

Review Article

EFFECT OF BIOACTIVE COMPONENTS OF PULSES ON HUMAN
HEALTH

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History

Submitted: May 14, 2019

Revision: Oct 16, 2019

Accepted: Oct 17, 2019

Keywords

Pulses, bioactive components, antioxidants, antinutrients, hyperglycemic effect.

Abstract

The pulses are dried seeds of the legumes. These are used as the human diet that include lentils, peas, chickpea etc. Pulses are known as the vital source of the protein in the human nutrition. They also provide other essential nutrients i.e dietary fiber, minerals, vitamins, and folic acid. Other than the essential nutrients, the pulses contain other non-nutritive bioactive compounds such as the isoflavones, phenols, phytic acid, enzyme inhibitors, saponins and lectins also. These non-nutritive components have biological activities and have metabolic and physiological effects, but they also consider as antinutrients due to their effect on food quality. But these compounds show protective health effects on human beings also. The protective effects of these components are due to their antioxidative properties and other properties such as antimutagenic, antihyperglycemic effects, anticarcinogenic etc. Those make the pulses a major crop for the human health.

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1. Introduction:

Pulses include the edible dried seeds that belong to the legume family. The term of pulse has its root in origin of the Latin word “puls” that means “pottage” (Sardana, Sharma and Sheoran, 2010). The term pulse is also defined by Food and Agriculture Organization of United Nations (FAO) as: “annual leguminous crops that yield from one to twelve grains or seeds in different shapes, colors and sizes that are present in a pod” (FAO, 1994). Most common types of pulses include dried peas, edible beans, lentils and chickpeas. They belong to Kingdom *Plantae*, Order *Fabales*, Family *Fabaceae* (or *Leguminosae*). Major varieties of pulses include such as the green gram (mung bean) (*Vigna radiata*), dry cowpea (*Vigna unguiculata*), pigeon pea (*Cajanus cajan*), field-pea (*Pisum sativum*), lima bean (*Vigna unguiculata*), chickpea (*Cicer arietinum*), moth bean (*Vigna acutifolia*), black gram (urdbean) (*Vigna mungo*), rice bean (*Vigna umbellata*), dry broad bean (*Vicia faba*), lupin (*Lupinus* spp.), adzuki bean (*Vigna angularis*), lentil (*Lens culinaris*), kidney bean (*Phaseolus vulgaris*), that are safe for human beings consumption (Singh and Basu, 2012a). Pulses are

important source of the nutritional compounds (Tharanathan and Mahadevamma, 2003). These provide such compounds that contain less fat, high complex carbohydrates and other compounds such as vegetables protein, vitamins, minerals and resistant starch. Pulses provide also dietary fiber (USDA, 2005; USDHHS, 2015). Dietary fiber and folate in pulses impart anticarcinogenic properties (Mathers, 2002a; Champ, 2002a); Howe et al., 1992), (Rampersaud et al., 2002). Recent researches have shown the association of consumption of the pulses with a reduced rate for the several degenerative diseases like obesity, diabetes, cancer, and cardiovascular diseases (Anderson et al., 2000), (Patterson et al., 2009), (Anderson and Major, 2002).

Different organizations such as Federal Department of Health Canada, American Institute of Cancer Research and World Cancer Research Fund International have also recommended that by the regular dietary pulse's consumption the risk of cancer mitigates (WCRFI and AICR, 2011; HC, 2011). The United Nations has announced the year 2016 as “International Year of Pulses (IYP2016)” (UN, 2013) due to the nutrition value and beneficial health properties of the pulses.

The very first content of IYP 2016 enlightens the public awareness about nutritional value and advantages of the pulses. It also explains that pulses are being used as a part of the sustainable food production system for the food nutrition and security purpose in the all over world.

So, this review has been highlighted to discuss the benefits of the pulses and their beneficial impact on human health. It also illustrates role of pulse's bioactive components such as enzyme inhibitors, saponins, isoflavones, lectins, phytic acid, phenolic compounds and phytosterols in obviation of different persistent disorders.

2. Bioactive Compounds in Pulses

Many the bioactive compounds are present in the pulses. They include saponins, isoflavones, phytic acid, lectins, phytosterols, phenolic components and enzyme inhibitors, apart from the essential nutrients. These non-nutritive bioactive components show protective effects on the health of humans (Champ, 2002b).

In previous studies these non-nutritive bioactive components considered as anti-nutritive compounds as they decrease the absorption of minerals and digestibility of protein, but the neoteric various studies have been shown to have salubrious (Chung, et al., 1998) protective effects on humans' health (Mathers, 2002b). Phytic acid has antioxidants that help to protect the DNA from damage (B, 2003). And the phenolic compounds also exhibit the antioxidant activity and impart important biological and physiological characteristics (Yeh and Yen, 2003). The saponins also show the anti-cancer property and as well as hypocholesterolaemic effect (Shi et al., 2004).

