



## Review Article

## Pharmacological aspects of Isabgol: An overview

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## Abstract

Herbal medicine is widely used globally, including in India, where it plays a significant role in primary health care. It is alternatively known as Ispaghula Psyllium, *Plantago ispaghula*, and *Plantago ovata*. Psyllium offers numerous health benefits.<sup>2</sup> Psyllium is a naturally occurring, hydrophilic gel-forming substance that has been historically utilized in China and India for an herbal remedy for various ailments. These include bladder issues, high blood pressure, skin irritations, constipation, diabetes mellitus, ulcerative colitis, haemorrhoids, cholesterol reduction, colorectal cancer, hyperlipidaemia, hyperuricemia, and anti-ulcer activity.<sup>1</sup> *Plantago* is a valuable botanical remedy containing various compounds such as phenolic, flavonoids, alkaloids, terpenoids, and vitamin C.<sup>4,2</sup> Its phenolic compounds, including flavonoids, provide the plant with antioxidant properties, while these phenolic also offer protection against UV radiation.<sup>5</sup> This review examines its bioactive components and their modes of action, shedding light on the therapeutic benefits of Isabgol in supporting gastrointestinal health, cardiovascular function, and metabolic balance. Research highlights its prebiotic capabilities and effectiveness in addressing conditions such as constipation, diarrhoea, and irritable bowel syndrome through gut micro biota modulation and improved stool quality. Additionally, Isabgol's blood sugar-lowering and cholesterol-reducing effects play a vital role in the management of diabetes and cardiovascular disorders. Its applications in weight regulation, skincare, and emerging cancer research further underscore its adaptability. This review highlights the importance of Isabgol in integrative medicine, offering a detailed evaluation of its pharmacokinetics, bioavailability, and safety profile for medical use.<sup>1</sup>

**Keywords:** *Plantago Ovata*, Anti-carcinogenic, Anti-inflammatory, Anti-oxidant, Drug delivery agent, Botanical remedy.

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## 1. Background

Psyllium, derived from the seeds of *Plantago ovata*, is a plant with a long history of use, particularly for its medicinal properties. The historical background of psyllium can be traced back to ancient civilizations, where it was used for its digestive health benefits and other therapeutic uses.

## 2. Ancient Uses

1. **Ancient Egypt:** Psyllium was used in ancient Egypt, where it was valued for its high fiber content, which promoted digestive health and helped in managing constipation. The Egyptians were known to use a variety of plant-based remedies for health, and psyllium was likely included in their medicinal practices.
2. **Traditional Indian Medicine (Ayurveda):** Psyllium has been used for centuries in Ayurvedic medicine, a traditional system of healing in India. In Ayurveda, psyllium is known as *Isabgol* or *Ispaghul*. It was commonly prescribed to treat digestive issues such as constipation, diarrhea, and as a gentle detoxifier. It was also recommended for its ability to lower cholesterol levels and help in managing diabetes.
3. **Ancient Greece and Rome:** In classical antiquity, *Plantago* species were used by the Greeks and Romans. While not all *Plantago* species were used for psyllium, some were valued for their healing properties, especially in treating wounds and infections. The seeds of *Plantago* were used as a mild laxative and for their soothing properties for the digestive tract.

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### 3. 19th Century and Modern Use

**19<sup>th</sup> Century (Europe and North America):** In the 19th century, psyllium gained more attention in Western medicine. It was recognized for its high soluble fiber content, which helped treat constipation. The plant became popular in Europe and the United States as a natural remedy for digestive health issues. It was often included in patent medicines and tonics.

**20th Century and Commercialization:** By the 20th century, psyllium became commercially available as a bulk-forming laxative. It was sold in various forms, such as powders, capsules, and granules, as a means to relieve constipation and improve overall digestive health. Its use expanded beyond the pharmaceutical industry to become a common dietary supplement for regulating bowel movements and supporting heart health.



