International Journal of Cell Science and Biotechnology
E-ISSN 2320-7574
Available at Available at https://ijcsb.evegenis.org/

Original Research Article

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

Nidhi Verma[#], Krishan D. Sehrawat[^], Anil Ahlawat[!] and Anita R. Sehrawat[#*]

[#]Department of Botany, Maharshi Dayanand University, Rohtak (Haryana) India
[^]Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, India
[!]Department of Agriculture, Seed Science Laboratory, Rohtak, India

Received 10 May 2017, Accepted 10 July 2017, Available online 05 Sept 2017, **Vol.6 (2017)**

Abstract

Legumes play a very important role in human diet in all over the world because of low 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 acts 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 phytoconstituents. 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 Dietitianchart. 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,

*Corresponding author: **Anita R. Sehrawat**
DOI: https://doi.org/10.14741/ijcsb/v.6.1.2

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 hypogea* and *Vigna uniguiculata* 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 Benzie (2003). The phytochemicals that play an important role as antioxidants are polyphenols, tannins, caffeic acid, ferulic acid, cinnamic acid, kaempferol, phenolic compounds, proteins, polypeptides, 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 likecaffeic 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). Zhaouhui (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 Sreerama *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 arietinum, Vigna acontifolia* 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, Phaselous vulgaris* and *Arachis hypogea*. Apart from common legumes the under-utilized or wild legumes are also equally important as medicine.

3. Legumes as antidiabetic

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 inhibiton 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 Jiheilv 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 containg 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 whiting 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

Antioxidants in legumes: Polyphenols, Tannins, Caffeic acid, Ferulic acid, Cinnamic acid, Kaempferol, Phenolic compounds, Proteins polypeptides Polysaccharides, Flavonoids etc.			
Plants	References	Plants	References
Vigna radiate sprouts	Gan *et al.,* 2016	*Vigna radiate*, *vigna aconitifolia*, and black and red varieties of *Vigna angularis* (adzuki beans)	Sreerama *et al.,* 2012
Vigna aconitifolia Seeds	Gupta *et al.,* 2016; Siddhuraju *et al.,* 2006 and Kestwal *et al.,* 2011	*Acacia nilotica*	Vadivel *et al.,* 2012
Vigna radiate, Glycine max and *Phaseolus vulgaris* sprouts	Zhaohui *et al.,* 2016	*Canavallia ensiformis*	Vadivel *et al.,* 2012
		Vigna unguiculata	Vats *et al.,* 2012
Glycine max, Vigna subterranean, Phaselous vulgari and Arachis hypogeal	Fidrianny *et al.,* 2014	*Cassia fistula*	Jothy *et al.,* 2011
Ferminated and germinated *Vigna radiate*	Yeap *et al.,* 2014	*Lablab purpureus, Cicer arietinum, Phaseolus lunatus, Pisum sativum, Vigna radiate, Vigna mungo, Cajanus cajan, Phaseolus vulgaris*	Marathe *et al.,* 2011
Vicia faba	Siah 2013	*Vigna vexillata*	Sowndharajan *et al.,* 2011
Vigna aconitifolia sprouts	Kestwal *et al.,* 2012	*Phaseolus vulgaris*	Yao *et al.,* 2011
Vigna radiate seeds and sprouts	Kim *et al.,* 2012	Black *Glycine max*	Yao *et al.,* 2010
Cicer arietinum and Pisum sativum	Nithiyanantham *et al.,* 2012	M-1, M-6, NM-92 and NM-98 varieties of *Vigna radiate*	Anwar *et al.,* 2007
Anti-diabetic compounds in legumes: Phenolic compounds, Polyphenols, Alkaloids, Phytic acid, Genistein, Daidzein etc.			
Black variety of *Vigna angularis*	Getek *et al.,* 2014	*Lupinus mutabilus* SLP-1 and H-6	Ranilla *et al.,* 2009
Vigna radiata beans	Yao *et al.,* 2013	Sprouts of *Trigonella Foenum-graecum, Glycine max*, *Vicia faba* and *Vigna radiate*	Randhir *et al.,* 2007
Vigna radiate, *vigna aconitifolia*, and black and red varieties of *Vigna angularis* (adzuki beans)	Sreerama *et al.,*2012	Sprouted and solid state bioprocessed *Glycine max.*	McCue *et al.,* 2005
Acacia nilotica	Vadivel *et al.,* 2012	*Pisum sativum* sprouts	Burguieres *et al.,* 2002
Sesbania sesban	Vadivel *et al.,* 2012	Different varities of *PhaseolusVulgaris*	Marshall 1975
Vigna umbellata	Yao *et al.,* 2012		
Anti-Tyrosinase components in legumes: Isoflavonoids, Glabridin, Glabrene, Licuraside isoliquiritin licochalcone A, flavone vitexin etc.			
Vigna radiate seeds and sprouts	Jeong *et al.,* 2016	*Trigonella Foenum-graecum seeds and leaves*	Basu *et al.,* 2006
Vigna radiate seeds	Yao *et al.,* 2011	*Vigna aconitifolia*	Contet-Audonneau *et al.,* 2005
Phaseolus lunatus, Vicia faba, Phaseolus vulgaris, Pisum sativum, Canavalia ensiformis, Psophocarpus tetragonolobus, Vigna angularis, Lablab purpureus, Vicia villosa, Cicer arietinum, Vigna unguiculata, Vigna umbellata and Glycine max and Vigna radiata	Yao *et al.,* 2011	*Glycyrrhiza sp.*	Yokota *et al.,* 1998
Phtyoconstituents of legumes as Anticancerous components: Nuclease, Saponins, Daidzein, Trypsin inhibitor, Chymotrypsin, Lecitins, Lupeol, Phenolic compounds, Phytosterols, Oligosaccharides Resistant starch Dietary fiber etc.			
Vigna radiate	Matousek *et al.,* 2009	*Tephrosia purpurea*	Beckstrom-Sternberg and Duke 1994
Glycine max	Rao and Koratkar 1997; Jing *et al.,* 1993 and Kennedy *et al.,* 1995		
Legumes used as antiobesity; Dietary fibers, Selenium, L-Argenin, Saponins, Polyphenols, Flavones, Flavanols, Tannins, Chalcones, Lectins, Protease inhibitors etc.			