3. Enzyme Inhibitors

The enzyme inhibitors in the pulses are viable against lipases, amylases, proteases and glycosidases. Inhibitors of trypsin, protease, chymotrypsin, and serine are found in plant products (Belitz & Weder, 1990). By nutritional point of view, inhibitors of trypsin, serine, chymotrypsin and proteases are very essential (Belitz and Weder, 1990).

Beans contain highest amounts of α -amylase (Lajolo, et al., 1984). The protease inhibitors in the legumes have been divided into the two families, depending upon their molecular weight and cystine contents, that are known as Bowman-Birk family and Kunitz family. These both families of protease inhibitors have potential to inhibit trypsin and chymotrypsin. As the protease inhibitors are destroyed at high temperature so preliminary cooking of legumes is required before the consumption (Muzquiz et al., 2012a). Genetic

modification is being applied to decrease the protease inhibitors (Greiner and Domoney, 2004).

Trypsin inhibitors in the red kidney beans and soybeans are similar to high homology (Wu & Whitaker, 1991). The protease inhibitor's amount in the kidney beans and the cowpeas (8 and 10.6 g of trypsin and 9.2 g of chymotrypsin inhibited kg^{-1} , respectively), is higher than lupin seeds (1.1 g of trypsin and 1.4 g of chymotrypsin inhibited kg^{-1}) (Grant et al., 1995). They may be considered as disease preventing factors related to human health. The addition of amylase inhibitor lowers the glucose level in blood and increases the insulin levels. This indicates that this antinutrient can be taken as curative cause in control of the obesity and diabetes (Rizkalla et al., 2002). But it is considered anti-nutrient for those individuals who are protein deficient (Somaiya, 2017a).

4. Lectins

Lectins are present in plant foods (Nachbar and Oppenheim, 1980a). Beans (*Phaseolus vulgaris*) is important of source of lectins (Singh and Basu, 2012b). Lectins are agglutinins means they are carbohydrate binding proteins which are capable of reversibly binding with the glycoproteins and some specific sugars on the gut wall surface, which induces intrusion with the breakdown and absorption of the nutrients. They have different types depending on the several associations based on the toxicity, mitogenesis, blood groups, agglutination and digestion (Muzquiz et al., 2012b). Kidney beans have high level of lectins (840×10^{-5} hemagglutinating activity units (HU) kg^{-1}) as compared to cowpea and lupin seeds having low level of lectins (3×10^{-5} HU $\cdot \text{kg}^{-1}$) (Nachbar and Oppenheim, 1980b). Higher level of lectins in beans causes the reduction of the body muscles, skeletal muscles, glycogen and lipid (Bardocz et al., 1992, 1996). This bean lectin can be used as curative vehicle in effective gut functioning and reducing obesity by establishing a safe and effectual dosage for human beings (Pusztai et al., 2004). Lectins used in prevention of various cancers types and activate the innate immunity mechanisms (Somaiya, 2017b).

5. Phytic acid

Phytic acid reacts with the minerals that include Zn, Fe and Ca therefore they can make insoluble compounds that are inaccessible for the digestion and absorption processes (Cheryan and Rackis, 1980; Sandberg, 2002). Phytate starts forming when plant seeds become mature and the dormant seeds start showing total phosphate level of 60–90 % (Loewus, 2002). More amount phytate is present in legume-based food commodities as compared to the cereal based food commodities (Kumar et al., 2010a).

In the legume seeds, myo-inositol-(1, 2, 3, 4, 5, 6) hexakisphosphate and its salts and the phytic acid, shows storage of phosphorus (Urbano et al., 2000; Kumar et al., 2010b). The total inositol phosphates level (% dry matter) varies from the one cultivar variety to the other. Such as 0.15 to 2.34 % inositol phosphate present in *Lens esculenta*, 0.5 to 1.1 % present in *V. faba*, 0.2 to 1.9% present in *Ph. vulgaris*, 0.2 to 1.3 % present in *P. sativum* and 0.4 to 1.1 % present in *Cicer arietinum* (Campos-Vega et al., 2010). Phytic acid has been considered as anti-nutrient due to its binding with the other compounds that make them unable for digestion process, known as chelating agent. It alters the functional properties of nutrients such as the solubility, absorption, functionality and digestibility (Muzquiz et al., 2012c). The reduced toxicity of the heavy metals (i.e. lead, cadmium) and their bioavailability found in diet are some of the advantages of the phytic acid (Rimbach et al., 1996; Rimbach and Pallauf, 1997). Phytic acid has antioxidant properties (Lajolo et al., 2004). Myo-inositol phosphates i.e. IP6 in soybean imparts beneficial effects on human health. They cause the mitigation of heart diseases by lowering the high cholesterol level and arterial sclerosis, preventing formation of the stones in the kidney and reducing chances of cancer of colon (Champ, 2002c); Greiner et al., 2002). The scavenging property of phytic acid makes it anticarcinogenic in nature (Steer and Gibson, 2002).