**Figure 1:** Isabgol plant

**Table 1:** Nutritional value of Isabgol

Nutrient	Percentage (%)
Protein	0.94
Albumin	35.8
Globulin	23.9
Prolamin	11.7
Total Carbohydrates	84.98

### 4. Polysaccharide Composition of Psyllium

Psyllium (*Plantago ovata*) is an excellent source of dietary fiber, primarily consisting of complex polysaccharides that provide its remarkable water-retention, viscosity, and gel-forming properties. These polysaccharides are key to psyllium’s numerous health benefits, including supporting digestion, regulating blood sugar levels, and lowering cholesterol.

**Key Polysaccharides in Psyllium:**The primary polysaccharide in psyllium is arabinoxylan, accompanied by smaller amounts of sugars such as galactose, rhamnose, and galacturonic acid.

#### a) Arabinoxylans (~60–70%)

1. The most abundant polysaccharide in psyllium husk.
2. Made up of a xylan backbone with arabinose side chains.
3. Responsible for psyllium’s high viscosity and gel-forming ability when it absorbs water.
4. Aids in bulk formation in the digestive tract, promoting regular bowel movements and alleviating constipation.

#### b) Galacturonic Acid

1. A structural sugar that contributes to mucilage formation, giving psyllium its characteristic slippery texture when hydrated.
2. Plays a significant role in water-binding capacity and the fiber-like properties of psyllium.

#### c) Rhamnose

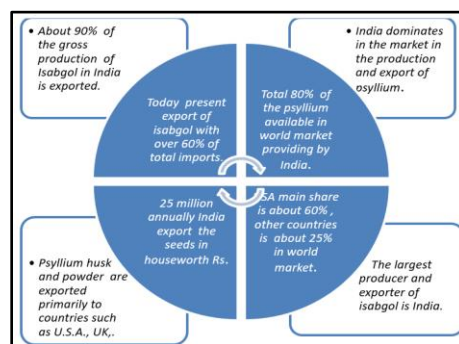
1. A deoxy sugar that supports the structural stability of psyllium mucilage.
2. Though present in small amounts, it is essential for maintaining the branched structure of psyllium’s polysaccharide network.

#### d) Galactose and Mannose

1. Found in minor proportions in psyllium’s polysaccharide composition.
2. Contribute to mucilage formation and enhance viscosity.

#### e) Glucose

1. Found in trace amounts, primarily as part of complex polysaccharides rather than as a free sugar.
2. Adds to fiber-like properties but is not a major structural component.



**Figure 2:** Isabgol import export market

### 4.1. India scenario

India leads global Isabgol production, contributing 98% of the world's supply, and is the primary exporter of psyllium seeds and husks in the international market. The USA and Europe are major importers. Originally native to Persia, psyllium is now extensively cultivated in the western Indian states, including Gujarat, Rajasthan, Madhya Pradesh, and Haryan<sup>5</sup>a. Gujarat serves as the hub for psyllium production and processing due to its favorable environmental conditions, with Rajasthan offering similar cultivation advantage s.<sup>6</sup>. These two states account for approximately 61,000 hectares under psyllium cultivation. Our Country provide crucial provision psyllium to the global market, with the USA being its largest importer.<sup>14</sup>

Various parts of the psyllium plant like leaf, grain, husks, are abundant in bioactive compounds, primary metabolites, and secondary metabolites.<sup>11</sup> Globally recognized for its laxative properties, psyllium is a valuable source of dietary fiber with significant antioxidant and anti-inflammatory benefits.<sup>10</sup> The composition of psyllium includes 15% non-polysaccharide material, while 85% comprises polysaccharides, including D-xylose (62%), L-arabinose (20%), L-rhamnose (9%), and D-galacturonic acid (9%). Its polysaccharide structure features a linear backbone of  $\beta$ -D-xylose in pyranose ring form, with disaccharide side chains terminated by  $\alpha$ -D-galacturonic acid linked to O-2 of  $\alpha$ -L-rhamnose. These side chains attach connected o he 2-oxygen or 3 oxygen the xylose units in the polymer backbone.<sup>12</sup>

