



# Pharmacology and Phytochemicals activities of Cajanus Cajan : Review

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## ABSTRACT

*Cajanus cajan* which is also known as 'pigeon pea' is used as food crop in tropical and subtropical areas of the world which is a great source of protein, vitamin B and minerals for human as well as animals and has a great contribution over medicinal uses. It belongs to the Fabaceae family and it has many medicinal properties such as anti-bacterial, anti-microbial, anti-inflammatory, hypocholesterolemic effects, anti-diabetic, anti-cancer, neuroactive properties, antioxidant, hepatoprotective, anthelmintic, glycemic and many more. Its extracts such as polyphenols, quercetin, luteolin, apigenin, isorhamnetin, flavonoids, cajaninstilbene acid etc. are very useful for the treatment of jaundice, diarrhea, sores, cough, bronchitis, bladder-stones and diabetes. From ancient period to present time, pigeon pea is used by different population for different purposes such as food, agricultural and treatment. The ethno-pharmacological importance of pigeon pea is utilized in various ways among the tribal community 'Garo' of Bangladesh, Chinese people, people of West Indies and people of Tamil Nadu and Rajasthan. This study has mainly focused on various pharmacological actions and medicinal uses through review study of different studies done on pigeon pea. This review article gives an overview on the biological activities of the compounds isolated, pharmacological actions and clinical studies of *C. cajan* extracts apart from its general details.

**Keywords:** Cajanaus cajan, therapeutic activity, pharmacological action, herbal drug

## INTRODUCTION

*Cajanus cajan* (L.) Huth. (Family: Fabaceae), generally known as "Pigeon pea" (English), an individual from the *Cajanus* variety, is a standout amongst the most significant lasting or yearly leguminous sustenance trims in Asia, Africa and a few sections of South America, broadly circulated in different parts of tropical and subtropical territories of the world, and assuming a vital part in the field of agribusiness and nourishment. *Cajanus cajan* is a beneficial nontoxic grain that provides both food supplement and a wide range of medicinal applications. Pigeon pea is a wellspring of protein, vitamin B and minerals for veggie lover populaces and creatures. The plant *C.cajan* contains many bioactive constituents such as stilbenes, flavones, phytosterols, coumarins and many more which possess therapeutic applications for diabetes, hepatitis, malaria, cancer, hyperglycemia etc. This plant is also considered to have anti-oxidant, anti-cancer, anti-tumor, anti-malarial and anti-bacterial properties. Concentrates of pigeon pea leaves are useful for jaundice, looseness of the bowels, wounds, hack, bronchitis, bladder-stones and diabetes. In the folk medicine of China, pigeon pea leaves are used to arrest blood, relieve pain and kill worms. The young leaves of the pigeonpea can be chewed for treating aphtha, and the decoction of the leaves has been proved to treat cough and diarrhea effectively. In recent years, pigeonpea leaves have been used to treat traumatism, burnt infection, bedsore etc. It was also found that pigeon pea leaves exhibit notable anti-inflammatory, antibiotic and abirritation effects and inhibit capillary permeability. Especially in China, it is considered as an excellent traditional Chinese medicine (TCM) in the market for the therapy of ischemic necrosis of femoral head. This paper is a comprehensive and an up-to-date review of the plant – *Cajanus cajan* and this review paper mainly focused on the pharmacological properties and further scope in the therapeutic uses of this plant.

### Scientific Classification

Kingdom: *Plantae*

Class: *Magnoliopsida*

Subclass: *Rosidae*

Order: *Rosidae*

Family: *Fabaceae*

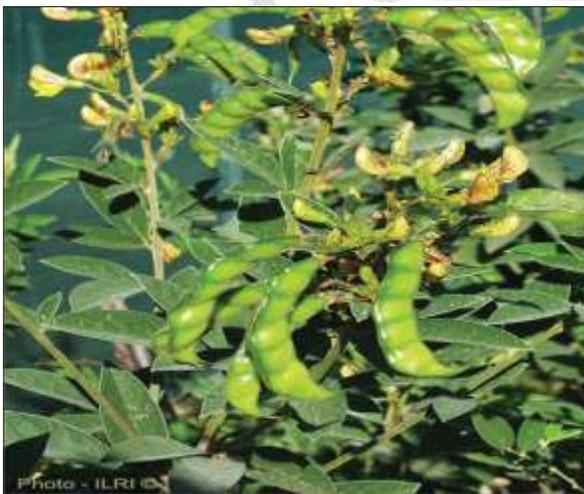
Genus: *Cajanus*

Species: *Cajanus cajan* (L.) Huth.

