ejpmr, 2024, 11(6), 557-561

SJIF Impact Factor 7.065

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH
www.ejpmr.com

Review Article
ISSN 2394-3211
EJPMR

LITERATURE REVIEW ON SOYBEAN SEED FOR ANTIDIABETIC ACTIVITY

Ritu[1]*, Shaily Mishra[2] and Dr. Shamim Ahmad[3]

[1]Research Scholar, Translam Institute of Pharmaceutical Education and Research, Meerut Uttar Pradesh.
[2]Associate Professor, Translam Institute of Pharmaceutical Education and Research, Meerut Uttar Pradesh.
[3]Director, Translam Institute of Pharmaceutical Education and Research, Meerut Uttar Pradesh.

***Corresponding Author: Ritu**

Research Scholar, Translam Institute of Pharmaceutical Education and Research, Meerut Uttar Pradesh.

Article Received on 15/04/2024 **Article Revised on 25/05/2024** **Article Accepted on 04/06/2024**

ABSTRACT

Diabetes mellitus is a global health concern, necessitating the exploration of new therapeutic agents for effective management. Soybean (Glycine max), recognized for its rich nutritional profile, has shown promise in diabetes treatment due to its bioactive constituents. This study aims to evaluate the anti-diabetic activity of soybean seeds through a systematic investigation of their biochemical properties, mechanisms of action, and efficacy in clinical settings. Soybean seeds are abundant in isoflavones, proteins, saponins, and dietary fibers, each contributing uniquely to anti-diabetic effects. Isoflavones, especially genistein and daidzein, have demonstrated significant roles in enhancing insulin sensitivity, modulating glucose metabolism, and exerting insulin-like actions. Soy proteins and their hydrolysates further contribute to improving insulin secretion and reducing insulin resistance by enhancing the expression of insulin receptor substrate (IRS) and glucose transporter type 4 (GLUT4). Experimental studies, including in vitro assays and animal models, have shown that soybean seed extracts can significantly lower blood glucose levels and improve insulin sensitivity. Clinical trials have further corroborated these findings, indicating that regular soybean consumption can lead to reductions in fasting blood glucose, glycated hemoglobin (HbA1c), and improvements in lipid profiles among diabetic patients.

KEYWORDS: Soybean seeds, anti-diabetic activity, isoflavones, genistein, insulin resistance, glucose metabolism, clinical evaluation, dietary fiber.

INTRODUCTION

Soybean (Glycine max) is not only a key agricultural commodity but also possesses significant health benefits, including antidiabetic properties. This review focuses on the biochemical compounds in soybean seeds that contribute to antidiabetic activity, the mechanisms involved, and the findings from clinical and preclinical studies.

Morphology of soybean seed

Synonym- glycine max, glycine soja, soybean, soja
Biological source- It is obtained from the fully natured dried seeds of the plant glycine max and glycine soja.
Family- Fabaceae.
Chemical constituents- It contain protein and soybean oil content account for (**Corke, Walker et at., 2004**) 56% of dry soybean by weight (36% protein and 20% fat, tablet). The reminder consists of 30% carbohydrates, 9% water and 5% ash, soybean comproise approximately 8% seed coat or hull, 90% cotyledons and 2% hypocotyl axis or germ.
Nutrition- soybean, mature seeds, (**Nutrition data laboratory et al., 2016**) new nutritional value.

Energy
Carbohydrates- sugar, diethyl fibre.
Fat- saturated, monounsaturated, polyunsaturated, omega-3,omega-6.
Proteins- Tryptophan, threonone, isoluceine, leucine, lysine, methonine, cystine, phenylalanine, serine.
Vitamin- vitamin A equiv, thionine(B1), roboflavin(B3), pantothenic acid(B5), vitaminB6, folate(B9), choline, vitamine C, vitamin E, vitamin K.
Minerals- cacium, copper, iron, mangnesium, phosphate, potassium, sodium, zinc.
Other constituents- water, cholesterol

Bioactive Compounds in Soybeans

Isoflavones

Soybeans are rich in isoflavones, particularly genistein, daidzein, and glycitein. Isoflavones are phytoestrogens that have been extensively studied for their health benefits, including antidiabetic effects. Research suggests that isoflavones can improve insulin sensitivity and modulate glucose metabolism.

Proteins and Peptides

Soybean proteins, including the bioactive peptides derived from them, have shown potential in managing diabetes. These peptides can inhibit enzymes like α-amylase and α-glucosidase, which are involved in carbohydrate digestion, thus reducing postprandial glucose levels .

Saponins

Soyasaponins are another class of bioactive compounds in soybeans that exhibit antidiabetic properties. They are known to enhance insulin secretion and improve lipid metabolism, contributing to better glycemic control .