## 5. Psyllium Product and Its Application

### 5.1. Psyllium seeds

Psyllium seeds are rich in phenolic and flavonoid compounds, which are primarily responsible for their potent anti-inflammatory and antioxidant properties. These seeds are derived from the dried, mature psyllium seeds and are carefully cleaned to remove dust, fibers, debris, mud, stones, and metallic particle.<sup>11</sup> Psyllium seeds are typically light to moderate brown in color with a faint odor. They consist of approximately 70% soluble fiber and 30% insoluble fiber, making them an excellent source of dietary fiber.<sup>79</sup>

The seeds are composed of 40% linoleic acid (LA), an essential fatty acid crucial for maintaining health, along with 19% fiber content, 18.8% protein, and 10–20% triglycerides. The mucilage in psyllium seeds contains polysaccharides, which account for their soluble fiber content. Additionally, the seeds are a source necessary amino acids, likevaline, aniline, glycine, glutamic acid, cystine, lysine, leucine, and tyrosine, among others, further enhancing their nutritional profile.<sup>13</sup>



**Figure 3:** Seeds of Isabgol

**Table 2:** Physical properties of seeds

Length of seeds	2-3mm
Width of seeds	0.8-1.5mm
Weight of 100 seeds	0.1-0.2gram
Weight of 1000 seeds	1.3gram
Density of seeds	1350.6kg/m <sup>3</sup>
Bulk density of seeds	647.4kg/m <sup>3</sup>
Sphericity of seeds	51.1%
Angle of repose	33.8%

**Table 3:** Nutrient provided by seeds

Fat	7%
Ash	3%
Carbohydrate	49%
Dietary fiber	25%
Protein	17%

### 5.2. Psyllium husk

Psyllium husk is the mucilage-rich outer coating of the psyllium seed and is considered a pure source of dietary fiber.<sup>4</sup> It is the primary Plant component utilized in the production of psyllium-based products. The husk's nutritional profile primarily includes 1. Bioactive compounds. With a fiber content exceeding 80%, it surpasses other sources like oat bran (less than 15%) and wheat bran (approximately 10%).<sup>6</sup> The husk is predominantly composed of hemicellulose, a complex carbohydrate found in whole grains, fruits, and vegetables.<sup>29</sup> Although indigestible, hemicellulose is subjected to partial colonic fermentation serving as nourishment for beneficial intestinal bacteria.<sup>36</sup>

To obtain the husk, psyllium seeds undergo processing to remove their outer coating. The husk comprises approximately 70% soluble fiber and 30% insoluble fiber. This white, fibrous material finds applications across pharmaceutical, cosmetic, and food industries. Psyllium husk can be found in different grades based on factors like Quality& particle size catering to various industrial needs.<sup>37</sup>





**Figure 4:** Psyllium husk

### 5.3. *Psyllium fiber powder*

Psyllium husk powder is produced by processing the husk through pulverizing machines with various particle mesh sizes. It is commonly available in four purity grades: 99%, 98%, 95%, and 85%.<sup>6,10</sup>

1. **Leaves:** These are slender, green, and resemble grass. They hold little commercial significance.
2. **Stem:** A thin, upright structure that provides support for the leaves and seed spikes.
3. **Roots:** Responsible for anchoring the plant in the soil, but they do not have notable medicinal or commercial value.
4. **Flowers:** Small, white blossoms that grow in spike-like formations at the top of the stems.

### 5.3. *Therapeutic indication*

Psyllium is a herbal medicine widely utilized for treating various conditions, including constipation, diarrhea, inflammatory bowel disease (IBD), ulcerative, Bowel disease, colon malignancy, blood sugar imbalance hypercholesterolemia, gastroesophageal reflux disease (GERD), and hypertension. It also exhibit Oxidative stress reduction and inflammation. modulation. Beyond its medicinal applications, psyllium Serves as stabilizer in the ice cream industry and in calico printing and dyeing processes.<sup>9</sup>

