



Review Article

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A PHYTOPHARMACOLOGICAL REVIEW ON *PHASEOLUS VULGARIS*

Bolisetty Padmavathi *, A. Narendra Babu, R. Naveen, K. Kiranmai, V. Naga Sai Prameel
Department of Pharmacology, Chalapathi Institute of Pharmaceutical Sciences, Chalapathi Nagar, Guntur,
Andhra Pradesh, India

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*Corresponding author

E-mail: padmavathiganeshbabu@gmail.com

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ABSTRACT

Natural medicine plays a significant role in pharmaceutical industry. *Phaseolus vulgaris* L is a naturally available plant which is very frequently used in our daily life. *Phaseolus vulgaris* L is commonly known as bean; is an annual leguminous plant, belonging to family Fabaceae. *Phaseolus vulgaris* L is highly nutritious, easily and cheaply available. It is indigenous to central and South America. *Phaseolus vulgaris* L has wide number of uses due to its high content of phytochemical constituents. Flavonoids are responsible for its wide range of uses like antioxidant and neuroprotection. *Phaseolus vulgaris* L is most commonly taken by mouth for weight loss and obesity. It is also commonly taken for treatment of diabetes. The seed is diuretic, hypotensive and also used in the treatment of cancer of the blood. The present review reveals nutritional values, geographical conditions, propagation, collection and cultivation, phytochemical constituents and pharmacological activities of *Phaseolus vulgaris* L.

Keywords: *Phaseolus vulgaris* L, Fabaceae, leguminous, Antioxidant, Neuroprotection, Flavonoids, Obesity, diabetes, Cancer.

INTRODUCTION

From ancient times we are using plants as a medicinal source. Ayurvedic medicine and folk medicine has created a tremendous era in treatment of many diseases. Natural products are safer than synthetic compounds. Herbal medicines are widely used due to their less toxic nature. *Phaseolus vulgaris* L is a herbal substance which have wide number of uses in treatment of acne, bladder, burns, cardiac, carminative, depurative, diabetes, diarrhoea, diuretic, dropsy, dysentery, hiccups, itch, kidney, resolvent, eczema, emollient, rheumatism, sciatica, and tenesmus.^{1,2}

Phaseolus vulgaris Linn is widely consumed food crop due to its seed. It is most likely used as human and animal food and is a popular pharmacological agent in medicine. Its uses have been extended to folk medicine. It is originated in tropical America and grown in tropic and temperate regions of the world. The highest bean producer and consumer is Latin America. Beans are traditional and mostly used food in Brazil, Mexico, the Andean zone, Central America and the Caribbean³. Common bean has high nutritional importance and it is a good source for proteins and calories. It contains very important nutrients like iron, copper, phosphorus, magnesium, zinc, calcium, potassium and vitamins. It also has its high importance in diet with its starch, fiber, vitamins, and minerals.

Plant profile

Plant name: *Phaseolus vulgaris* Linn

Synonyms: *Phaseolusa borigineus* Burkart, *Phaseolus communis* Pritz, *Phaseolus compressus* DC, *Phaseoluses culentudsalisb*, *Phaseolus nanus* L.

Taxonomic classification

Kingdom: Plantae
Subdivision: Tracheoblonta

Super-division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Rosidae
Order: Fabale
Family: Papilionaceae
Tribe: Phaseolae
Sub tribe: Phaseolinae
Genus: *Phaseolus*
Species: *vulgaris*^{1,4}