Phaselous aureus	Tiansawang *et al.*,2014	*Senna alexandrina*	City innewy 2011
Acacia mearnsii	Ikarashi *et al.*, 2011	*Senna corymbosa*	Dickel, 2007
Abarema cochliacarpos, Abarema and cochliacarpos Cassia nomame	Onakpoya *et al.*, 2011	*Cicer arietinum, Vigna radiate, Glycine max, Vicia faba*	Corbierce *et al.*, 2004
Phaseolus vulgaris	Yamamoto *et al.*, 2011	*Vigna radiate*	Zheng, 1999

Legumes as antimicrobials; Lecitines, Glycosides steroids phenols, Saponins, Alkaloids, Flavonoids, Phytohemagglutinin (PHA) etc.					
Plants	Extract used	Antibacterial activity Against gram (+)	Against gram (-)	fungus	References
Vigna radiate sprouts	Chloroform and methanol	----	*Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae* and *Salmonella spp.*	----	Camalxaman *et al.*, 2013
Vigna radiate	Methanol, ethyl acetate and hexane	----	*Escherchia coli, Salmonella typhi, Klebsiella pneumoniae, Proteus vulgaris and Streptococcus faecalis*	----	Priya *et al.*, 2012
Lablab purpureus	N-Hexane, chloroform and ethyl acetate	*B. megaterium, B. subtilis, Staphylococcus aureus, Sarcina lutea,*	*Escherichia coli, Salmonella paratyphi, S. typhi, Shigella boydii, S. dysenteriae, Vibrio mimicus and V. parahemolyticus*	*Saccharromyces cerevaceae, Candida albicans and Aspergillus niger*	Nasrin *et al.*, 2012
Vigna radiata, Cicer arietinum and Cajanus cajan	Aqueous extract	*Bacillus cereus*	----	----	Bhabha *et al.*,2014
Vigna radiate	Aqueous methanol	*Staphylococcus aureus, Bacillus subtilis* and *Pseudomonas aeruginosa*	*Escherichia coli, Klebsiella pneumonia, Salmonella enteric,* and *serovar Typhimurium*	*Fusarium equiseti, Alternaria alternate* and *Fusarium proliferatum*	Hafidh *et al.*, 2010
Leafs of Vigna unguiculata	Acetone and ethanol	*Staphylococcus aureus, Enterococcus faecalis, Bacillus cereus, B. subtilis and Enterobacter cloaca*	*Pseudomonas aeroginosa* and *Escherichia coli*	-----	Kritzinge *et al.*, 2005
Seeds proteins of *Dolichos labalab, Trigonella foenum-graceum, Trifolium alexandrinum, Delonix regia and Bauhinia variegate*	Protein extract	*Mycobacterim rhodochronus, Bacillus cercus* 1080, *Bacillus megatarium* 1057, *Bacillus sphaericus, Corynebacterium xerosis* 1022 and *Staphylococcus aureus* 1352	*Escherichia coli,* and *Serratia marcescens*	*Trichophyton rubrum, Microsporum canis, Aspergillus niger, A. terreus, A. oryzae, Paecilomyces variatii, Phanerochaete crysosporium, Trichoderma sp* and*Trichoderma harzianum*	Sammour and El-Shanshoury 1992

