Legumes: The Natural Products for Industrial and Medicinal Importance-A Review

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Abstract

Legumes play a very important role in human diet in all over the world because of lower cost and fat as well as richer sources of proteins and nutrient variety. The bioactive constituents of legumes like Alkaloids, Phytic acid, Genistein and Daidzein, Polyphenols, Phytoestrogens, Phenolic compounds, Phytic acid (myo-inositol hexaphosphate), Saponins, Lupin quinolizidine alkaloids, Isoflavones and lignans, Isoflavones; Formononetin, Biochanin, Flavanoids, Saponines, Lecitins A etc. were isolated and purified by scientists. These phytochemicals act as an antioxidant, anti-diabetes, anticancerous, anti-inflammatory. The purpose of this review with scientific evidence is to encourage the people to consume legumes as natural medicine for treatment of nearly all health related diseases like coronary heart disease, cancer, tyrosinase and glucosidase inhibition activities, obesity, aging, heart related diseases, high blood pressure etc. It was also reviewed that various processing method like germination, sprouting, oil frying, steaming etc. increased the activity of various phytotoconstituents. This review provides an attention to the lavish medicinal values of legumes that are being used in past decades as a better alternative to medicine without any side effects for curing of many diseases.

Keywords: Legumes, Antioxidant, Anti-diabetes, Tyrosinase & Glucosidase inhibition, Phytoconstituents.

1. Introduction

The Fabaceae or Leguminosae (legumes or beans) is third largest and economically important family of flowering plants, consists of 650 genera and nearly 20,000 species (Doyle, 1994) of herbs, shrubs, trees and climbers. The Papilionoideae, Caesalpinoideae, Mimosoideae, and Swartzioideae are the subfamily of legumes. As crops people have been grown legumes since millennia as a vital ingredient of human diet (Nene, 2006). The Legumes (including alfalfa, clover, Lupines, green beans and peas, peanuts, soybeans, dry beans, broad beans, dry peas, chickpeas, mung bean, lentils and moth bean) are an important meal of the human diet in all over the world, especially in the developing countries. India is as one of the important legume producing nation accounts 29% of world area and 19% of world production. The major areas are in the state of Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh, Chhattisgarh, Bihar and Tamilnadu Singh et al., (2015). Food legumes covered all legume crops which are used for human food such as in the form of dry grains or vegetables. Beans have been called the “poor man’s meat” and “rich men vegetable” because of lower cost as compared to animal protein so show inverse relationship between bean intake and income. Second to cereals, legume seeds are the most important source of human or animal food (Vietmeyer, 1986). Legumes can be divided in to two categories i.e. immature and mature varieties. Immature legumes are also called fresh legumes because these are used in fresh form. Mature legumes are harvested in dried form from pod when completely developed. The protein nutrition is completed when cereals and legumes are taken together. The nutritional importances of legumes are due to presence of low fat, dietary fiber, high protein content and many micronutrients Rungruangmaitree et al., (2017). Legumes are integral part of healthy Dietitian chart. Along with nutritious food, legumes can also help in prevention of many diseases. Legumes provide different types of phytochemicals, primary metabolites and secondary metabolities Ganiyu et al., (2006). The legumes also provide special products like rotenoids that is used as pesticide Balandrin et al., (1985).

The medicinal importance of legumes is due to presence of pharmaceutical compounds for curing or improving human health Nikkhah et al., (2014). Alkaloids, flavonoids, glycosides, isoflavones, phenols,
phytosterols, phytic acid, protease inhibitors, saponins, and tannins are the active biocompounds of legumes. Legumes are more beneficial to vegetarians however non-vegetarians can also take benefits when consumed more. Legume seeds are the only protein supply in the diet in some parts of the world. Red meat replace with black beans it boost up intake of protein and fiber and lowers fat intake.