Vernacular Names

Bengali: Barbati Beej.
English: Kidney bean, Snap bean, Green bean, Dry bean, String bean.
French: Haricot commun.
German: Gartenbohne.
Hindi: Rajma.
Italian: Fagiolo, Faxoe, Faisoe (Liguria), Fasoel (Piemonte), Cornett (Lombardia), Fasioi, Fasoler (Veneto), Fasol, Fasulein (Emilia), Fasciolo (Umbria), Fascinale (Abruzzi), Suriaca, Vasuli (Calabria), Fasolu, Trujaca (Sicilia), Fasoleddu, Basolu, Pisu (Sardegna)
Latin: *Phaseolus vulgaris*
Malayalam: Beans.
Portuguese: Feijao (dry), Feijao-vagem (green).
Spanish: (green - Mexico), Judía, Judíacomún, Frejol (Bolivia, Chile, Peru), Fréjol (Ecuador), Frijol (Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Cuba, Peru), Alubia, Frijol (Colombia), Frísol (Colombia), Habichuela (Puerto Rico, Dominican Republic), Habilla (Paraguay), Chicharo (dried seed), Poroto (Argentina, Bolivia, Chile, Panama, Peru, Uruguay), Tabla (green - Chile), Vainita (green - Bolivia, Ecuador, Peru, Chile). Tamil Sigappu Kaaramani.
Telugu: Chikkudu ginjala

Urdu: Lal lobia, Caraota (Venezuela), Chaucha (green - Argentina, Uruguay), Ejote⁴

Fruit: 1-15 cm long, 1-1.3 cm broad, linear, calceolate, pubescent or glabrous, 5-12 seeded.¹

Taxonomy

Plant: Annual, climber or sub erect, stem, pubescent to glabrescent.
 Leaves: Trifoliolate, Petiolate 4-9 cm long; leaflet 4.5-15 cm long, 2.5-6.5 cm broad ovate to ovate rhombic, acuminate, lateral leaflet oblique; Petiolate 1.5-2.5 mm long, stipules 4 mm long
 Seed: Reniform, dark red 0.9-2.0 × 0.3-1.2 cm
 Inflorescence: 1-3 flowered, peduncle 0-5 cm long.
 Bracts: 3 mm long bracteolate 5-6 mm long.
 Calyx: Pubescent, tube 2-3 mm long, teeth 1 mm long, joined to form an emarginated
 Corolla: White, yellowish, purple/pale pink.
 Vexillum: 1-1.9 cm long, glabrous, 5-12 seeded.
 Keel: 2.2 cm long spirally incurved.

Botanical distribution

Phaseolus vulgaris L is a highly polymorphic annual leguminous plant, erect and bushy, 20–60 cm tall, or twining with stems 2–3 m long; with a taproot and nitrogenous nodules.
 Leaves - alternate, green or purple, trifoliolate, stipulate, petiolate, a marked pulvinus at base; leaflets ovate, entire; acuminate, 6–15 cm long, 3–11 cm wide.
 Flowers - in lax, axillary few-flowered, racemes, zygomorphic, white, pink, or purplish
 Pods - slender, green, yellow, black, or purple, cylindrical or flat, 8–20 cm long, 1–1.5 cm wide.
 Seeds - 4–6-(12), usually glabrous, sometimes puberulent, white, red, tan, purple, grey or black and reniform.²

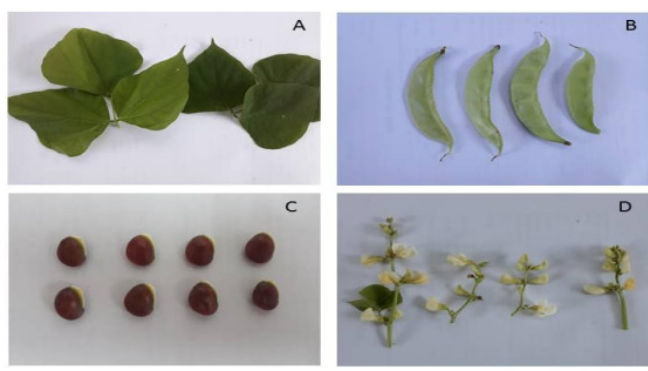


Figure 1: Common bean (*Phaseolus vulgaris* L.)
 A) Leaves B) Pods C) Seeds D) Flowers⁵