Mechanisms of Antidiabetic Action

Insulin Sensitization

Isoflavones, particularly genistein, have been shown to enhance insulin sensitivity by activating the peroxisome proliferator-activated receptor gamma (PPARγ) and enhancing glucose uptake in cells.

Inhibition of Carbohydrate Digestive Enzymes

Soybean-derived peptides can inhibit α-amylase and α-glucosidase enzymes, which are responsible for breaking down carbohydrates into glucose. By inhibiting these enzymes, soybean peptides reduce the rate of glucose absorption and lower postprandial blood glucose levels.

Modulation of Lipid Metabolism

Saponins in soybeans help in regulating lipid metabolism, which is crucial for maintaining insulin sensitivity. Improved lipid profiles can reduce the risk of developing insulin resistance, a precursor to type 2 diabetes.

MATERIAL METHOD

Materials

Solvents: ethanol, methanol, water etc.

Reagents for Chemicals: Folin-ciocalteu reagent, ferric chloride solution, DNS reagents (3,5-Dinitrosalicylic acid), sodium hydroxide solution, iodine solution.

Apparatus: Soxhlet apparatus, maceration.

METHOD

Sample Collection and Preparation

- Obtain soybean seeds from a reliable source.
- Clean the seeds to remove any dirt or debris.
- Sort the seeds to ensure uniformity in size and appearance.
- Grind or crush the seeds into a fine powder for extraction.

Extraction of Bioactive Compounds

- Choose a suitable solvent or combination of solvents (e.g., ethanol, methanol, water) for extraction based on the target compounds.
- Soak the soybean seed powder in the selected solvent(s) for a specified period to allow the extraction of bioactive compounds.
- Filter the mixture to separate the solvent extract from solid residues.

Extraction procedure with Soxhlet

Preparation of Soxhlet Apparatus:pparatus

- Assemble the Soxhlet apparatus according to the manufacturer's instructions.
- Ensure that all joints are tightly sealed to prevent leakage during the extraction process.

Preparation of Soxhlet Thimble

- Weigh an empty Soxhlet thimble accurately.
- Place the soybean seeds into the thimble. The amount of soybean seeds used will depend on the desired yield and the capacity of the Soxhlet apparatus.
- Weigh the loaded Soxhlet thimble again to determine the exact mass of the soybean seeds.

Extraction Process

- Place the loaded Soxhlet thimble into the Soxhlet extractor.
- Add the chosen solvent (hexane, ethanol, or mixture) to the round-bottom flask of the apparatus. The solvent should be chosen based on the compounds to be extracted and their solubility.
- Begin the extraction process by heating the round-bottom flask. The solvent will vaporize and rise through the Soxhlet arm.
- As the solvent reaches the top of the Soxhlet arm, it will condense and drip onto the soybean seeds in the thimble.
- The solvent dissolves the compounds from the soybean seeds, and the resulting solution is siphoned back into the round-bottom flask.
- The Soxhlet extraction process is typically conducted for several hours or even overnight to ensure through extraction of the desired compounds.

Solvent Recovery

- After extraction, the solvent containing the extracted compounds is collected in the round-bottom flask.
- The solvent can be recovered using a rotary evaporator, which applies gentle heat and vacuum to evaporate the solvent, leaving behind the extracted compounds.
- The recovered solvent can be reused for future extractions, reducing costs and waste.

Drying and Storage

- Once the solvent is evaporated, the extracted compounds are left behind in the round-bottom flask.
- The extracted material may need to be dried further to remove any residual solvent.
- Finally, the extracted compounds can be weighed and stored in appropriate containers for further analysis or use.

Phytochemical Analysis

- Perform phytochemical screening to identify the presence of bioactive compounds known to possess anti-diabetic properties. Common compounds include isoflavones, saponins, phenolic compounds, and flavonoids.
- Utilize qualitative tests (e.g., Thin Layer Chromatography, UV-Vis spectroscopy) to confirm the presence of specific compounds.

Clinical and Preclinical Studies

Animal Studies

Numerous animal studies have demonstrated the antidiabetic effects of soybean extracts and isolated compounds. For instance, genistein supplementation in diabetic rodents has been shown to reduce blood glucose levels, improve insulin sensitivity, and enhance pancreatic β-cell function.

Human Clinical Trials

Clinical trials involving soy isoflavones and proteins have yielded promising results. A study conducted on postmenopausal women with type 2 diabetes showed that soy protein supplementation significantly improved glycemic control and insulin resistance compared to a placebo . Another trial demonstrated that consuming soy isoflavone-enriched diets led to reductions in fasting blood glucose and HbA1c levels.