### 5.4. *Weight loss*

Weight gain often occurs due to poor or weak digestion, leading to the buildup of excess fat or toxins in the body. Isabgol can aid in weight reduction thanks to its Pichhila (smooth) and Mutral (diuretic) properties. It supports the smooth movement of waste through the intestines, facilitating easy stool passage, and promotes increased urine production, helping to eliminate excess fat from the body.<sup>20</sup> The soluble fiber in Isabgol can create a sense of fullness after meals, reducing hunger between meals and minimizing the risk of overeating. While psyllium supplementation has shown no significant relationship with weight control it may assist in appetite control by delaying stomach emptying and reducing

overall appetite. This decreased appetite and reduced calorie intake can contribute to weight management.<sup>44,45</sup>

## 6. **Constipation**

Medicinal plants are commonly favored for treating gastrointestinal disorders, such as constipation. Isabgol is considered a first-line treatment for Bowel irregularity caused by its multiple active constituents, which enhance its effectiveness while minimizing side effects, making it safe for prolonged use.<sup>25</sup> Psyllium husk is particularly renowned for its efficacy in managing chronic constipation, largely attributed to its high fiber content.<sup>4</sup> Extensive research has highlighted psyllium's widespread use as a natural laxative. In a study involving 50 patients and 70 research articles on chronic constipation, consuming 10–30 grams of psyllium seeds daily provided bowel relief in 80% of participants, though only 15% of patients with slow bowel transit responded effectively to psyllium.<sup>20</sup> The seeds and Psyllium husk are frequently utilized as fiber supplements for constipation treatment. Regular consumption of 10–30 grams of ground psyllium seeds daily has proven effective in relieving constipation.<sup>26</sup>

## 7. **Marketed Preparation: Naturolox-A.**

### 7.1. *Diarrhea*

Diarrhea is a major cause of mortality in developing regions. Isabgol is effective in managing loose motions, especially when taken with curd, due to its absorbent properties.<sup>23</sup> It helps absorb excess water from the digestive tract, making the stool bulkier and preventing loose stools. The looseness of stools in diarrhea is determined by the ratio of fecal water to the holding capacity of insoluble solids.<sup>4</sup> Psyllium increases the frequency of normal stools and reduces the frequency of liquid stools.<sup>24</sup> A combination of psyllium and calcium offers an affordable and effective alternative to traditional treatments for chronic diarrhea. Isabgol helps control diarrhea by absorbing water from the digestive system and adding bulk to the stool, thanks to its Guru (heavy) property. Tip: For diarrhea, take Isabgol with curd.<sup>22</sup>

### 7.2. *Ulcerative colitis*

[Crohn's disease]: Dietary fiber plays a significant role To maintain clinical remission in ulcerative colitis by preventing the development of colonic inflammation.<sup>6</sup> This beneficial effect is linked to the increased production of short-chain fatty acids (SCFAs). Crohn's disease primarily affects the ileum (the last portion In the proximal intestine) and the colon.<sup>44</sup> Although limited studies have investigated psyllium's ability to sustain Management of ulcerative colitis, dietary fiber plays a role in shown to support remission by enhancing the luminal production of SCFAs. Additionally,

fiber supplementation has been observed to prove colonic health in HLA-B27-associated conditions.<sup>28</sup>

### 7.3. Diabetes mellitus

Psyllium has a positive Effect on human well-being and is recognized as a medicinally valuable natural polysaccharide with glucose-reducing properties. Diabetes mellitus is a condition characterized by insufficient insulin production or reduced insulin effectiveness, leading to elevated blood glucose levels.<sup>29</sup> A study conducted with 34 men suffering from Insulin resistance and high cholesterol investigated the effects of psyllium husk.<sup>80</sup> Participants an inactive control, subjects were administered either or 8. Twice-daily administration of 5.1 grams of psyllium over 8 weeks. The results showed an 8.9% Improvement in lipid profile, including a reduction in total cholesterol and a 1.0% decrease in LDL cholesterol. Additionally, the postprandial rise in Glucose levels decreased substantially.<sup>1</sup> Isabgol proves favorable for glucose regulation by reducing the sharp Postprandial glucose spike Furthermore, Isabgol enhances the absorption and glucose-lowering effect of other antidiabetic medications, such as metformin.<sup>14</sup>