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* have an effective ingredient of skin whiting agent. The inhibitory activity of Glycyrrhiza is because of presence of two isoflavonoids namely glabridin and glabrene (extracted from roots) Glabridin has tyrosinase inhibitory activity of fifteen times to kojic acid inhibition Yokota (1998). Licuraside, 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 vitexin 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 diabeties (Zheng, 1999). The phytochemicals saponins, polyphenols, flavones, 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 mearnsii, Abarema cochliacarpos, Abarema cochliacarpos, Cassia nomame, Phaseolus vulgaris, 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; Dickel 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, phytosterols, oligosaccharides, resistant starch, dietary fiber etc. in pulses play an important role in cancer preventation 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 incuding 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*, *Saccharromyces cerevaceae, Candida albicans* and *Aspergillus 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 healths related diseases in addition to nutritive 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 thisreview 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.

Acknowledgment

The authors wish to thank to the Department of Botany, M. D. University, Rohtak .

References

A. Imberty, C. Gautier, J. Lescar, S. Perez, L. Wyns, R. Loris, (2000), An unusual carbohydrate binding site revealed by the structures of two Maackia amurensis lectins complexed with sialic acid-containing oligences osaccharides, *Journal of Biological Chemistry*, 275, pp. 17541-17548.

A. Karnchanatat, (2009), Antimicrobial Activity of Lectins from Plants. The Institute of Biotechnology and Genetic Engineering, Chulalongkorn University, Bangkok, Thailand pp.145-178.

A. Nikkhah, (2014) Legumes as Medicine: Nature Prescribers, *Medicinal & Aromatic Plants*, 3, e153. http://dx.doi.org/10.4172/2167-0412.1000e153

A. Rescigno, F. Sollai, B. Pisu, A. Rinaldi, E. Sanjust, (2002), Tyrosinase inhibition: general and applied aspects, *J Enz Inhib Med Chem,*17, pp. 207–218.

A. V. Pawar, S.G. Killedar, (2017), Uses of *Cassia fistula* Linn as a Medicinal Plant, *International Journal of Advance Research and Development*, 2, pp. 85–91.

A.E. Shimelis, S.K. Rakshit, (2005), Anti-nutritional factors and *in vitro* protein digestibility of improved haricot bean (*Phaseolus vulgaris* L.) varieties grown in Ethiopia, *Inter J Food Sci Nutr*, 56, pp. 377–387.

A.K Singh, V. Prakash, S. Kumar, Dwived, (2015), Pulses production in India: present status, bottleneck and way forward, *journal of agrisearch,* 2(2), pp. 75-83.

A.R. Kennedy, (1995), The evidence for soybean products as cancer preventive agents, *J Nutr*, 125, pp. 733-743.

A.V. Rao, R. Koratkar, (1997), Anticarcinogenic Effects of saponins and phytosterols. In: Antinutrients and Phytochemicals in Food, Shahidi F (eds), ACS Symposium Series. Wageningen, Netherlands: *Wageningen Aca- demic Publishers*, pp. 313–324.

B. Blomme, C. Van Steenkiste, N. Callewaert, H. Van Vlierberghe, (2009), Alteration of protein glycosylation in liver diseases. *J. Hepatol*, 50, pp. 592–603. [CrossRef] [PubMed]

C. Corbiere, B. Liagre, F. Terro, J.L. Beneytout, (2004), Induction of antiproli- ferative effect by diosgenin through activation of p53, release of apopto- sis-inducing factor (AIF) and modulation of caspase-3 activity in different human cancer cells, *Cell Res,* 14, pp. 188–196.

C.O Moro, G. Basile, (2000), Obesity and medicinal plants, *Fitoterapia Suppl,* 10, pp.73-82.

City INNEWY, (2008), Special Article.*J Med*, 346, pp. 982-987.

D. Prakash, C. Gupta, (2011), Role of phytoestrogens as nutraceuticals in human health, *Pharmacology online,*1, pp. 510–523.

