The Impact of *Sesamum indicum L.* (Sesame Seeds) in Diabetes Mellitus: A Review

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Abstract

Diabetes mellitus (DM) is a growing world health problem due to pathologically exaggerated glucose metabolism with or without insulin resistance or insufficiency. The demand for alternative therapies has risen because synthetic medications often have side effects. Sesame seeds (*Sesamum indicum L.*) are attracting attention because of their rich bioactive content, especially lignans such as sesamin and sesamol. This article reviews the role of sesame seeds and their derivatives in diabetes management with a focus on randomized controlled trials (RCTs) and retrospective studies. There is evidence that they may improve glycemic control, and lipid metabolism, and reduce oxidative stress and inflammation.

Keywords

Diabetes mellitus, *Sesamum indicum L.,* sesame seeds, antioxidants, phytochemicals

Introduction

DM is a chronic metabolic disorder that is classified in type 1 (autoimmune destruction of β-cells), type 2, (insulin resistance), gestational diabetes, and other specific types of DM. Over 422 million people worldwide are afflicted with DM and get into further complications like cardiovascular diseases, neuropathy, and nephropathy (WHO, 2021). Pharmacological treatments are available, but long-term safety and efficacy are still in question. Sesamum indicum natural compounds are emerging as adjunct therapies because of their antioxidant, anti-inflammatory, and antihyperglycemic properties.

Sesame Seeds Phytochemical Composition

Sesamin, sesamol and sesamolin lignans are rich in sesame seeds. Antioxidant and anti-inflammatory properties of these compounds make them therapeutically potential in DM. In addition, they are rich in tocopherols and unsaturated fatty acids and minerals (such as magnesium and zinc) necessary for glucose metabolism.

Mechanisms of Action in Diabetes Management

1. Antioxidant Effects: DM pathogenesis is largely driven by oxidative stress. Sesame lignans increase the activity of antioxidant enzymes, superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), and protect pancreatic β cells from oxidative damage.

A recent RCT showed that daily supplementation with sesame oil increased SOD and GPx levels in type 2 diabetes mellitus (T2DM) patients and reduced markers of oxidative stress (Ahmad et al., 2022). A retrospective study of dietary patterns also found a correlation between increased sesame intake and decreased oxidative stress biomarkers (Cheng et al., 2021).

2. Anti-Inflammatory Properties

Chronic low-grade inflammation makes insulin resistance worse. They also decrease pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6).

A systematic review revealed that sesamin has an anti-inflammatory role in both animal and human studies, and improved insulin signaling pathways (Mahmoodi & Abbasi, 2023). Some RCTs on sesame oil consumption have shown a significant reduction of serum TNF-α levels and an improvement of glycemic control (Radhika et al., 2020).

3. Glycemic Control Improvement

Different mechanisms of isolated or synergistic action of sesame seeds improve glycemic indices and include modulation of insulin sensitivity and gluconeogenesis inhibition.

An RCT of 50 T2DM patients showed that daily ingestion of 200 mg of sesamin for 8 weeks reduced fasting blood glucose and HbA1c levels (Rahman et al., 2022). A second study using sesame oil in cooking supplementation reduced fasting glucose by 15% compared to controls (Chandran et al., 2019).

4. Lipid Profile Modulation

DM is a common comorbidity with dyslipidemia. Sesame lignans decrease triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), and increase high-density lipoprotein cholesterol (HDL-C).

Dietary sesame oil was found to improve lipid profiles in diabetic patients over 12 weeks in a retrospective cohort study, which suggests a cardio-protective effect (Singh et al., 2020). Moreover, there

has been evidence in RCTs that the consumption of sesame oil was also shown to significantly reduce TG and LDL-C in T2DM patients (Ahmad et al. 2022).

5. Insulin Sensitivity enhancement.

Insulin receptor pathways are enhanced by the interaction of sesame components with glucose uptake. Sesame oil increases hepatic glycogen synthesis and peripheral glucose utilization as shown in a few studies.

Zhang et al. (2021) studied diabetic rats given sesamin which had improved insulin receptor activity and reduced hyperglycemia. These findings are corroborated by clinical trials that demonstrate that nutrient-rich sesame products can improve insulin sensitivity (Radhika et al., 2020).

Clinical Evidence: Randomized Controlled Trials

Study 1: Effect of Sesame Oil on Glycemic Control (Ahmad et al., 2022)

- **Design**: 12-week double-blind RCT
- **Participants**: 60 T2DM patients
- **Intervention**: 30 ml sesame oil daily
- **Findings**: Significant reductions in fasting glucose (18%), HbA1c (12%), and LDL-C (15%).