1. **Slows Glucose Absorption:** Forms a *viscous gel* in the digestive tract, delaying carbohydrate digestion and glucose absorption. Helps *prevent post-meal blood sugar spikes (postprandial hyperglycemia)*. Lowers the *glycemic index (GI)* of carbohy rate-rich foods, ensuring a gradual release of glucose into the bloodstream.
2. **Improves Insulin Sensitivity:** Reduces the *demand for insulin* by slowing glucose release, preventing excessive insulin secretion. Enhances *cellular response to insulin*, aiding individuals with insulin resistance (common in type 2 diabetes). Over time, may contribute to *better long-term blood sugar regulation*.
3. **Lowers Fasting Blood Glucose & HbA1c Levels:** Regular psyllium intake helps reduce *fasting blood sugar* and *HbA1c* (a marker for long-term glucose control). Supports steady blood sugar levels, reducing fluctuations that contribute to *diabetes complications*.

### 7.4. Hypertension

Soluble fiber, such as psyllium, is an essential component of a healthy diet and plays a protective role in normalizing blood pressure. Observational studies indicate that increasing

dietary fiber intake by 7–15 grams per day above typical levels is significantly linked to reduced blood pressure and decreased chance of hypertension compared to the low-fiber diets commonly found in Western populations. Consumption of soluble fiber has been shown to reduce both systolic blood pressure (SBP) and diastolic blood pressure (DBP) in various populations, with psyllium fiber being particularly effective in lowering overall SBP.<sup>6</sup>

## 8. Irritable Bowel Syndrome

Psyllium is effective in managing irritable bowel syndrome (IBS) due to its high fiber content. The fiber in psyllium acts as a bulking agent, making it an essential component in both primary and secondary care for IBS.<sup>36</sup> It contains dissolvable fiber & non-dissolvable fiber. Soluble fiber has been shown to significantly improve symptoms, while insoluble fiber may, in some cases, exacerbate clinical outcomes.<sup>44</sup> For individuals suffering from IB Dcessive psyllium consumption can worsen symptoms. Epidemiological studies indicate that psyllium supplementation helps reduce C-reactive protein (CRP) levels in individuals with irritable bowel syndrome.<sup>30</sup>

### 8.1. Hemorrhoids

Given its known benefits for both constipation and diarrhea, it's not surprising that psyllium is also effective for managing hemorrhoids. Hemorrhoids occur when the veins within the anal tissues or rectum become dilated, often due to untreated constipation, though they can also be linked to chronic diarrhea.<sup>10</sup> In studies, the psyllium group showed significant improvement, with a notable reduction in bleeding and symptoms. Adequate fiber supplementation, when When used in conjunction with the TONE method, can arrest the advancement of hemorrhoids and bleeding potentially preventing the need for Surgical intervention for severe hemorrhoid cases Isabgol should be administered with sufficient water or another fluid. It is not recommended for individuals who have difficulty Ingestion or throat issues. For Chronic or relapsing hemorrhoids hemorrhoidectomy remains the most potent and successful comprehensive treatment.<sup>6</sup>

### 8.2. Antioxidant activity

Psyllium is rich in polyphenols, flavonoids, and tannins, which may contribute to its antioxidant and anti-ulcer properties. Known for its phenolic compounds with antioxidant activity.<sup>7</sup> Studies have shown that psyllium enhance antioxidant enzyme levels, such as superoxide dismutase, catalase, and glutathione peroxidase, while reducing lipid peroxidation in stomach tissues during pre-treatment with Plantago ovate.<sup>54</sup> These compounds are vital for neutralizing free radicals, quenching singlet and triplet oxygen, and breaking down peroxides. Psyllium helps prevent gastrointestinal lesions As a result of its high fiber content solubility and viscosity, which reduces ethanol

absorption and promotes the antioxidant effects of its active compounds.<sup>55</sup>