### Botanical Description

Pigeon pea occurs in several varieties and known as congo pea, no eye pea, dhal, red gram, gungo pea,

gandul, gandure, frijol de árbol and pois cajan etc. Varieties that are old in cultivation and semi-cultivation in the West Indies treated are semi-deciduous, short-lived shrubs which are generally 1 to 4 cm in basal stem diameter. They are usually single stemmed, freely branching and become woody after a few months. These woods can be more hard and brittle. They have deep root (up to 3m) as well as lateral roots and nodulated fine roots. The branches and fine twigs support abundant yellowish green foliage which are sparingly arranged, silky-pubescent, trifoliolate leaves have narrowly elliptic, lanceolate or oblong leaflets, 2.5 to 9 cm long, and the center leaflet being slightly longer than the laterals. The five- to 12-flowered racemes are axillary. Flowers are about 2 cm long, yellow, the standard often being orange to purple outside. The legumes, which are flattened, somewhat constricted between seeds, and 4 to 8 cm long, are mottled bronze-purple when immature, drying to brown. They contain 2 to 9 mottled brown (white, red, brown, gray, or black in improved varieties) seeds, 7 to 8 mm long by 6 mm broad. There are  $2n = 22, 44, \text{ or } 66$  chromosomes.



**Fig 1 :** Leaves, fruits and flowers of *C. cajan*

**Fig 2 :** Mature fruits of *C. cajan*

## GEOGRAPHICAL SOURCE

It has been cultivated in ancient Egypt, Africa and Asia since prehistoric times, and was later introduced to America. Now it acclimatizes in several tropical countries. The major producer is India contributing about 90% of world production. Its altitude range is 1250 m in Hawaii, 0-3000 m in India and Columbia. It is essentially a plant of the semi-dry lowlands but has wide adaptability.

## Cultivation

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90% of world production. Its altitude range is 1250 m in Hawaii, 0-3000 m in India and Columbia. It is essentially a plant of the semi-dry lowlands but has wide adaptability.

## CHEMISTRY

Chemical constituent investigations have indicated that *C. cajan* leaves are rich in flavonoids and stilbenes. They also contain saponins, conspicuous amount of tannins, and moderate quantities of reducing sugars, resins and terpenoids. Chemical studies reveal 2'-2' methyl cajanone, 2'-hydroxy genistein, isoflavones, cajanin [Figure 3], cahanones etc., which impart antioxidant properties.<sup>[17]</sup> Roots are also found to possess genistein and genistin. It also contains hexadecanoic acid,  $\alpha$  amyryl,  $\beta$ -sitosterol, Pinostrobin [Figure 4], longistylin A [Figure 5] and longistylin C [Figure 6] which impart anticancer activity. Presence of cajanuslactone [Figure 7], a coumarin imparts antibacterial activity. Presence of cajaninstilbene acid [Figure 8], pinostrobin, vitexin [Figure 9] and orientin [Figure 10] is responsible for antiplasmodic activity.