2. Legumes and phytochemicals

The various types of phytochemicals like Alkaloids, Genistein and daidzein, Polyphenols, Phytoestrogens, Phenolic compounds, Phytic acid (myo-inositol hexaphosphate), Saponins, Lupin quinolizidine alkaloids, Isoflavones and lignans, Isoflavones; formononetin, biochanin A, etc. (Table 1) are studied from legumes by many researchers (Lopez et al., 2004; Shimelis, 2006; Randhir and Shetty, 2007; Bhathena and Velasquez, 2002; McCrory, 2010; Gonzalez-Castejon and Rodriguez-Casado 2011, Marathe et al., 2012). The phytochemicals acts as antioxidant, anti-inflammatory and prevention of many diseases like obesity, aging, diabetes, heart related diseases and many health related problems to cure and prevention of many physiological disorders as therapeutics (Sharma et al., 2011; Prakash et al., 2011). The seeds of Vigna subterranea, Glycine max, Arachis hypogaea and Vigna unguiculata contains useful phytonutrients. The phytochemical screening of these legumes was also screened out by Mbagwu et al., (2011).

3. Legumes as antioxidants

The antioxidants are the compounds that scavenge free radicals and reactive oxygen species so act as defensive mechanism to degenerative diseases. The natural antioxidants from diet act as a natural endogenous antioxidants Benzic (2003). The phytochemicals that play an important role as antioxidants are polyphenols, tannins, caffeic acid, ferulic acid, cinnamic acid, kaempferol, phenolic compounds, proteins, polyphenols, polysaccharides, flavonoids, isoflavonoids etc. (Table 1). The various processing methods in legumes increases bioactive compounds by which antioxidant activity has been increased such as germination, sprouting, oil frying, steamed etc. The increase in predominant phenolic compounds like caffeic acid, ferulic acid, cinnamic acid and kaempferol were found to be increased in sprouts of Vigna aconitifolia that act as free radical scavenger by Kestwal (2012). Zhaohuui (2016) researched on mung bean, soybean and black bean sprouts and found remarkable increased in antioxidant activity of sprouts (3-5 days old) as compared to seeds. Phenolic extracts of four Vigna species of legumes (mung bean, moth bean, and black and red varieties of adzuki beans) were potential source of antioxidant phenolics evaluated by Sreramara et al., (2012). Polyphenols particularly tannins from legumes are considered as important dietary antioxidants. Peanuts, peas, and edible beans are considered as valuable antioxidants due to presence of polyphenolics and phenolic acids. The Cicer arrietinum, Vigna aconitifolia and Pisum sativum raw processed and heated samples are potent antioxidant suppliers showed by Siddhuraju et al., (2006) and Nithiyanantham et al., (2012). Fidrianny et al., (2014) found remarkable antioxidant activities in the shells of four legumes Glycine max, Vigna subterranea, Phaseolus vulgaris and Arachis hypogaea. Apart from common legumes the under-utilized or wild legumes are also equally important as medicine.

3. Legumes as anti-diabetic

Diabetes mellitus is a condition linked to abnormal increase in blood sugar level. The two strong carbohydrate digesting enzymes are alpha amylase and alpha glucosidase. These two enzymes break carbohydrates into oligosaccharides and disaccharides and then into monosaccharides. Inhibition of these two enzymes delays the process of carbohydrate breakdown and absorption. So, inhibitors of these two enzymes are useful in treatment of diabetes related diseases. The phenolic compounds, polyphenols, alkaloids, phytic acid, genistein, daidzein, vitexin, isovitexin, glycitin etc. are the major bioactive ingredients from legumes that help in prevention of diabetes related diseases (Table 1). Burguieres et al., (2008) found phenolic-enriched pea sprouts had the ability to inhibit alpha-amylase and alpha-glucosidase activity. The Sesbania sesban Merrill seeds are natural source of dietary antioxidants with the potential treatment of type II diabetes Vadivel et al., (2016). The Phenolic extracts of four Vigna species of legumes (mung bean, moth bean, and black and red varieties of adzuki beans) are great sources of strong natural inhibitors for alpha-glucosidase enzymes. Randhir et al., (2009) researched on sprouts of fenugreek, soybean, fava bean and mung bean and found fenugreek had the highest α-amylase and α-glucosidase inhibition activity, followed by soybean, fava bean and mung bean. Yao et al., (2013) studied the antidiabetic activities in black mung beans and found the mung bean variety Jhielv 27-3 black bean show remarkable higher antidiabetic activities as compared to the other tested mung beans. A good α-amylase and α-glucosidase enzyme inhibition activities were recorded in the methanolic extract of Acacia nilotica Vadivel et al., (2012).