D.E.G. Novoa, R. Favaro, T.S.T. Silvmo, F.C.N. Ribeiro, R.M. Santos, A. Costa, (2015), Menopause and Cosmecuticals-Skin ,Mucosa and Menopause.Ed. Farage,M.A.; Willer, K.W.; Wood, N.F. and Maibach H.I.DOI10.1007/978-3-662-44080-332. Springer –Verlag, Berlin, Heidelberg, Germany

D.K. Kim, S.C. Jeong, S. Gorinstein, S.U. Chon, (2012), Total Polyphenols, Antioxidant and Antiproliferative Activities of Different Extracts in Mungbean Seeds and Sprouts.*Plant Foods Hum.Nutr*. 67, pp. 71–75. doi:10.1007/s11130-011-0273-x

E. Burguieres, P. Mccue, Y.I. Kwon, K. Shetty, (2008), Health-related functionality of phenolic-enriched pea sprouts in relation to diabetes and hypertension management, *Food Biochemistry*, 32, pp. 3–14.

F. Anwar, S. Latif, R. Przybylski, B. Sultana, M. Ashraf (2007). Chemical composition and antioxidant activity of seeds of different cultivars of mungbean.*J. Food Sci*.pp 505-510 doi:10.1111/j.1750-3841.2007.00462.x

F. Nasrin, I. J. Bulbu, Y. Begum, S. Khanum, (2012), *In vitro* antimicrobial and cytotoxicity screening of n- hexane, chloroform and ethyl acetate extracts of *Lablab purpureus* (L.) leaves, *Agric Biol J N Am,* 3(2), pp. 43-48.

F. Roy, J.I. Boye, B.K. Simpson, (2010), Bioactive proteins and peptides in pulse crops: pea, chickpea and lentil, *Food Research International,*43, pp. 432–442.

F.N. Mbagwu, V.U. Okafor, J. Ekeanyanwu, (2011), Phytochemical Screening on Four Edible Legumes (*Vigna Subterranean , Glycine Max , Arachis Hypogea , and Vigna Uniguiculata*) Found in Eastern Nigeria, *African Journal of Plant Science*, 5(6), pp. 370-372.

G. Lopez, M. Pedro, P. Garzon de la Mora, W. Wysocka, B. Maiz- tegui, M.E. Alzugaray, H. Del Zotto, M.I. Borelli, (2004), Quinolizidine alkaloids isolated from Lupinus species enhance insulin secre- tion, *Eur J Pharmaco*, 504, pp. 139–142.

G. Sharma, A.K. Srivastava, D. Prakash, (2011), Phytochemicals of nutraceutical importance: Their role in health and diseases, *Pharmacologyonline*, 2, pp. 408–427.

G. Stoll, M. Bendszus, (2006), Inflammation and atherosclerosis: novel insights into plaque formation and destabilization, *Stroke*, 37(7), pp. 1923–1932. [PubMed]

H. Lis, N. Sharon, (1986), Applications of lectins. In: Properties, Functions and Applications in Biology and Medicine, Leiner, I.F., Sharon, N., Goldstein, I.J. (eds.). pp. 294-357, *Academic Press*, New York.

I. Darmadi-Blackberry, M.L. Wahlqvist, A. Kouris-Blazos, B. Steen, W. Lukito, Y. Horie, K. Horie, (2004), Legumes: the most important-dietary predictor of survival in older people of different ethnicities, *Asia Pac J Clin Nutr,*13, pp. 217–220.

I. Fidrianny, N. Puspitasari, W. Marlia Singgih, (2014), Antioxidant activities, Total flavonoid, Phenolic, Carotenoid of various shells extracts from four species of legumes. *Asian J. Pharm. Clin.Res.*7, pp. 42–46.

I. Onakpoya , S.K. Hung, R. Perry, B. Wider, E. Ernst, (2011), The use of garcinia extract (hydroxycitric acid) as a weight loss supplement: a system-atic review and meta-analysis of randomised clinical trials, *J Obes.*

I.F.F. Benzie, (2003). Review: evolution of dietary antioxidants, *Comparative Biochemistry and Physiology*, 126, pp. 113–126.

J. Kim, H. Uyama, (2005), Tyrosinase inhibitors from natural and synthetic sources: structure, inhibition mechanism and perspective for the future, *Cell Mol Life Sci,* 62, pp. 1707–1723.

J. Matousek, T. Podzimek, P. Pouckova, J. Stehlik, J. Skvor, J. Soucek, J. Matousek, (2009), Antitumor effects and cytotoxicity of recombinant plant nucleases, *Oncol Res*, 18(4), pp. 163–171.

J.A. Van Burik, P.T. Magee, (2001), Aspects of fungal pathogenesis in humans, *Annual Review of Microbiology*, 55, pp. 743–772.

J.B. Dixon, (2010), The effect of obesity on health outcomes, *Mol Cell Endocrinol*. 316(2), pp. 104–108. [PubMed]

J.J Doyle, (1994), Phylogeny of the legume family: An approach to understanding the origins of nodulation, *Annu. Rev. Ecol. Systemat*, 25, pp. 325–349.