6. Phenolic Compounds

The phenolic compounds are very vital group of the nonessential dietary components of pulses. The ability of chelating the metals, scavenging the free radicals and inhibiting the lipid peroxidation and autolysis are the bioactivities exhibited by phenols (Cheun et al., 2003). Phenolic compounds have antioxidant properties having potential for redox reactions, causing them to act as reducing agents, neutralizing free radicals and donating hydrogen (Rice-Evans et al., 1997). Tannins, flavonoids and phenolic acids are the most important phenolic compounds of pulses. Polyphenolic compounds in the pulses impart color to their seeds. Polyphenolic compounds include flavonoids (flavonol glycosides, condensed tannins, anthocyanins) (Dueñas et al., 2003). Pulses containing the highest number of polyphenolic compounds involve highly pigmented and dark colored varieties of pulses such as black gram (*Vigna mungo*) (South and Miller, 1998a) and red kidney beans (*Phaseolus vulgaris*). The important phenolic acid present in the pulses is ferulic. Catechin and epicatechin are the dominant phenolic compounds than chrysin, genistein and quercetin found in legumes (Somaiya, 2017c).

The high level of phenolic, condensed tannin and flavonoid content are found in lentils (6.56 mg gallic acid equivalents/g, 5.97 and 1.30 mg catechin equivalents/g, respectively), then to red kidney beans and the black beans (South and Miller, 1998b). Lentils show the high value of the total antioxidant capacity also known as (TAC) because of highest amount of the condensed tannins exists in lentils. Further researches showed that phenolic compounds provide beneficial health effects and they are very important in the human diet (Xu and Chang, 2010). Level of polyphenolic compounds in the plant origin foods is affected by different factors i.e. genetic, environment, degree of ripeness, processing, germination, variety and storage (Bravo, 1998). They cause the reduction in the oxidative stress, cancer, inflammation, cardiovascular diseases, and osteoporosis. (Somaiya, 2017d).

7. Saponins

The name of saponins has been obtained from their property of formation of stable, soap like foam in the aqueous solution and having surface active detergent characteristics. And they make various chemical compounds. (Muzquiz et al., 2012d). Saponins comprise of the lipid soluble aglycon compounds and they contain also either a sterol or water-soluble sugar residuals that vary in the quantity and variety of the sugars. (Singh and Basu, 2012c). Saponins cause the less availability of nutrients (West and Greger, 1978). And they also lower down the enzyme activity (Cheeke and Oldfield, 1970). Saponins include the properties of hypocholesterolemia (Cheeke, 1971), anti-carcinogens (Tokuda et al., 1991) and immune stimulatory (Wu et al., 1990). Chickpea and soybean are important sources of the saponins in diet of humans (Oakenfull, 1981).

Saponins found in the many pulses such as in lupin (Woldemichael et al., 2003) and lentil (Ruiz et al., 1996) etc. Saponins from range of 1.2 to 2.3 g/kg of the dry matter are present in the dehulled light and dark colored peas (Daveby et al., 1998). During cooking some saponin content gets lost such as in the moth bean (Khokhar and Chauhan, 1986), black gram (Kataria et al., 1989) and pigeon pea (Duhan et al., 2001). Consumption of saponins in foods provides many benefits such as the reduction in cardiovascular diseases, cancers and cholesterol thus preventing the absorption of cholesterol in the intestine (Muzquiz et al., 2012e). Sometimes saponins cause the increase in the bile acids excretion that is secondary way used to decrease the cholesterol level (Rochfort and Panozzo, 2007). These compounds exhibit anticarcinogenic characteristics also, such as saponin containing diet inhibit the mutations in the colon (Koratkar and Rao, 1997).

8. Conclusion

Major portion of the human diet consists of pulses. Pulses are the important source of protein. They also provide minerals, folic, dietary fiber and vitamins. In addition to essential nutrients, the pulses also contain minor non-nutritive bioactive compounds including the saponins, phytates, phenolic compounds, enzyme inhibitors and lectins. Hence these minor compounds show metabolic and physiological effects. But they also have been considered as the anti-nutritional compounds owing to their effect on the food quality. But these compounds also have potential health effects. In pulses these bioactive components show high level of antioxidant, anticarcinogenic, antimutagenic properties and show antihyperglycemic effects, making pulses an essential crop for the human consumption and as well as imparting beneficial health effects.

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