	0.2
Niacin (mg/100 g)	1.7
Pantothenic acid (mg/100 g)	0.8
Vitamin B_6 (mg/100 g)	0.3
Folate (mg/100 g)	243.8
Choline (mg/100 g)	58.7
Vitamin E (mg/100 g)	0.8

Bennink and Rondini (2008).[12]

Anti-nutrients in common beans

Raw beans contain several anti-nutritional components that may limit their consumption. The adverse effects include growth inhibition, low nitrogen balance, decreased intestinal absorption of sugars and amino acids, and an altered immune response. Among the anti-nutritional substances are phenolics, trypsin inhibitors, lectins, phytates and non-digestible oligosaccharides.[13] Various treatments like soaking, sprouting, heat treatment and fermentation can be beneficial in reducing the anti-nutrient.[14]

Therapeutic potential

Dry beans have several health benefits. They aid to prevent from chronic diseases such as heart disease, infarcts, cancer, pulmonary diseases and diabetes. These diseases are the major causes of mortality in the world.[15] Consumption of dry beans helps in decreasing cholesterol level and cardiac diseases. Due to the presence of antioxidant, antimutagenic and antiproliferative properties it can fight against various diseases such as cancer, diabetes and obesity.[16,10] Table 2 shows the anti-nutritional and health benefits effects of beans.

Table 2: Beans anti-nutritional factors and their nutraceutical effects.

Phytochemicals	Antinutritional effects	Beneficial effects	References
Lectins	Weight loss and weight gain, atrophy of certain organs such as fatty liver and other histological injuries	Appetite lowering effect. beneficial effects on the efficiency of digestion and intestinal absorption, immune response and bacterial flora through low oral doses of lectins Target diseases: Obesity, cancer, and immune	[17,18]
α-amylase inhibitor and glycosidase inhibitors.	Interfere with starch and complex carbohydrate breakdown reducing digestibility	Hypoglycemic effect. Target diseases: being overweight, obesity, diabetes	[19,20,21]
Protease inhibitors	Interfere with protein digestion or absorption and utilization of amino acids and other nutrients.	Effect on proteolytic enzymes, cell proliferation and survival Target diseases: Cancer, HIV	[22]
Flavonoids: flavonol glycosides, anthocyanins and	Tannins antinutritional effects relate to the decrease	Oxidation inhibition. Suppression of prostaglandin. Target diseases: obesity,	[6,23,24]

condensed tannins	in food intake	diabetes, cancer	
Fibre (soluble and insoluble), resistant starch and oligosaccharides.	Flatulencein common beans caused due to resistant starch, oligosaccharides and dietary fibre components.	Cholesterol, triglycerides and LDL lowering Activity; increased bile acid excretion in faeces. Target diseases: hypercholesterolemia, CVD, cancer, diabetes,	[6,25]
Phytates	Interactionwith proteins; inhibition of digestive enzymes and chelation. Decreasing essential element bioavailability, such as calcium, iron, magnesium and zinc.	Induction of cell differentiation. Target diseases: cardiovascular diseases, cancer	[15,26]

CONCLUSION

Modern lifestyle changes bring differences in the eating habits of humans including increase in consumption of high calorie dense food that may lead to many health problems. Dry beans due to their good antioxidants' content, are advantageous for human health. They help in reduced risk of diabetes and obesity and also provide anti-mutagenic, anticancer properties and help in the treatment of cardiovascular diseases. It becomes important to make efforts for increased intake of beans among human beings. Beans as a healthy source of nutraceuticals can be utilized for human supplementation.

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