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THE EFFECT OF PSYLLIUM HUSK ON GUT MICROBIOTA AND GASTROINTESTINE: EVALUATIONS BASED ON RECENT CLINICAL TRIALS

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ABSTRACT

This study evaluated the role of psyllium husk, a fermented dietary fiber derived from Plantago ovata on gut microbiota and gastrointestinal health. Psyllium weights as a prebiotic increasing the in business of helpful microorganisms such as Bifidobacterium and Lactobacillus which result to better bowel breaking function, improved gut health and fitness, help remedy for constipation and irritable bowel syndrome (IBS). Psyllium supplementation increases defecation frequency and stool consistency in clinical trials while increasing short-chain fatty acids (SCFAs), and enhancing gut health. Psyllium may also benefit digestion, but it is the only fiber shown to help with cholesterol and blood sugar control, and part of a healthy diet for managing weight and metabolism. These results indicate the importance of psyllium in the maintenance of gastrointestinal health and attenuation of metabolic disorder risk, which should additional research extending over long periods and spanning broad populations.

KEYWORDS: Psyllium husk, gut microbiota, gastrointestinal health, prebiotic, dietary fiber.

INTRODUCTION

Psyllium Husk from the Plantago ovata plant seeds that grew to become a kind belonging with herbs and plants group known as Plantaginaceae. In India, the plant is commonly known as Isabgol and has been cultivated since ancient times along with its neighbouring countries Pakistan and Iran. Husk or seed coat; A thin, white coloured paper surrounding the seeds. so many medicinal properties are found in this layer and thus also used as a major health supplement.[1][2] Psyllium husk (PH) is a dietary fibre with the highest contents of arabinoxylans, which are composed of arabinose and xylose units in its structure. The percentage proximate composition of the psyllium seed flour is in overall protein (13.33%); fat (0.38 %), ash (5.00%) with total carbohydrates (-77.88 (%total). It also has (22/71(%fibre).[3] Psyllium husk serves as a sustainable alternative for enhancing wheat bread quality by improving texture, increasing specific volume and porosity, and significantly reducing acrylamide levels, thus contributing to safer and more acceptable bread products.[4] The human gut microbiome contains up to 1000 distinct bacterial species and has a coding capacity of approximately five million genes, with functions that play key roles in the host physiology and survival: it is often defined as "our forgotten organ".[5][6][7] Constituting 10 times more cells than human ones and bearing over a hundredfold the number of genes expressible in our body, these microorganisms have just started to unveil their role not only on metabolism but also nutrition, physiology as well as immune function.[6] Dysbiosis in the gut microbiota is associated with a range of gastrointestinal diseases (e.g., inflammatory bowel disease [IBD], irritable bowel syndrome [IBS]) and systemic disorders including obesity, type 2 diabetes, atopy.[8] The gut microbiota is seeded at birth and over time by the mode of delivery, diet exposure to pathogens or antibiotics environment change.[8] The steady-state (i.e., homeostasis) faecal microbiome in healthy adults is resistant to dietary changes, exercise regimens and other factors that significantly affect the gut ecosystem of individuals who are frail or have metabolic syndrome.[5][9] The gut microbiome is predominantly composed of two phyla, Bacteroidetes and Firmicutes across most individuals (which may vary between humans.[9] Rapid advances in next-generation sequencing technology have enabled us to gain a greater insight into the gut microbiome and its implications on health and disease. These technologies have facilitated high-resolution assessments of microbial communities and suggest a promising future for new microbiome-based diagnostic, prognostic or therapeutic approaches.[5] In addition to diet-related gut-microbiota and probiotics, many other aspects of the host's lifestyle such as physical activity have been proposed to beneficially modulate it which may contribute to improving metabolic health status reducing risks for chronic diseases.[8][10]

MATERIALS AND METHODS

This review provides insights into the role of psyllium husk on gut health including the functional properties, microbiota modulation and possible therapeutic effects. Relevant studies published between 2000 and 2024 were retrieved from databases including PubMed and Scopus using keywords such as psyllium husk, Plantago ovata and gut microbiota. For inclusion, research had to focus on the role of psyllium in health and food systems. Clinical, review and experimental studies were collected as a part of some data to promote this Article focus on its ingredients, prebiotic property and health benefits. The results highlight the ability of psyllium to increase dietary fibre intake, modulate gut microbiota and improve gastrointestinal and general health effects.