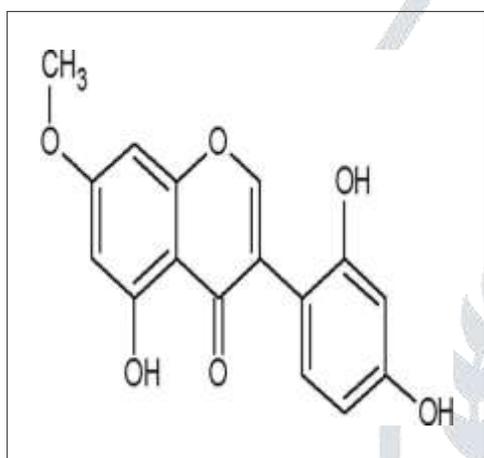


Figure 3: Structure of cajanin

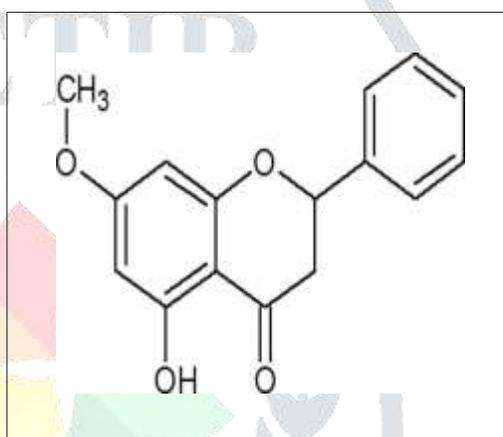


Figure 4: Structure of pinostrobin

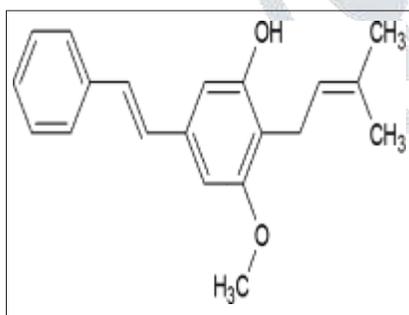


Figure 5: Structure of longistylin A

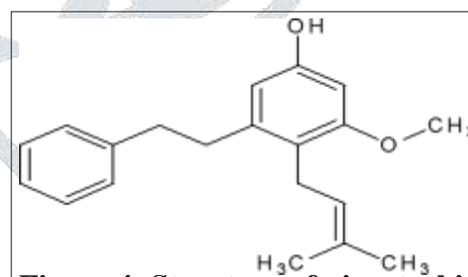


Figure 6 : Structure of longistylin C

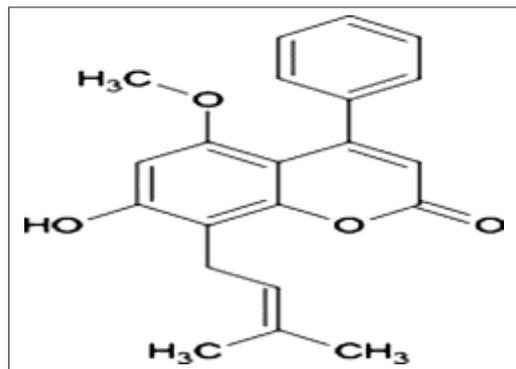


Figure 7 : Structure of Cajanuslactone

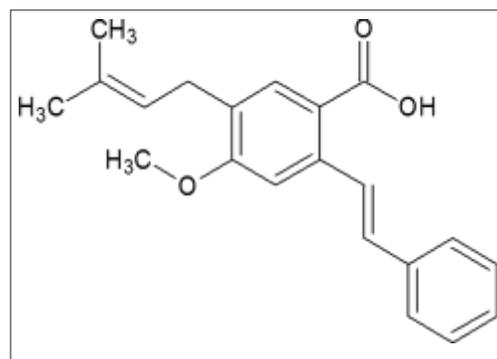


Figure 8 : Structure of cajaninstilbene acid

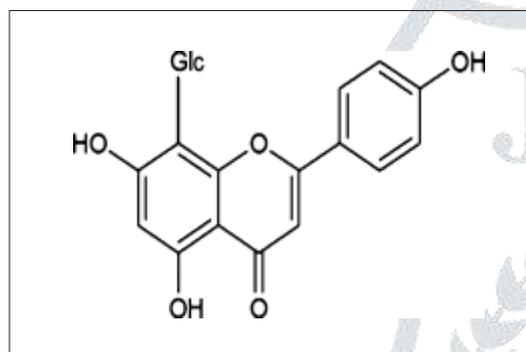


Figure 9 : Structure of Vitexin

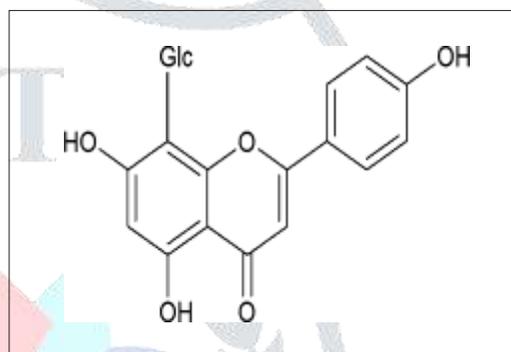


Figure 10 : Structure of Orientin

### Pharmacological Properties

Different parts of *Cajanus cajan* are used for their biological activities from ancient times and most of them have been experimented with solid grounds of their therapeutic values. Besides their uses in folkloric medicines, there are wide availability of modern scientific study conducted on the biological activities and pharmacological actions of *C. cajan*.