Nutritional value

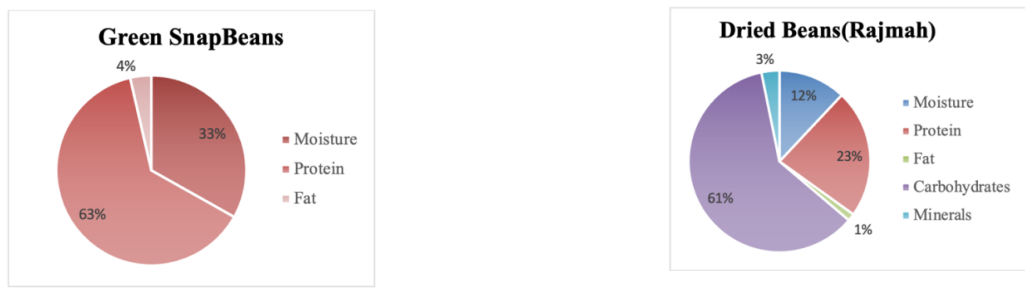


Figure 2: Nutritional Value⁵

Nutritional value of beans

Table 1: Nutritional Value of beans

Basic composition (mg/g)		Fatty acids (mg/g)	
Total lipid	10.60	Total saturated	1.54
Protein	225.30	Total mono unsaturated	0.82
Carbohydrate	612.90	Total poly unsaturated	5.86
Essential minerals (mg/g)		Vitamins (mg/g)	
Macro-minerals		Alpha-Tocopherol (E)	0.0021
Calcium	0.83	Ascorbic acid (C)	0.045
Magnesium	1.38	Folate	3.94 µg/g
Phosphorus	4.06	Niacin (B3)	0.0211
Potassium	13.59	Phylloquinone (K1)	0.056 µg/g
Sodium	0.12	Pyridoxine (B6)	0.00397
Micro-minerals		Retinol (A1)	---
Iron	0.0669	Riboflavin (B2)	0.00215
Zinc	0.0279	Thiamin (B1)	0.00608
Total dietary fiber	0.1520	Caloric value	3.37 kcal/g ^{4,6}

Toxicity

Table 2: Toxicity

Plant part	Toxicity
Roots	Giddiness, Narcotic
Seeds	Trypsin and Chymotrypsin inhibitors ¹
Raw Beans or Dried Beans	Symptoms of poisoning, sickness, diarrhoea, rhabdomyolysis due to phasin, atoxa albumin which is destroyed by cooking ^{2,7}

Ecology

Climate

Beans tolerate most environmental conditions in tropical and temperate zones but poorly survive in very wet tropics where rain causes disease and flower drop. Rain is undesirable when dry seeds are harvested.

Soil

Phaseolus vulgaris L is suitable for light (sandy) medium (loamy) and heavy (clay) soils and mostly prefer well drained soil. It cannot grow in the shade.

Propagation

Presoak the seeds for 12 hours in warm water and sow in mid spring in a greenhouse. Germination will take place within 10days. When they are large enough to handle, prick the seedlings out into individual pots and plant them out.

Cultivation

Seeds should be planted in temperate areas when soil has become warm, Dislikes heavy wet or acid soils. It Prefers a PH in the range 5.5 to 6.5.

Harvesting

Beans mature very quickly, and green beans may be harvested 4-6 weeks after sowing. Beans should be picked every 3-4 days. To minimize shatter, harvesters should not shake the vines. Now a days bean are usually hand harvested.

Yields

Yields vary widely with CV, culture and region. Yields are highest in Netherlands

Phytochemistry of *Phaseolus vulgaris* L

Phytochemical analysis of plant extracts reveals the bioactive components in the plant. Screening was performed by using different techniques which includes standard phytochemical tests, UV-Visible spectroscopy, FT-IR, Liquid chromatography, Gas chromatography, Nuclear magnetic resonance, Mass spectroscopy and infrared.