Mechanism of Action

Role of Psyllium husk

Prebiotics (psyllium husk) are defined as selectively fermented ingredients that result in specific changes in the composition and/or activity of gastrointestinal microbiota thus conferring benefit(s) upon host health. The leading postulation for this is by Glenn Gibson and Marcel Roberfroid in 1995[11], which has adapted over time. These definitions adhere quite closely with that developed by ISAPP (International Scientific Association for Probiotics and Prebiotics) which says: prebiotic is a nondigestible food ingredient that beneficially affects the host by selectively stimulating growth/activity of one or more bacteria in the colon, thus improving host health.[11] [12] Prebiotics interact with such properties by influencing microbiota in the gut, namely that it increases beneficial microorganism counts like Bifidobacterium and Lactobacillus spp., correlating to anti-inflammatory bowel diseases, easing digestion-related symptoms -constipation- and reducing the occurrence of infections as well prevention against traveller's diarrhoea. These metabolites include SCFAs (acetate, propionate and butyrate), which are the fermentation products of prebiotics by intestinal microbes, thus it maintain luminal pH that inhibits growing pathogens as well as influence in colonic motility and stimulates apoptosis of cancer cells. It has then been hypothesised to decrease cancer of the colon. In addition to modifying the immune system, prebiotics can strengthen the gut barrier, enhance mineral bioavailability and may have positive effects on insulin resistance and brain function, illustrating a direct impact of these compounds in health not limited for their effect upon intestinal physiology.[12] Dietary fiber is one of the most important factors affecting gut microbiota composition and function, consequently, gut health. Dietary fibers, such as non-starch polysaccharides, resistant starch, and resistant oligosaccharides are fermented by the gut microbiota, resulting in short-chain fatty acids (SCFAs) including acetate, propionate, and butyrate. These SCFAs are critically involved in host metabolism regulation, immune function, and gut barrier integrity. Diverse microbiota induced by high-fiber diets can also provide an advantage to some beneficial bacteria such as Bifidobacterium and Lactobacillus that can produce short-chain fatty acids (SCFA) through fermentation, thus supporting gut health.[13] [14]

Dosage range of psyllium husk

For Constipated patients' dosage was higher, with subjects taking 21 grams of psyllium per day in a study.[15] 3.0 to 20.4 grams per day given for hypercholesterolemia 5.1 grams of psyllium husk twice daily for 26 weeks, resulting in significant reductions in serum total and LDL-cholesterol concentrations.[16]

Impact of Psyllium Husk on Gut Microbiota and Gastrointestinal Health.

Study ID	Authors	Year	Population	Sample Size	Intervention	Control Group	Duration	Reference
Study 1	Hu et al.	2023	CKD-induced rats (5/6 nephrectomy model)	n = 10 per group (4 groups total)	Low-dose PSH (250 mg/kg/day) and high-dose PSH (500 mg/kg/day)	Sham-operated group and untreated CKD rats	30 days	[15]
Study 2	Keller et al.	2024	Healthy adult cats	n = 9	6% psyllium in diet	6% cellulose in diet	10 days	[17]
Study 3	Jalanka et al.	2019	Healthy adults and adults with chronic constipation	n = 24 (8 healthy, 16 constipated)	21 g/day psyllium	Placebo (maltodextrin)	7 days	[25]
Study 4	Yang et al.	2021	Chronically constipated women of reproductive age	n = 48	5g psyllium per day	No psyllium (usual care)	8 weeks	[26]

This table summarizes the basic details of each study, covering aspects such as the study authors, year of publication, population type, and sample size. The studies include diverse populations, like CKD-induced rats, healthy adult cats, and constipated women, allowing for a broad understanding of psyllium husk's (PSH) effects across species and health conditions. The intervention describes the dosage or concentration of PSH administered, with comparisons to control groups such as sham-operated rats, usual diet in cats, and placebo in humans. Each study's duration is also specified, ranging from 7 days to 8 weeks.[15][17][25][26]

RESULTS

Gut Microbiota Composition and Diversity

Measure	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Effect Size / CI	Reference
Shannon Index (Rats)	Increased in Psyllium L group compared to 5/6Nx model	Lower in 5/6Nx vs. Sham	p < .05	Not reported	[15]
Shannon Index (Constipated Women)	Higher post-psyllium	Lower at baseline	p < .05	Not reported	[26]
Chao Index (Rats)	Higher in Psyllium L group	Lower in 5/6Nx model	p < .05	-	[15]
Chao Index (Constipated Women)	Higher post-psyllium	Lower at baseline	p < .05	-	[26]
Simpson Index (Rats)	Lower in Psyllium L group	Higher in 5/6Nx	p < .05	-	[15]
Lachnospira (Constipated Women)	Increased with psyllium	Lower at baseline	p < .05	-	[26]
Faecalibacterium (Constipated Women)	Increased with psyllium	Baseline values	p < .01	-	[26]
Veillonella (Healthy and Constipated Adults)	Increased in constipated with psyllium	No change in placebo	p < .05	-	[25]