#### Antimicrobial Activity

The extracts of *Cajanus Cajan* were showed potential activity against eight microbial strains: *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Aspergillus niger* and *Candida albicans*. A great inhibitory effect of the SFE extracts of *C.cajan* was seen against *S. epidermidis*, *S. aureus* and *B. subtilis*. *In vivo*, the antimicrobial activity was observed in mice which was inoculated with *S. aureus* and the pathway through which the plant extract works again these microorganisms was studied by histopathology . The ethanol extracts and supercritical fluid extraction extracts from *Cajanus Cajan* were evaluated from its antimicrobial activities and the plant extracts showed significant antimicrobial activities both in vivo and in vitro and this might be a potential candidate for the treatment of *S. aureus* and might also work against MRSA. In a study conducted by Qi *et al.*, the essential oil extracted from solvent-free microwave extraction and

hydrodistillation have showed excellent activity against gram positive and gram negative bacteria, *B. subtilus* and *P. acnes* .

### Antibacterial Activity

Extracts from *C.cajan* leaves in the bioassay-guided fractionation of chloroform resulted into the isolation of new natural coumarins: Cajanuslactone and two phyto alexins: Pinostrobin and cajaninstilbene acid. It was seen that cajanuslactone have high antibacterial activity against the bacteria, *S. aureus* . The extracts of pigeon pea leaves have shown to be effective against some pathogenic bacteria and test result reported that the extract could successfully inhibit the proliferation of bacteria *Salmonella Thypi* . Typhoid is an infectious disease that is caused by the gram (-ve) bacteria *Salmomella Thypi* and it this disease is a burden in many developing countries. The major component in *C. cajan* are classified into two groups: stilbene and flavonoids and the extract of this plant could effectively inhibit growth of *S.thypi*, *S. aureus* and *E. coli* .

### Antidiabetic Effects

The antidiabetic activity of methanolic extract of leaves of *C. cajan* was studied in alloxan-induced diabetic and oral glucose-loaded rats. The acute toxicity and lethality (LD<sub>50</sub>) and phytochemical analysis of the extract were also evaluated. The results showed that the extract significantly reduced the fasting blood sugar of alloxan diabetic rats in a dose-related manner with maximumhypoglycemic effect at 4-6 h.

### Antioxidant Activities

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging assay and  $\beta$ -carotene-linoleic acid test were done on aqueous, ethanol, ethyl acetate and petroleum ether which are the extracts of *C.cajan* leaves to find out the antioxidant activities. Additionally, those test were also done on cajaninstilbene acid (3-hydroxy-4-prenylmethoxystilbene-2-carboxylic acid), pinostrobin, vitexin and orientin which are the four main compounds of ethanol extract of *C.cajan*. After the tests were carried out, it was seen that the leaf extracts of *C.cajan* can be valuable natural antioxidants and likely usable as medicine and can be used in food or health industry. Negative pressure cavitations extraction (NCPE), a new method was introduced and genistein and genistin which are the extraction of the main isoflavonoids of *C.cajan* was suggested. This method showed notable concentration- dependent antioxidant activity. The profile of Syringol, also known as 2,6-dimethoxyphenol, seem to have anti-oxidative properties and is found to have suppress oxidative stress . Previous studies have found the chemical constituents in *C. cajan* leaves to have stilbenes, flavones, coumarins, and phytosterols that seem to possess anti-oxidant properties. Metabolites analysis of *C.cajan* plants showed the presence organic compounds, phenolics, fatty acids, aminopyrimidines, tripeptides, phytohormone are some of the important metabolites which have anti-oxidant and iron chelating activity. In the study extracted large amount of enrich flavanoids and stilbenes from *C.cajan* where different extraction techniques were used to determine which technique yields greater anti-oxidant properties. Negative-

pressure cavitations in addition with aqueous two-phase extraction tend to optimize yield flavanoids and stilbenes and thus provide relatively high anti-oxidant activity .