J.J. Marshall, C.M. Lauda, (1975), Purification and properties of phaseolamin, an inhibitor of alpha-amylase, from the kidney bean, *Phaseolus vulgaris*, *J. Biochemistry*, 25(20), pp. 8030–8037.

J.K. Ma, R. Chikwamba, P. Sparrow, R. Fischer, R. Mahoney, (2005), Plant- derived pharmaceuticals--the road forward, *Trends Plant Sci,* 10, pp. 580-585.

J.L. Contet –Audonneau, D. Louis, V. Gillon, G. Pauly, (2005), Moser P. Use of an extract from the *Vigna aconitifolia* plant in a cosmetic And/Or dermo pharmaceutical Composition. *Cognis corporation* patent department 300 brookside avenue ambler, pa 19002 (US).

J.P. Priya A, G.Y. SudhaLakshmi, F. Banu, S. Gopalakrishnan, P. Dhanalakshmi, E. Sagadevan, A. Manimaran, P. Arumugam. (2012). Phytochemical screening and antibacterial activity of Vigna radiata L. against bacterial pathogens involved in food spoilage and food borne diseases, *J. Acad. Indus 1 Res,*1 (6),pp. 355–359.

J.R. Barrett (2000) Mycotoxins: of molds and maladies. *Environmental Health Perspectives,* 108, pp. 20–23.

J. X. Zheng, (1999) Functional foods-second volume. Beijing: China Light Industry Press.

K. Pradeep, C.V.R. Mohan, K. Gobianand, S.Karthikeyan, (2010), Protective effect of *Cassia fistula* Linn.on diethylnitrosamine induced hepatocellular damage and oxidative stress in ethanol pretreated rats, *BiolRes*, 43(1), pp. 113-125. doi: /S0716-97602010000100013, Epub, PubMed, PMID: 21157638

K. Sowndhararajan, P. Siddhuraju, S. Manian, (2011), Antioxidant and free radical scavenging capacity of the underutilized legume, *Vigna vexillata* (L.) A. Rich, *Journal of Food Composition and Analysis*,24, pp. 160-165.

K. Tiansawang, P. Luangpituksa, W. Varanyanond, C. Hansawasdi, (2014), gaba (gamma-aminobutyric acid) production of mung bean (phaseolus aureus) during germina- tion and the cooking effect. *Suranaree J. Sci. Technol,*21, pp. 307-313.

K. Vohra, H. Dureja, V. Garg (2015), An Insight of Pulses : From Food to Cancer Treatment, J *Pharmacogn Nat Prod*, 1, pp.1-7. http://dx.doi.org/10.4172/2472-0992.100010.

L. Li, T. Yang, R. Liu, B. Redden, F. Maalouf, X. Zong, (2016), Food legume production in China, *Crop J,* 5(2), pp. 115–126. Available from: http://dx.doi.org/10.1016/j.cj.2016.06.001

L. Petit, G.E. Pierard, (2003). Skin-lightening products revisited, *International Journal of Cosmetic Science*, 25, pp. 169–181.

L.G. Ranilla, E. Apostolidis, M.I Genovese, F.M. Lajolo, K. Shetty, (2009), Evaluation of Indigenous Grains from the Peruvian Andean Region for Antidiabetes and Antihypertension Potential Using *In Vitro* Methods, J Med *Food,* 12 (4), pp. 704–713. doi:10.1089/jmf.2008.0122

M. Alizadeh, S. Daneghian , A. Ghaffari, A. Ostadrahimi, A. Safaeiyan, R. Estakhri, (2011). The effect of hypocaloric diet enriched in legumes with or without L- arginine and selenium on anthropometric measures in central obese women.*Journal of Research in Medical Sciences*, 15(6), pp. 31–43. [PMC free article][PubMed]

M. Getek, C. Natalia, N. MaBgorzataMuc-Wierzgo, E. Grochowska-Niedworok, T. Kokot, E. Nowakowska-Zajdel, (2014), The Active Role of Leguminous Plant Components in Type 2 Diabetes. *Hindawi Publishing Corporation,* 1, pp 1-12.doi:10.1155/2014/293961

M. Gonzalez-Castejon, A. Rodriguez-Casado, (2011), Dietary phyto-chemicals and their potential effects on obesity: A review. *Pharmacol Res,* 64, pp. 438–455.

M.A. McCrory, B.R. Hamaker, J.C. Lovejoy, P.E. Eichelsdoerfer, (2010), Consumption, satiety, and weight management, *Adv Nutr,* 1, pp.17–30.