4. Legumes as tyrosinase inhibitors

Tyrosinase is a key copper containing enzyme which is involved in formation of melanin pigments and resulting melanogenesis (Petit and Pierard, 2003; Kim and Uyama, 2005; Chang, 2009). This enzyme is responsible for pigmentation of human of the skin, eyes and hair, browning of fresh fruits, beverages, vegetables, and mushrooms, which are undesirable. So, the search of potent tyrosinase inhibitors for skin whitening and anti-browning of food products is necessary (Rescigno et al., 2002; Kim et al., 2005; Parvez et al., 2007). The Legumes are the good source of tyrosinase inhibitors.
### Table 1 Important phytoconstituents in legumes

<table>
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<tr>
<th><strong>Antioxidants in legumes:</strong> Polyphenols, Tannins, Caffeic acid, Ferulic acid, Cinnamic acid, Kaempferol, Phenolic compounds, Proteins, polypeptides Polysaccharides, Flavonoids etc.</th>
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<td><strong>Vigna radiate</strong> sprouts</td>
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<td><strong>Vigna aconitifolia</strong> sprouts</td>
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<td><strong>Vigna radiate</strong> seeds and sprouts</td>
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<th><strong>Anti-diabetic compounds in legumes:</strong> Phenolic compounds, Polyphenols, Alkaloids, Phyty acid, Genistein, Daidzein etc.</th>
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<td><strong>Black variety of Vigna angularis</strong></td>
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<th><strong>Anti-Tyrosinase components in legumes:</strong> Isoflavonoids, Glabridin, Glabrene, Licursaside soliguirin in Biochalone A, Flavone vitexin etc.</th>
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<td><strong>Vigna radiate</strong> seeds</td>
<td>Yao et al., 2011</td>
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<td><strong>Phaseolus lunatus,</strong> Vicia faba, <strong>Phaseolus vulgaris,</strong> Pisum sativum, Canavalia ensiformis, Psophocarpus tetragonolobus, Vigna angularis, <strong>Lablab purpureus,</strong> Vicia villosa, Cicer arietinum, Vigna unguiculata, <strong>Vigna umbellata</strong> and Glycine max and <strong>Vigna radiata</strong></td>
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<td><strong>Glycyrrhiza sp.</strong></td>
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<th><strong>Phytoconstituents of legumes as Anticancerous components:</strong> Nuclease, Saponins, Daidzein, Trypsin inhibitor, Chymotrypsin, Lectins, Lupoe1, Phenolic compounds, Phytoestrogens, Oligosaccharides Resistant starch Dietary fiber etc.</th>
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**Legumes used as antiobesity:** Dietary fibers, Selenium, L-Argenin, Saponins, Polyphenols, Flavones, Flavanols, Tannins, Chalcones, Lectins, Protease inhibitors etc.
The Isoflavonoids, glabridin, glabrene, Licuraside isoliquiritin licochalcone A, flavone vitexin are the active components of the legumes (Table 1). that act against tyrosinase activity. The Potential antityrosinase activity was reported in moth bean by Novoa (2015). In cosmetic production moth bean extract being high stability, quality longer even when come in contact with atmosphere played important role in cosmetic products Contet-Audonneau et al., (2005). The roots and seeds of leguminous species i.e. Glycyrrhiza are an effective ingredient of skin whiting agent. The inhibitory activity of Glycyrrhiza is because of presence 