### **Anticancer Activity**

*C. cajan* roots contains Cajanol, an isoflavanone which is an important phytoalexin. The anticancer properties of cajanol towards MCF-7 human breast cancer cells were studied and experimented . In order to determine the mechanism of cell growth inhibition of cajanol, other parameters like DNA fragmentation assay, cell cycle distribution and morphological assessment of nuclear change, mitochondrial membrane potential disruption, reactive oxygen species (ROS) generation and caspase-3 and caspase-9 expression, Bcl-2, PARP and cytochrome-C were quantified . Cajanol have showed to inhibit the growth of MCF-7 cells in a time- and dose- dependent manner. Cajanol have showed to arrest the cell cycle in the G2/M phase and have also induced apoptosis via a reactive oxygen species (ROS)-mediated mitochondria- dependent pathway. Cajanin stilbene acid isolated from Pigeon Pea (*Cajanus Cajan*) is structurally similar to estrogens which have showed cytotoxic effects to estrogen receptor-alpha and possess anti-estrogenic properties, promising therapeutic effects against breast cancer cells . The methanol extract of *Cajanus Cajan* shows high cytotoxicity against many cancer-cell lines .

### **Anti-Mutagenic properties**

Phytochemical compounds in *Cajanus cajan* contains many bioactive compounds such as tannins, reducing sugars, anthroquinone, triterpenoids, alkaloids, phenols, saponins and flavonoids where flavonoid fraction extraction from this plant improved cytotoxic and genotoxic effects in mutagenic agents induced animals. Quercetin is one of the extracted flavonoids from *C. cajan* which is a very active compound to work against mutagen induced cells and mutagenicity in rats' hepatic cells, thus providing protection against DNA damage and chromosomal changes in germ and somatic cells.

### **Hypocholesterolemic Effects**

The effects of the stilbenes containing extract-fraction from *C. cajan* (SECC) on diet-induced hypercholesterolemia in kunming mice were identified. The SECC reduced the atherogenic properties of dietary cholesterol in mice. Its hypocholesterolemic effect may involve enhancement of the hepatic Low Density Lipoprotein-receptor and cholesterol-7- alpha-hydroxylase expression levels and bile acid synthesis . Research using methanol extract of *C.cajan* seeds were fractionated into petroleum ether, chloroform, and methanol. The methanol fraction significantly decreased lipid profiles of streptozotocin-induced Swiss Albino mice compared to control. The extract was then subjected to chromatographic analysis and a compound (CCA1) was isolated which possessed first prominent hypolipidemic activity .

*C. cajan* diet at doses of 200-800 (g/kg feed) has improved cholesterol level of hypercholesterolemia hamsters by converting cholesterol to bile acids and by increasing CPT-1, LDL receptor, cholesterol-7-

alpha hydroxylase, antioxidant enzymes and further increasing lipid peroxidation. The *C. cajan* beverages administration at doses equivalent to human consumption of 30 grams/day to Sprague Dawley male rats has confirmed to have potential to reduce total cholesterol levels by 19.78 % of diabetic-hypercholesterolemia rats.

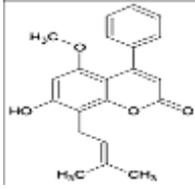
### Glycemic Activity

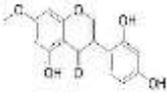
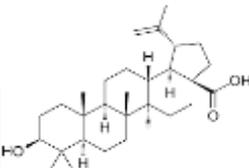
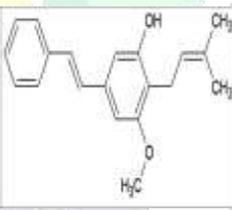
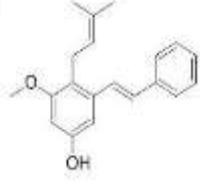
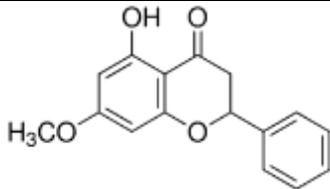
The glycemic profile of the aqueous extract of *C. cajan* leaves in streptozocin-induced Type 2 diabetic rats was evaluated. This extract showed significant increment in fasting blood glucose levels of normal rats. The study of leaves was taken into consideration on the basis of earlier reported hypoglycemic activity of *C. cajan* seeds. However, the results observed were found to be just opposite and therefore it may be useful in controlling hypoglycemia occasionally caused due to excess of insulin and other hypoglycemic drugs.