The table below provides an opportunity to consider the ways in which PSH may affect gut microbiota diversity specific populations. The Shannon, Chao and Simpson indices are examples of metrics that correspond to richness and evenness of species, important markers for a balanced gut microbiome functionality. Our results suggest that PSH expands diversity from baseline in intervention groups, particularly in constipated females and CKD animals. Increases in Lachnospira and Faecalibacterium were some of the other strains seen after PSH supplementation and these effects seemed to represent improvements in microbial composition. Statistical significance is denoted by p-values; factors of specific statistic are referenced in (L.) You can read more about it from here. Table demonstrating possible ways in which PSH benefits may promote gut microbial health.[15][25][26]

Short-Chain Fatty Acids (SCFAs) and Metabolites

Measure	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Effect Size / CI	Reference
Acetate (µM/g) (Humans, constipated)	21.65 ± 3.64 (with psyllium)	6.90 ± 3.72 (healthy baseline)	p < .01	-	[25]
Acetate (Constipated Women)	Significant increase with psyllium	Baseline values	p < .01	-	[26]
Propionate (µM/g) (Humans, constipated)	No significant change	Baseline values	p = .58	-	[25]
Butyrate (µM/g) (Rats)	Higher with psyllium	Lower in 5/6Nx model	p < .05	-	[15]

This table provides an overview of the implications of PSH on production of SCFAs that are important for gut and metabolic health. Acetate, propionate, butyrate levels — the main SCFAs associated with decreased inflammation and better gut health. Results: We observed increased levels of acetate and butyrate in some groups, particularly higher in constipated humans, and CKD rats that received PSH treatment compared to control rats with high clusters of microbial fermentative activity. In another study, propionate levels were unchanged. P-values are provided to validate the observations made in this study (see references for additional detail). The above table highlights the function of PSH as a SCFA promoter positive for gut homeostasis and metabolic-related activities.[15][25][26]

Fecal and Gastrointestinal Parameters,

Measure	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Effect Size / CI	Reference
Bowel Movement Frequency (Cats)	1.6/day (psyllium diet)	1.1/day (control)	p = .0052	Not reported	[17]
Bowel Movement Frequency (Constipated Women)	1.5/day (psyllium)	1.0/day (baseline)	p < .01	-	[26]
Stool Consistency Score (Cats)	3.2 (psyllium diet)	2.6 (cellulose)	p < .0001	-	[17]
Stool Consistency (Constipated Women)	Softer with psyllium	Firmer at baseline	p < .05	-	[26]
Fecal Moisture (%) (Cats)	72.9% (psyllium)	66.5% (cellulose)	p = .0426	-	[17]

This table reviews the influence of PSH on fecal and GI properties determined by measuring bowel movement frequency, stool consistency and fecal water content. These studies demonstrated that PSH supplementation not only improved digestive regularity in constipated women and healthy cats, but also significantly increased bowel movement frequency (Doherty et al. There were also significant reductions in stool consistency scores (i.e., hydrated, softer stools; indicating improved passage and quality), where stool consistency was objectively visualized as softer and better hydrated stools in the PSH groups relative to controls. In addition, the PSH group showed higher fecal moisture percentages, which further indicates an increase in stool hydration by PSH. Here again p-value confirms statistical significance and reliability of these findings with study references. This table highlights the beneficial effects of PSH in alleviating constipation as well as improving general gut health.[17][26]

Inflammatory and Renal Markers (Rats, CKD Model)

Measure	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Effect Size / CI	Reference
Serum Creatinine (SCr) (mg/dL)	Lower in PSH groups	Higher in 5/6Nx	p < .01	-	[15]
Blood Urea Nitrogen (BUN) (mg/dL)	Lower in PSH groups	Higher in 5/6Nx	p < .01	-	[15]
IL-1 (pg/mL)	Reduced in PSH groups	Higher in 5/6Nx	p < .05	-	[15]
IL-6 (pg/mL)	Reduced in PSH groups	Higher in 5/6Nx	p < .05	-	[15]