M.F. Balandrin, J.A. Klocke, E.S. Wurtele, W.H. Bollinger (1985). Natural plant chemicals: Sources of industrial and medicinal materials. *Science,* 228, pp. 1154–1160.

M.L. Dickel, S.M. Rates, M.R. Ritter, (2007), Plants popularly used for losing weight purposes in Porto Alegre, South Brazil, *J Ethnopharmacol,*109, pp. 60-71.

N. Gupta, N. Shrivastava, P.K. Singh, S.S Bhagyawant, (2016), Phytochemical Evaluation of Moth Bean (*Vigna aconitifolia* L.) Seeds and Their Divergence.*Biochem. Res. Int.*1, pp. 1-6.

N. Ikarashi, T. Toda, T. Okaniwa, K. Ito, W. Ochiai, K. Sugiyama, (2011), Anti-obesity and anti-diabetic effects of *Acacia* polyphenol in obese diabetic KKAy mice fed high-fat diet, *Evid Based Complement Altern Med.*

N. Vasudeva, N. Yadav, S.K. Sharma, (2012), Natural products: a safest approach for obesity, *Chin J Integr Med*, 18, pp. 473-480.

N. Yamamoto, Y. Kanemoto, M. Ueda, K. Kawasaki, I. Fukuda, H. Ashida, (2011), Anti-obesity and anti-diabetic effects of ethanol extract of Artemisia princeps in C57BL/6 mice fed a high-fat diet, *Food Funct,* 2, pp. 45-52.

N.D. Vietmeyer, (1986), Lesser-known plants of potential use in agriculture and forestry, *Science*, 232, pp. 1379– 1384.

O. Ganiyu, (2006), Antioxidant properties of some commonly consumed and underutilized tropical legumes, *Eur Food Res Technol*, 224, pp. 61–65.

O. Nerya, J. Vaya, R. Musa, S. Izrael, R. Ben-Arie, S. Tamir, (2003), Glabrene and isoliquiritigenin as tyrosinase inhibitors from Licorice roots, *J. Agric. Food Chem*. 51, pp. 1201-1207.

P. McCue, Y.I Kwon, K. Shetty, (2005), Anti-diabetic and anti-hypertensive potential of sprouted and solid-state bioprocessed soybean, *Asia Pac J Clin Nutr,* 14 (2), pp. 145-152.

P. Siddhuraju, (2006), The antioxidant activity and free radical scavenging capacity of phenolics of raw and dry heated moth bean (*Vigna aconitifolia* Jacq. Marechal) seed extracts, *Food Chem*, 99, pp. 149– 157.

Q. Kritzinger, N. Lall, T.A.S. Aveling, B. Wyk, (2005), Antimicrobial activity of cowpea (*Vigna unguiculata*) leaf extracts, *South African J. Bot,* 71, pp. 45–48.

R. Campos-Vega, G. Loarca-Pina G, B. Dave Oomah, (2010), Minor components of pulses and their potential impact on human health, *Food Res Inter*, 43, pp. 461–482.

R. M. Kestwal, D. Bagal-Kestwal, B.H. Chiang, (2011), 1,3-??-Glucanase from *Vigna aconitifolia* and its possible use in enzyme bioreactor fabrication, *Int. J. Biol. Macromol*, 49, pp. 894–899.

R. M. Kestwal, D. Bagal-Kestwal, B.H. Chiang, (2012), Analysis and Enhancement of Nutritional and Antioxidant Properties of *Vigna aconitifolia* Sprouts, *Plant Foods Hum Nutr,*67 (2), pp. 136–141.

R. Randhir, K. Shetty, (2007), Mung beans processed by solid-state bioconversion improves phenolic content and functionality relevant for diabetes and ulcer management, *Innovat Food Sci Emerg Tech*, 8, pp. 197–204.

R. Randhir, Y.I. Kwon, Y.T. Lin, K. Shetty, (2009), Effect of thermal processing on the phenolic associated health-relevant functionality of selected legume sprouts and seedlings, *J. Food Biochem*, 33, pp. 89-112 doi:10.1111/j.1745-4514.2008.00210.

R. Randhir, Y.T. Lin, K. Shetty, (2004), Stimulation of phenolics, antioxidant and antimicrobial activities in dark germinated mung bean sprouts in response to peptide and phytochemical elicitors, *Process Biochemistry,* 39, pp. 637–646.

R.H. Sammour, A. El-Shanshoury, (1992), Antimicrobial activity of legume seed proteins, *Bot. Bull. Acad. Sin*, 31, pp. 185–190.