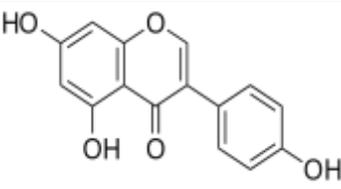
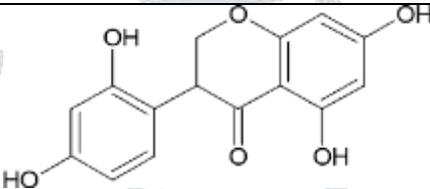
### Neuroactive properties

Pinostrobin is a substitute of flavanone from *C.cajan* and its in vitro neuroactive properties were estimated. Voltage-gated Na-channels of mammals' brain were inhibited by pinostrobin on the ability of the substance to suppress depolarizing effects of Na-channel selective activator veratidine in a synaptoneurosomal preparation from mouse brain. It has been seen that pharmacological profile of pinostrobin is similar to the depressant drugs which block Na-channel. Lui (2015), also mentioned in his study that stilbenes found in *C.cajan* leaves have ameliorate cognitive defects and neuron apoptosis in mice and thus having neuroprotective activity . Then again, it has been seen that all the four stilbenes extracted from *C.cajan* leaves (cajaninstilbene acid, longistyline A, Longistyline C and cajanolactone A posses neuro-protective properties against the damaged induced by corticosterone and glutamate in PC12 cells by the inhibition of oxidative stress . Voltage-gated sodium channel are widely present CNS of mammals where sodium ions play an important role in the maintenance of the neural firing in the central nervous system. A substituted flavanone, pinostrobin which can be found in *Cajanus Cajan* seem to have inhibitory activity of the sodium channels and has been used as a sedative in traditional Chinese medicine .

**Table 1: Pharmacological activities and active constituents of *C. cajan***

Active chemical constituent	Plant part	Pharmacological activity	Chemical structure	Extract
Cajanuslactone (coumarin)	Leaf	Antibacterial		Chloroform

			Cajanuslactone	
Cajanin, longistylin C, longistylin A	Leaf	Hypocholesterolemic	 <p>Cajanin</p>	Ethanol
Betulinic acid, longistylin A and longistylin C	Roots, leaf	Antiplasmodial	 <p>Betulinic acid</p>  <p>Longistylin A</p>  <p>Longistylin C</p>	Ethanol
Pinostrobin	Leaf	Anti-inflammatory, neuroactive		Ethanol

			Pinostrobin	
Genistein	Roots	Antioxidant	 <p>Genistein</p>	Ethanol : Water (70:30 v/v)
Cajanol (isoflavonoids)	Roots	Anticancer	 <p>Cajanol</p>	Ethanol
Protein fraction CI-1	Leaf	Hepatoprotective	-	Methanol

## Conclusion

The abundance and availability of pigeon pea plants in many countries, in addition with their high nutritional value, have made Pigeon pea plant one of the vast usage for consuming and . Pulse crops have long been known for their nutritional and health-promoting properties, such as being an excellent source of protein, fiber, carbohydrates, and for their role in decreasing the risk of certain cancers, managing obesity, lowering cholesterol and type-2 diabetes. Recently, the bioactive properties of proteins and peptides derived from pulse seeds have gained increased recognition in the areas of food science and nutrition for their potential benefits in treating and/or reducing the onset of disease. Lectins and protease inhibitors which were traditionally considered as protein anti-nutritional compounds have shown potential in the treatment and/or prevention of various cancers, obesity and hypertension which has necessitated a reconsideration of the use of the term “anti-nutritional”. Additionally, the ACE inhibitor properties of pulse peptides could make them primary therapeutic agents or adjuncts to treatment for certain cardiovascular diseases. Pulse seeds may, therefore, be potentially excellent source of beneficial bioactive proteins and peptides, and techniques for the efficient extraction and fractionation of these proteins and peptides are needed. Further research is also needed to improve our understanding of the mechanisms involved in the absorption into the

blood stream, target sites and their activity in various tissues of biologically active compounds derived from dry peas, chickpeas and lentils.

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