The phytochemical literature survey of *Phaseolus vulgaris* revealed the presence of anthocyanins, brassinosteroids, caffeic acid, catechic and gallic acid, coumestrol, daidzein, delphinine, equol, ferulic acid, galactomannans, gallic acid, genistein, hemagglutinins, kaempferol, lectins, malvidin, myricetin glycoside, para-coumaric acid, petunidin, phaseolamin, phaseolin, para hydroxybenzoic acid, phytic acid, phytohemagglutinin, proanthocyanidins, proanthocyanins, quercetin, robinin and vanillic acid.³

In recent findings most of the scientists proved that beans contains flavonoids like quercetin and kaempferol which are having a great role in cytoprotective nature. *Phaseolus vulgaris* also contain significant amounts of lectins which have a medical importance in anti-cancer, anti-human immune deficiency virus, anti-microbial infection and many others.

Chemical Constituents

Phaseolus vulgaris L shows the presence of alkaloids anthraquinones, flavonoids, glycosides, polyphenols, saponins, steroids and terpenoids. The average moisture content was 11%, ash 3.5%, fat 1%, protein 25%, starch 40%, crude fiber 4% and pentosans 7%. Phytochemicals can decrease the nutritional values of beans by minimizing the digestibility of proteins and carbohydrates (e.g., enzyme inhibitors, lectins and tannins) or by decreasing the bioavailability of minerals.⁸

Lectins

In the middle of 20th century, Nowell (1960) had discovered that lectin of red kidney bean called as phytohemagglutinin (PHA) is mitogenic because of this, the discovery of lectins brought into public notice.

Lectins are carbohydrate binding proteins which are of non-immune origin. Literature shows that good amount of lectins have been found in *Phaseolus vulgaris*. Many studies have proved that lectins are anti nutritional factors which can lead to intestinal disorder other than those lectins have many useful effects like anti-cancer, anti-human immune deficiency virus; anti-microbial infection, preventing mucosal atrophy, reducing type 2 diabetes and obesity are of great interest.⁹

Saponins

Common beans contain very little amounts of saponin. These are identified by the presence of a structure containing steroidal aglycone or a triterpenoid including one or more sugar. Saponin are classified as A, B&E based on aglycones structure.¹

Non flavonoids phenolic compound

The non-flavonoid phenolic compound such as hydroxybenzoic acid and hydroxycinnamic acid, are located in cotyledons, whereas flavonoid is found on seed coat.

Polyphenols

The seed colour of beans mainly contains polyphenolic compounds include flavonoids like flavonal glycosides, anthocyanins and condensed tannins (pro antho cyanidins).¹⁰

Flavonoids

Flavonoids contained on common bean are phenolic compound that has been work as inhibitor of tumour growth and some cancer types. Flavonoids share a common structure consists of two aromatic rings that links 3c, form oxygenated heterocyclic. These are divided into six sub classes depending on their heterocyclic flavones, flavones, isoflavones, anthocyanidins and flavonols (catechin & proanthocyanides). Main flavonoids are catechin, kaempferol, quercetin, myricetin and procyanidin.¹¹

The other biological activities of flavonoid present in beans include anti-oxidant activity

Proanthocyanidins

Proanthocyanidins mainly distribute in the common bean seed coats and are the vital component of polyphenols in common

beans. Mostly, the identified proanthocyanidins are procyanidin dimers and trimers

Tannins

Tannins are present most on seed coat, tannins are polymeric flavonoids that comprises a small part of widely distributed group of phenolic compounds.¹

Phenolic acids

Phenolic acids are of high importance in vegetables as they act as precursor of other more complex phenolic compounds like Gallic, Vanillic, Coumaric, Sinapic, Ferulic and Chlorogenic acids.