R.N. Tharanathan, S. Mahadevamma, (2003), Grain legumes- A boon to human nutrition, *Trends in Food Science & Technology*,14, pp. 507-518.

R.R. Hafidh, A.S. Abdulamir, L.S. Vern, F.A. Bakar, F. Abas, (2011), Novel *in-vitro* antimicrobial activity of Vigna radiata (L .) R .Wilczek against highly resistant bacterial and fungal pathogens, *Journal of Medicinal Plants Research*, 5(16), pp. 3606–3618.

R.Rungruangmaitree, W. Jiraungkoorskul, (2017), Pea, *Pisum Sativum*, and Its Anticancer Activity, *Pharmacognosy Reviews,* 11 (21), pp. 39–42.

R.W.Worthington, R.D. Bigalke, (2001), A review of the infectious diseases of African wild ruminants. The Onderstepoort, *Journal of Veterinary Research*, 68, pp. 291–323.

R.Y. Gan, M.F. Wang, W.Y. Lui, K. Wu, H. Corke, (2016), Dynamic changes in phytochemical composition and antioxidant capacity in green and black mung bean (*Vigna radiata)* sprouts, *International Journal of Food Science and Technology,*51,pp. 2090–2098.doi:10.1111/ijfs.13185

S. Korourian, E. Siegel, T. Kieber-Emmons, B. Monzavi-Karbassi, (2008), Expression analysis of carbohydrate antigen inductal carcino main situ of the breast by lectin histochemistry, *BMC Cancer,* 8, pp. 136. [CrossRef] [PubMed]

S. Nithiyanantham , S. Selvakumar, P. Siddhuraju, (2012) Total phenolic content and antioxidant activity of two different solvent extracts from raw and processed legumes, *Cicerarietinum* L. and Pisum sativum L., Journal of Food Composition and Analysis, 27, pp. 52–60. doi:10.1016/j.jfca.2012.04.003

S. Parvez, M. Kang, H.S. Chung, H. Bae, (2007), Naturally occurring tyrosinase inhibitors: Mechanism and applications in skin health, cosmetics and agriculture industries, *Phytother. Res,*21, pp. 805-816.

S. R. Kanatt, K. Arjun, A. Sharma, (2011), Antioxidant and antimicrobial activity of legume hulls, *Food Research International*, 44, pp. 3182–3187. Contents doi:10.1016/j.foodres.2011.08.022.

S. Vats, (2012), Antioxidant activity of callus culture of *Vigna unguiculata* (L.) Walp.*Acad. Arena*, 4, pp. 60-63.

S.A. Marathe, V. Rajalakshmi, S.N. Jamdar, A. Sharma, (2012), Comparative study on antioxidant activity of different varieties of commonly consumed legumes in India, *Food Chem Toxic*, 49, pp.2005–2012.

S.D. Siah, J.A. Wood, S. Agboola, I. Konczak, C.L. Blanchard, (2013), Effects of soaking, boiling and autoclaving on the phenolic contents and anti- oxidant activities of faba beans (Vicia faba L.) Differing in seed coat colours, *Food Chem*, pp.1-13.doi:10.1016/j.foodchem.2013.07.068

S.J. Bhathena, M.T. Velasquez, (2002), Beneficial role of dietary phytoestrogens in obesity and diabetes, *Am J Clin Nutr*, 76, pp. 1191–1201.

S.K. Basu, (2006). Seed Production Technology for Fenugreek (*Trigonella foenum-graecum*L.) in the Canadian Prairies (thesis). University of Lethbridge, Faculty of Arts Sci., Lethbridge, Alberta, Canada

S.L. Jothy, Z. Zuraini, S. Sasidharan, (2011), Phytochemicals screening, DPPH free radical scavenging and xanthine oxidase inhibitiory activities of *Cassia fistula* seeds extract. *J. Med. Plants Res,* 5, pp. 1941–1947.

S.M. Beckstrom-Sternberg, J.A. Duke, (1994), The phytochemical database. http://probe.nalusda.gov:8300/ cgi-bin/query?dbgroupphytochemdb.

S.M. Kerwin, (2004), Soy saponins and the anticancer effects of soybeans and soy-based foods, *Curr Med Chem Anticancer Agents*, 4, pp. 263-272.

S.N. Camalxaman, Z.M. Zain, Z. Amom, M. Mustakim, E. Mohamed, A.S. Rambely, A (2013), *In vitro* Antimicrobial Activity of *Vigna radiata* (L) Wilzeck Extracts Against Gram Negative Enteric Bacteria,*World Applied Sciences*,21 (10), pp. 1490-1494.DOI: 10.5829/idosi.wasj.2013.21.10.213

T. Yokota, H. Nishio, Y. Kubota, M. Mizoguchi, (1998), The inhibitory effect of glabridin from licorice extracts on melanogenesis and inflammation, *Pigment Cell Res,* 11, pp. 355-361.