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<td>Vigna radiate sprouts</td>
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<td>Vigna radiate</td>
<td>Methanol, ethyl acetate and hexane</td>
<td>Escherichia coli, Salmonella typhi, Klebsiella pneumoniae, Proteus vulgaris and Streptococcus faecalis</td>
<td>Priya et al., 2012</td>
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<td>Lablab purpureus</td>
<td>N-Hexane, chloroform and ethyl acetate</td>
<td>B. megaterium, B. subtilis, Staphylococcus aureus, Sarcina lutea, Escherichia coli, Salmonella paratyphi, S. typhi, Shigella boydii, S. dysenteriae, Vibrio mimicus and V. parahemolyticus</td>
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<td>Vigna radiata, Cicer arietinum and Cajanus cajan</td>
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<td>Aqueous methanol</td>
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<td>Leaves of Vigna unguiculata</td>
<td>Acetone and ethanol</td>
<td>Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, B. subtilis and Enterobacter cloaca</td>
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<td>Seeds proteins of Dolichos lablab, Trigonella foenum-graceum, Trifolium alexandrinum, Delonix regia and Bauhinia variegata</td>
<td>Protein extract</td>
<td>Mycobacterium rhodochrous, Bacillus cereus 1080, Bacillus megaterium 1057, Bacillus sphaericus, Corynebacterium xerosis 1022 and Staphylococcus aureus 1352</td>
<td>Sammour and El-Shanshoury 1992</td>
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of two isoflavonoids namely glabridin and glabrene (extracted from roots). Glabridin has tyrosinase inhibitory activity of fifteen times to kojic acid inhibition Yokota (1998). Licurside, isoliquiritin, and licochalcone A are three chalcones extracted from the roots of the Glycyrrhiza species showed 5.4 more tyrosinase inhibitory activity than kojic acid Nerya et al. (2003). Yao et al. (2011) studied the biological potential of sixteen legumes (lima bean, broad bean, common bean, pea, jack bean, goa bean, adzuki bean, hyacinth bean, chicking vetch, garbanzo bean, dral, cow bean, rice bean, mung bean and soybean). They found the highest tyrosinase inhibition activity in mung bean. The ethanolic extract of one day sprouted mung bean showed influential antityrosinase inhibition activity due to flavone vextitin and could be used as novel ingredient in skin whiting cosmetics Jeong et al., (2016).

5. Legumes as obesity to de-obesity

Dietary fibers are beneficial against obesity. Legumes are important source of dietary fibers Tharanathan et al., (2003). The obesity in linked to many kinds of non-communicable diseases like insulin resistance, diabetes, and cardiovascular disease. Hence, obesity prevention related to health promotion Dixon et al., (2010). The consumption of hypo-caloric rich legumes in healthy women reduced anthropometric measures Alizadeh et al., (2011). The important parts of legumes like fiber, selenium and L-Argenin as well as low glycemic index and low energy dense characteristics helps in prevention of abdominal obesity and obesity-related diseases Stoll et al., (2006). The energy provided by mung bean sprouts is beneficial for persons with obesity and diabetes (Zheng, 1999). The phytochemicals saponins, polyphenols, flavonoids, flavanols, tannins and chalcones present in legumes (Table 1) have anti-obesity effects (Moro et al., 2000; Vasudeva et al., 2012; Sung et al., 2015). The phenolic compounds in legumes such as flavones, flavanols, flavanones and isoflavones dominant in plants Acacia mearnii, Abarema cochliacarpos, Abarema cochliacarpos, Cassia fistula, Senna alexandrina and Senna corymbosa wild have an anti-obesity activity (Ikarashi et al., 2011; Onakpoya et al., 2011; Yamamoto et al., 2011; city innewy, 2008; Diciel 2007). The antinutritional compounds of legumes like lectins and protease inhibitors have potential in the treatment and prevention of obesity Roy et al., (2010). Legume consumption is a perfect way to improve weight in obese and prevention of chronic and degenerative diseases.