Coumarins

Coumarins are class of phenolic compounds mostly found in plants. These compounds show good effect in anticoagulation and antithrombotic treatment of cardiovascular diseases

Structure of some compounds identified in *Phaseolus vulgaris* L¹²

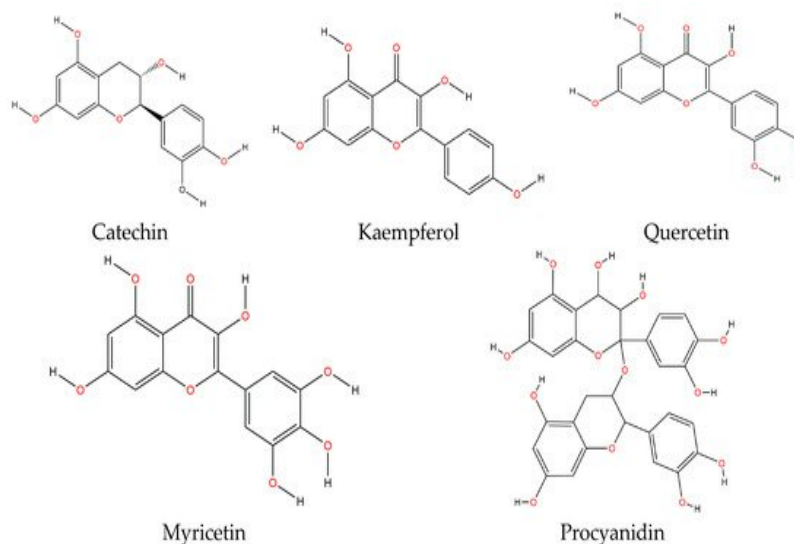


Figure 3: Structures of some isolated compounds in *Phaseolus vulgaris* L

Medicinal uses

Phaseolus vulgaris L have a wide range of medicinal uses.

Various extracts of *Phaseolus vulgaris* have been assessed for its medicinal uses and have shown anti-oxidant¹⁴, anti-fungal, anti-microbial, analgesic, anti-obesity, anti-fertility, anti-cancer, anti-diabetic, anti-inflammatory, hepato-protective, hypolipidemic, litholytic, trypsin and α -amylase inhibitor.

- Often taken orally for weight loss and obesity.¹⁵
- Commonly used for diabetes.
- Beans and bean pods are rich in dietary fiber. This fiber reduce cholesterol absorption and enhance elimination of fat from diet.
- Some research revealed that eating of *Phaseolus vulgaris* beans decreases the occurrence in people with advanced colon and rectal cancer.
- Some studies recommend that people who take high amount of dietary phyto estrogens like isoflavones have low capability of developing lung cancer than people taking small amount.
- Urinary tract infections (UTI's)
- Kidney stones
- Plant contain Phaseolin which has fungicidal activity
- Used in the treatment of arthritis and rheumatism¹³

Pharmacological activities

Anti-hypertensive activity

Phaseolus vulgaris L have shown anti-hypertensive activity due to its chemical constituents like flavonoids and saponins.¹⁶

Anti-urolithic activity

Phaseolus vulgaris L exhibit anti urolithic activity because it reduces the creatinine clearance. The parameters like urinary, serum biochemical and oxidative stress parameters were set back to normal values. *Phaseolus vulgaris* L seeds have shown both preventive and curative effects.¹⁷

Analgesic activity

Phaseolus vulgaris L show good analgesic activity as standard drugs. It is estimated that the activity is due to biochemical constituents present in the plant. However Research is under process to prove the exact mechanism.¹⁰

Anti-inflammatory activity

Hulls of *Phaseolus vulgaris* L exhibit higher anti-inflammatory activity due to its phenolic content. *Phaseolus vulgaris* L inhibit both cyclooxygenases, COX-1 and COX-2. Total phenolic content was measured by using oxygen radical absorbance capacity (ORAC) values.