### 8.3. Colorectal cancer

Psyllium helps in the prevention of colorectal cancer, which was responsible for the loss of 55,000 lives in the United States in 1995. Isabgol is famous for its anticarcinogenic properties, particularly in the treatment of breast and colon cancers.<sup>10</sup> It works by reducing the exposure of the intestinal wall to harmful compounds found in stool and by increasing stool bulk, which in turn shortens transit time.<sup>52</sup> It is considered that fiber may mitigate cancer risk by reducing transit time, which lowers bile metabolism by gut microflora, dilutes bile acids through stool bulking, alters microbial bile acid metabolism into short-chain fatty acids, or directly binds to bile acids, preventing their metabolism. Psyllium fiber has demonstrated anti-carcinogenic effects in rats.<sup>49</sup>

## 9. Anti-inflammatory Activity

Isabgol contains a variety Rich in phytochemicals including polysaccharides, lipids, caffeic acid derivatives, flavonoids, iridoids, glycosides, and terpenoids. Alkaloids and certain organic acids have also been identified in the plant. Studies have demonstrated that its high fiber content contributes to its strong anti-inflammatory effects. Dietary fiber supplementation helps alleviate colon inflammation, primarily through the increased production of short-chain fatty acids. A high-fiber diet can potentially reduce inflammation by altering the pH and permeability of the gut. Isabgol's anti-inflammatory properties also help reduce inflammation in haemorrhoids.<sup>73</sup> Upon topical application with aloe vera gel, Isabgol helps to control acne and pimples. Psyllium husk can be mixed with warm milk or water and taken before bedtime for maximum effectiveness.<sup>59</sup>

### 9.1. Hyperlipidemia

Psyllium has both cholesterol-lowering and wound-healing properties. Hyperlipidemia, also known as hypercholesterolemia and hyperlipoproteinemia, is a condition characterized by elevated lipid levels in the blood, which is a critical determinant of ischemic heart disease.<sup>10</sup> Evidence suggests that Psyllium reduce levels of total cholesterol (TC; 19.7%), low-density lipoprotein cholesterol (LDL-C; 23.7%), triglycerides (TG; 27.2%), and the ratio of LDL-C to high-density lipoprotein cholesterol (HDL-C; 24.1%). Psyllium husk is an effective and well-tolerated dietary option for treating mild to moderate hyperlipidemia, particularly in individuals suffering from non-insulin-dependent diabetes mellitus (NIDDM).<sup>19</sup> (20). Thus, psyllium plays a significant role in lowering LDL cholesterol levels. Treatment with 5.1 grams of psyllium twice daily has been shown to produce notable declines in serum concentrations of total and LDL cholesterol levels in people with primary high cholesterol.<sup>63</sup>

## 10. Conclusion

Isabgol (*Plantago ovata*) has proven to be a medicinal plant with significant pharmacological properties, offering numerous health advantages. Its bioactive compounds, including polysaccharides, flavonoids, phenolic acids, and other secondary metabolites, are central to its therapeutic effects. As a soluble fiber, psyllium is effective in treating gastrointestinal issues such as gastrointestinal disorders while also potentially lowering the risk of colorectal cancer and aiding in the management of metabolic Medical conditions such as diabetes and hyperlipidaemia. Additionally, Isabgol's antioxidant, anti-inflammatory, and anticarcinogenic qualities provide protection against various health conditions, including heart disease and chronic inflammation. Its benefits extend to wound healing, cholesterol reduction and glucose control, showcasing its versatility in therapeutic use. Despite this, it is necessary to be cautious of possible side effects, particularly in individuals with inflammatory bowel disease or other specific conditions. In conclusion, Isabgol presents considerable potential as a holistic treatment offering. A meaningful enrichment to both conventional and alternative medicine, though further research is needed to fully explore its therapeutic applications and unlock its full benefits.

## 11. Source of Funding

None.

## 12. Conflict of Interest

None.

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