6. Legumes as anticancerous agents

The various types of Saponins, Daidzein, trypsin inhibitor, the trypsin and chymotrypsin inhibitor are present in beans like soyabean which showed remarkable anticancer properties (Koratka et al., 1997; Jing et al., 1993; Kennedy et al., 1995). The amphiphilic structure of legumes saponins makes surface active. The anticarcinogenic activities of saponins are via direct cytotoxicity, immune modulation, bile acid binding etc Nikkhah et al., (2012). The methanolic extract of Cassia fistula seeds had vigorous anticancer activity Pawar et al.,(2017). The legume tephrosia (Tephrosia purpurea) contains lupeol which is used against tumor Beckstrom-Sternberg and Duke (1994). The legumes are used alternative to chemotherapy for the treatment of many cancers mainly colon cancer by diet supplemented with different quantity of beans, lentils, chickpeas, or soybeans, mostly. The intake of legumes in early stages of cancer prevents carcinogenesis Sanchez-Chino et al., (2015). Kerwin et al., (2004) showed novel mechanism of soy saponin directly as effective anticancer agents. The phenolic compounds, phytoesters, oligosaccharides, resistant starch, dietary fiber etc. in pulses play an important role in cancer prevention Vohra et al., (2015, Table 1).

7. Legumes as antimicrobials

Many bacterial and fungal pathogens are responsible for many harmful diseases in humans and animals (Van Burik and Magee 2001; Worthington and Bigalke 2001). These harmful pathogens during storage process infects the seeds and produce various type of harmful chemicals, which when ingested by human are responsible for many types of chronic diseases (Barrett, 2000). Now, the plants extracts are explored as natural antimicrobial alternative to control the harmful microbes. Kritzinge et al (2005) found the antimicrobial activity of leaf extracts of Vigna unguiculata (cowpea). The fungus pathogen like Alternaria alternate, Fusarium proliferatum and bacterial pathogens like Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, B. subtilis and Enterobacter cloacae bacterial pathogens all were inhibited by acetone and ethanol extracts of cowpea. Among three legumes hull Vigna radiata (mung bean), Cicer arietinum (Bengal gram) and Cajanus cajan (pigeon pea) the pigeon pea showed highest antibacterial activity against Bacillus cereus researched by Kanatt et al (2014). Randhir et al (2004) studied the antimicrobial activities in dark germinated mung bean sproutsagainst Helicobacter pylori. Camalxaman et al (2013) showed mung bean sprouts as natural antibacterial agent against Gram negative enteric bacteria Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae and Salmonella spp. The major phytochemicals in Vigna radiata sprouts were glycosides, steroids, phenols, saponins, alkaloids and flavonoids (Table 1) which were responsible for significant antibacterial activity Priya A et al., (2012). The Lablab purpureus showed amazing antimicrobial activity including gram positive, gram negative bacteria and fungus (like Staphylococcus aureus,B. megaterium, B. Subtilis, Sarcina lutea, Escherichia coli, Salmonella
paratyphi, S. typhi, Shigella boydii, S. dysenteriae, Vibrio mimicus, V. Parahemolyticus, Saccharomyces cerevisaeae, Candida albicans and Aspergiillus niger) microbes Nasrin et al., (2012). The fruit pulp leaves and bark stem of Cassia fistula showed wonderful antibacterial activity. The fruit pulp showed remarkable antimicrobial activity as compared to leaves and stem bark may be due to presence of flavonoids Pradeep et al., (2010). Legume is the globally known staple food. The current review discussed the legumes phytochemical and their pharmacological effect used for medicines. As we discussed the non-nutrient component of legumes play a very vital role in the prevention of many health related diseases in addition to nutritious value. Absolutely, this review concluded the nutritional importance of legumes as well as effective role of their phytochemicals on the prevention of cardiovascular risks, diabetes, obesity, infectious related diseases. From this review it can be concluded that legumes are the main essential component of vegetarian human diet. Our review gives focus in future studies of extraction and purification of bioactive constituents of legumes that may be used in applications of pharmaceutical industry.

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