Antioxidant activity

Phaseolus vulgaris Linn have significant antioxidant activity due to its chemical constituents like phenolic acids, flavonoids, stilbenes, and tannins. The anti-oxidant activity is mainly due to the reducing capacity of polyphenols as the play an important role in neutralizing free radicals and scavenging radicals. Many studies have proved that *Phaseolus vulgaris* Linn possess significant anti-oxidant capacity by estimating various biochemical parameters like including thiobarbituric acid reactive substances (TBARS), glutathione peroxidase (GPx), glutathione reductase (GR), hydroperoxides, glutathione (GSH), superoxide dismutase (SOD), catalase (CAT) and glutathione S-transferase (GST).^{18,19}

Anti-diabetic Activity

Phaseolus vulgaris L possess anti hyperglycemic activities because of their phenolic compounds like flavonoids and their glucosides of petunidin, delphinidin and malvidin, anthocyanins, catechin, myricetin 3-O-arabinoside, vanillic acid, syringic acid, epicatechin, and O-coumaric acid. *Phaseolus vulgaris* L inhibit α -amylase, α -glucosidase and dipeptidyl peptidase-IV, due to which they exhibit anti hyper glyceemic effect. Daily intake of dry common beans has useful effects in preventing and managing of diabetes²⁰

Anti-obesity and Cardio-protective Activity

Phaseolus vulgaris L show anti-obesity and cardioprotective studies due to its reducing capacity of TC, TG, free fatty acids (FFA), phospholipids and FA composition of total lipids.

Anti-hyperlipidaemic activity

Phaseolus vulgaris L exhibit anti-hyperlipidaemic activity because of their phenolic constituents which include quercetin, quercetin 3-O-glucoside, kaempferol, p-coumaric acid, orientin, isorientin, rutin, myricetin-3-rhamnoside, hyperoside, isorhamnetin-3-O-glucoside, 26 kaempferol-glucuronide, kaempferol, isorhamnetin-3-O-glucoside, caffeine, hydroxycinnamic acid, ferulic acid, p-hydroxybenzoic acid, vanillic acid and proanthocyanidins.

Anti-mutagenic and Anti-carcinogenic Activities

A larger survey conducted in 41 countries revealed that the daily intake of common beans reduced the mortality by cancers such as colon, breast, and prostate. The anti-carcinogenic and anti-mutagenic activities of *Phaseolus vulgaris* L are connected with the presence of phenolic compounds and other bioactive compounds. Phenolic compounds have the capability to inhibit mutagenic agents like polycyclic aromatic hydrocarbons, nitrosamines and mycotoxins by inhibiting activation enzymes and provoking detoxification enzymes.

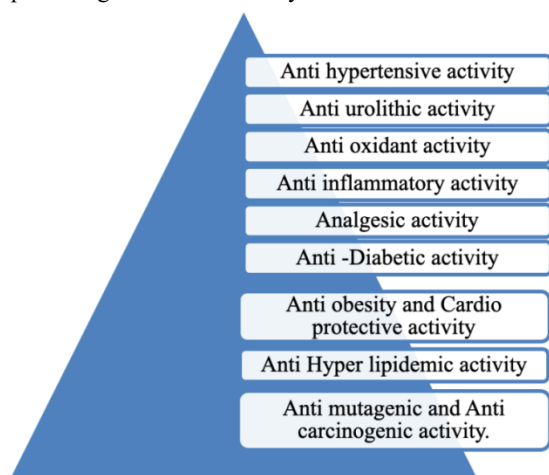


Figure 4: Activities of *Phaseolus vulgaris* L

Known Hazards of *Phaseolus vulgaris*

Large quantities of raw matured seeds are poisonous. Children eating just a few seeds have shown mild forms of poisoning with nausea and diarrhoea, though complete recovery took place in 12-24 hours.²¹

CONCLUSION

Phaseolus vulgaris L is a medicinal plant which is widely used in traditional and folk medicine. It is generally used in raw and

cooked form. It contains very good amount of nutrients which require for our body like proteins, vitamins and carbohydrates. And also it can be used in treatment of many diseases.

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