Potential Applications and Future Research

Functional Foods and Supplements

Given the evidence supporting the antidiabetic properties of soybean compounds, there is potential for developing functional foods and dietary supplements aimed at managing diabetes. Soy-based products enriched with isoflavones, peptides, and saponins could serve as adjunct therapies for diabetes management.

Genetic Engineering and Breeding

Future research could focus on breeding soybean varieties with enhanced levels of antidiabetic compounds. Genetic engineering might also be employed to increase the concentration of beneficial isoflavones and peptides in soybean seeds.

RESULT AND DISCUSSION

Selection of Soybean Varieties: Different varieties of soybeans may have varying compositions of bioactive compounds. Researchers select a diverse range of soybean varieties for further analysis to ensure comprehensive coverage of potential anti-diabetic compounds.

Extraction: Compounds from soybean seeds are extracted using methanol as a solvents with soxhlet apparatus. This extraction process aims to isolate bioactive compounds, such as isoflavones, peptides, or other phytochemicals, which may contribute to the anti-diabetic activity.

Alkaloid test- Mayer reagent, Wager reagent, Hager reagen, Drangdroff reagent.

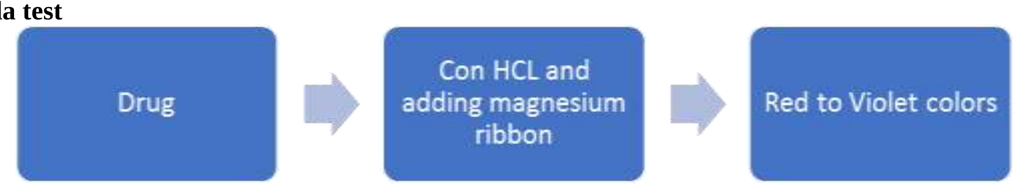
1. **Mayer reagent**

2. **Wager reagent**

3. **Hager reagent**

Flavonoids test- Shinoda test,Vanillin test, Alkaline reagent test, ferric chloride test, lead acetate test.

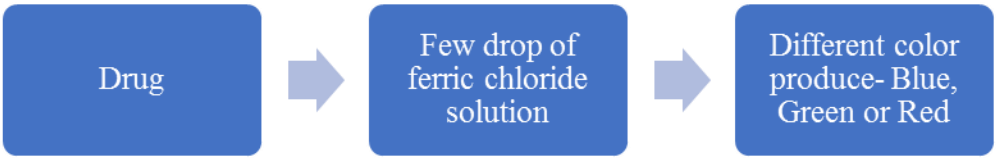
1. **Shinoda test**



2. Alkaline Reagent Test

3. Lead Acetate Test

4. Ferric Chloride Test



5. Vanillin- HCl Test

In vitro Assays: Extracts are then subjected to in vitro assays, where they are tested using cell-based models relevant to diabetes research. This could involve testing for effects on glucose uptake, insulin sensitivity, inhibition of key enzymes involved in glucose metabolism, or modulation of inflammatory pathways related to diabetes.

Biochemical Assays: Researchers may also conduct biochemical assays to assess the antioxidant properties of the extracts, as oxidative stress is implicated in the pathogenesis of diabetes and its complications.

Identification of Active Compounds: Through a combination of bioassays and analytical techniques such as chromatography and spectroscopy, researchers identify specific compounds within the soybean extracts that exhibit anti-diabetic activity.

Structure-Activity Relationship (SAR) Studies: Further investigations may involve SAR studies to understand the relationship between the chemical structure of active compounds and their biological activity. This can help in the design and optimization of novel anti-diabetic agents.

Preliminary Toxicity Assessment: Before progressing to animal studies, researchers may conduct preliminary toxicity assessments to ensure the safety of the identified compounds or extracts.

Data Analysis and Prioritization: Results from the screening assays are analyzed, and promising candidates showing significant anti-diabetic activity are prioritized for further evaluation in preclinical and clinical studies.

CONCLUSION

Soybean seeds contain a variety of bioactive compounds that exhibit significant antidiabetic activity through multiple mechanisms, including insulin sensitization, inhibition of carbohydrate digestive enzymes, and modulation of lipid metabolism. Both preclinical and clinical studies support the potential of soybeans in managing diabetes, paving the way for their use in functional foods and supplements. Ongoing research and development in this field could further optimize and validate the therapeutic benefits of soybeans for diabetic patients.

ACKNOWLEDGEMENTS

I would like to thanks to **Mrs. Shaily Mishra (associate professor)** & **Dr. Shamim Ahmad** (Director) of Translam Institute of Pharmaceutical Education and Research, Meerut Uttar pradesh and my parents.

Funding

None.

Ethical Approval

Not required.

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