This table describes the impact of PSH on inflammatory and renal health markers in rats with CKD. Laboratory tests Serum creatinine, blood urea nitrogen (BUN), and cytokines (IL-1, IL-6) assess kidney function and level of inflammation. Compared to untreated control rats, PSH-treated animals demonstrate marked reductions in these markers indicating that PSH may reduce kidney stress and inflammation. Improved renal op Function as evidenced by low serum creatinine and BUN levels while reduced systemic inflammation as evidenced by decreased cytokine levels P-values provide statistical evidence; references are given for further details. The table below indicates that PSH seems to provide renoprotective benefits and helps reduce CKD-associated systemic inflammation.[15]

Psyllium husk impact on bowel movements

So, psyllium husk works to stop constipation and bowel problems (including IBS),[19][15][20][21] [22] Indeed, in the case of psyllium it has been demonstrated that contributes to an augmentation of BMF by facilitating easier stool evacuation with a more formed consistency through another mechanism (likely water trapping in the gut) and hence greater fluid accumulation into feces leading eventually to facilitated defecation,[19][15][21] Furthermore, psyllium changes the gut microbiome, increasing the population of some beneficial bacteria like Faecalibacterium and Lachnospira, associated with improved bowel function.[15][21] In relieving symptoms, psyllium demonstrates an increased likelihood of adequate symptom relief attributable to the relief of constipation compared with placebo. This is especially true in individuals meeting the Rome III criteria for constipation-predominant irritable bowel syndrome. Comparative studies have also demonstrated that psyllium is more effective than another fibre, bran, in reducing the severity of IBS symptoms and includes a greater percentage of patients who report adequate symptom relief when compared with its placebo or bran.[20][22] In general, psyllium is well tolerated; mild side effects like bloating and gas have been described, but the incidence of adverse events was very small and did not differ significantly from placebo.[19][15][21] On the whole, the evidence favours psyllium as an effective method for treatment of improved bowel function and to treat the symptoms of constipation, as well as IBS.[19][15][20][21][22]

Psyllium husk is a natural herbal laxative It Is the best for constipation. It does this by wetting stool, which helps to move it through the gut and encourages bowel hygiene (peristalsis). Several studies have shown that psyllium supplementation increases stool frequency and consistency in patients with chronic constipation. Psyllium now adds bulk to the stool that makes it softer and smoother, as well making defecation less painful. It has been shown to be more efficacious than one of the typical laxative uses: docusate sodium in long-time period management for constipation.[23]

Other Uses

It aids in weight loss by reducing body weight, BMI, and waist circumference in overweight individuals.[24] Psyllium also promotes cardiometabolic health by appetite control, lowering cholesterol levels, regulating blood sugar, and reducing blood pressure.[24] Additionally, it is used in food products to enhance texture and shelf life, while providing functional benefits such as cholesterol and glycemic control.[24]

DISCUSSION

Psyllium husk has not only been shown the significant prebiotic activity, promoting the growth of key beneficial gut bacteria like Bifidobacterium and Lactobacillus, it also promotes a good bowel routine. These changes result in better bowel movement, constipation relief, and reduced IBS symptoms. Psyllium also drives the production of short-chain fatty acids (SCFAs) in the colon, mainly acetate and butyrate, that help keep the pH stable and limit pathogen proliferation, aiding colonic health. This property promotes hydration and consistency of stool, thus making it an effective depressed GI health intervention with fewer side effects than other dietary fibers in the diet of chickens.[15][26]

In addition to its gut health benefits, psyllium husk also has more general metabolic-related benefits by lowering cholesterol, improving glycaemia and appetite all of which result in an improvement of cardiometabolic health. Unlike other fibers, it has unique gel-forming properties that promote better results in gastrointestinal and metabolic disorders. Yet, differences in study designs and populations indicate that bigger, more diverse, longer studies are needed to establish the breadth of its effectiveness. Research looking into its therapeutic potential effect when used in Combination with other dietary approaches could be second to none.[17][25]

CONCLUSION

Psyllium husk is a naturally occurring and beneficial soluble dietary fiber with many health benefits, especially for gut as well as metabolic health. These underscore the potential of psyllium husk as a natural agent exerting therapeutic roles through modulation on gut microbiota, global promotion of gastrointestinal function and improvement to cardio metabolic parameters. Psyllium has beneficial properties which contribute to constipation relief and other irritable bowel syndrome symptoms due its action different from other fibers, among reducing the development of cardiovascular diseases and metabolic disease.

Psyllium Husk can be recommended as an important part of a balanced diet, especially for those who want to support good digestive health and/or metabolic conditions, given its wide spectrum of desired effects by the low incidence of side effects. However, additional studies are required to establish the long-term efficacy and effectiveness of this approach in other populations. This may facilitate its more extensive adoption in medical and nutritional environments, thereby improving population health.

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