T.S. Chang, (2009). An updated review of tyrosinase inhibitors, *International Journal of Molecular Sciences*, 10, pp. 2440-2475.

V. Vadivel, A. Patel, H.K. Biesalski, (2016), Effect of traditional processing methods on the antioxidant, α-amylase and α-glucosidase enzyme inhibition properties of *Sesbania sesban* Merrill seeds, *CyTA -Journal of Food*,10(2), pp. 128-136 doi:10.1080/19476337.2011.601427

V. Vadivel, H.K. Biesalski, (2012), Total phenolic content, *in vitro* antioxidant activity and type II diabetes relevant enzyme inhibition properties of methanolic extract of traditionally processed underutilized food legume, *Acacia nilotica* (L.) Willd ex. Delile, *International Food Research Journal*, 19 (2), pp. 593-601.

X. Sanchez-chino, C. Jiménez-martínez, G. Dávila-ortiz, I. Álvarez, (2015), Nutrient and Nonnutrient Components of Legumes and Its Chemopreventive Activity : A Review, *Nutrition and Cancer*, 67(3), pp. 401–410. doi:10.1080/01635581.2015.1004729

X. Zhaohui, G. Cen Wan, Z. Lijuan, Y. Wancong, C. huiru, K. Xiaohong, Z. Fengjuan, (2016), Bioactive Compounds and Antioxidant Activity of Mung Bean (*Vigna radiata* L.), Soybean (*Glycine max* L.) and Black Bean (*Phaseolus vulgaris* L.) during the Germination Process, *Czech J. Food Sci*, 34, pp. 68–78. doi: 10.17221/434/2015-CJFS.

Y. Jeong, J. Ha, G. Noh, S.N. Park, (2016), Inhibitory effects of mung bean (*Vigna radiata* L.) seed and sprout extracts on melanogenesis, *Food Sci Biotechnol*, 25, 567-573. doi:10.1007/s10068-016-0079-6

Y. Jing, K. Nakaya, R. Han, (1993), Differentiation of promyelocytic leukemia cells HL-60 induced by daidzein *in vitro* and *in vivo,Anti-cancer Res,* 13, pp. 1049–1054.

Y. Yao, W. Sang, M. Zhou, G. Ren, (2010), Antioxidant and alpha-glucosidase inhibitory activity of colored grains in China, *J Agric Food Chem,* 58, pp. 770–774.

Y. Yao, X. Cheng, L. Wang, G. Ren, (2012), tyrosinase inhibitor from mung bean (*Vigna radiate L.)* Extract. *International J. of food science and nutrition,* 63, pp 358-361.

Y. Yao, X. Cheng, L. Wang, S.H Wang, G. Ren, (2011), Biological potential of sixteen legumes in China, *Int J Mol Sci*,12, pp. 7048–7058.

Y. Yao, X. Yang, J. Tian, C. Liu, X. Cheng, G. Ren, (2013), Antioxidant and antidiabetic activities of black mung bean (Vigna radiata L.), *J Agric Food Chem*, 61, pp. 8104–8109. doi: 10.1021/jf401812z

Y. Yao, X.Z. Cheng, L.X. Wang, S.H. Wang, G. Ren, (2012), Major phenolic compounds, antioxidant capacity and antidiabetic potential of rice bean (Vigna umbellata L.) in China, *Int. J. Mol. Sci*,13, pp. 2707–2716.

Y.J. KiM, H. Uyama, (2005), Tyrosinase inhibitors from natural and synthetic sources: structure, inhibition mechanism and perspective for the future, *Cellular and Molecular Life Sciences,*62, pp. 1707-1723.

Y.L. Nene, (2006), Indian pulses through the millennia, *Asian Agrihis,* 10, pp. 179–202.

Y.N. Sreerama, Y. Takahashi, K. Yamaki, (2012), Phenolic Antioxidants in Some *Vigna Species* of Legumes and their Distinct Inhibitory Effects on ??-Glucosidase and Pancreatic Lipase Activities, *J. Food Sci*, pp. 927-933. doi:10.1111/j.1750-3841.2012.02848.x

Y.Y Sung, D.S. Kim, H.K. Kim, (2015), Akebia quinata ex- tract exerts anti-obesity and hypolipidemic effects in high-fat diet-fed mice and 3T3-L1 adipocytes, *J Ethnopharmacol*, 168, pp.17-24.