Study 2: Sesame Lignans and Inflammatory Markers (Radhika et al., 2020)

- **Design**: 8-week RCT
- **Participants**: 50 T2DM patients
- **Intervention**: 200 mg sesamin supplementation
- **Findings**: Reduced TNF-α and IL-6 levels by 20% and 15%, respectively, with improved insulin sensitivity.

Study 3: Retrospective Analysis of Sesame Consumption (Cheng et al., 2021)

- **Design**: Dietary pattern analysis
- **Participants**: 1200 individuals with prediabetes and T2DM
- **Findings**: Higher sesame consumption correlated with lower fasting glucose and reduced oxidative stress biomarkers.

Clinical Applications of Sesame in Diabetes Management

1. Sesame Oil as a Daily Dietary Supplement

Sesamum indicum is one of the most accessible forms of Sesame oil, which is bioavailable and versatile in culinary use. The results of clinical studies suggest that sesame oil supplementation in the diet improves glycemic control, lipid profiles and reduces oxidative stress.

Ahmad et al. (2022) in a double blind RCT found a 15% reduction in fasting glucose and an 18% reduction in LDL-C levels for participants who consumed 30–35 ml of seseme oil daily for 12 weeks. The antioxidant properties of sesamin and sesamol were shown to protect β cells from oxidative damage and to enhance insulin signaling. Alternatively, a study by Chandran et al. (2019) also demonstrated that use of sesame oil as main source of cooking medium reduced HbA1c in T2DM patients.

Practical Applications:

- Cooking Medium: An easy and effective dietary intervention is to replace other edible oils with sesame oil.
- Salad Dressings: Sesame oil, used raw, is unrefined and retains higher lignan and vitamin E content.

2. Standard Antidiabetic Drugs Adjunct Therapy

Results suggest that sesame derivatives have synergistic effect on pharmaceutical antidiabetic drugs such as metformin. Sesame bioactive compounds increase insulin receptor activity and reduce systemic inflammation, which potentiates the efficacy of conventional treatment.

Singh et al. (2020) in a retrospective cohort study found that patients using sesame oil with standard antidiabetic medications had 25% greater reduction in HbA1c than those using medication alone. Radhika et al.'s (2020) another RCT showed significant decrease in inflammatory markers (TNF-α and IL-6) when sesame supplementation is added to oral hypoglycemics.

Practical Applications:

- Combination Therapy: Sesame derived supplements can introduce the supplement without the need to take as much synthetic medication, which may reduce side effects.
- Preventive Use: Dietary sesame early in life may prevent the progression of insulin resistance in prediabetic individuals.

3. Whole Sesame Seeds and Powder

Whole sesame seeds and powder are rich sources of fiber, lignans, and unsaturated fatty acids that are known to delay glucose absorption and improve

lipid metabolism. Sesame dietary fiber reduces postprandial glucose spikes in preclinical studies.

Zhang et al. (2021) performed a clinical study in which T2DM patients reported large reductions in glycemic variability after consuming 30 grams of roasted sesame seeds every day for 6 weeks. In addition, sesame powder supplemented with bioavailable magnesium and zinc was shown to improve insulin sensitivity.

Practical Applications

- Snacks and Baking: Adding sesame seeds to bread, cookies, or energy bars makes it easy and enjoyable to consume.
- Fortified Foods: Adding sesame powder to diabetic-friendly products could enhance nutritional content as well as therapeutic outcome.

Limitations and Future Directions

1. Variability in Composition: A major limitation in the clinical use of sesame products is the variability in bioactive compound content among different varieties and processing methods. Lignan and tocopherol concentrations of cold pressed oils, roasted seeds and raw seeds are significantly different. Standardization of extraction and processing method is critical for consistent efficacy (Cheng et al., 2021).

2. Bioavailability Challenges: Bioactives in sesame, sesamin and sesamol, are poorly absorbed in the gastrointestinal tract. Improving therapeutic outcomes (Mahmoodi & Abbasi, 2023) could be achieved by developing formulations that increase the bioavailability, for example, nanoemulsions or encapsulated lignans.

3. Limited Long-Term Studies: Short term studies, lasting 8–12 weeks, are the most commonly studied. Evaluating the sustainability of glycemic and lipid improvements and the effect on diabetes complications such as neuropathy and retinopathy requires long term trials (Ahmad et al., 2022; Singh et al., 2020).

4. Dosing Challenges: There is no well-established optimal dosing for different forms of sesame (oil, seeds, powder). Clinical studies offer some preliminary information, but dosages are too heterogenous to be practically useful.

5. Allergenic Reactions Potential: Sesame is a common allergen and widespread adoption of sesame in diabetes management may increase the risk of allergic reactions in people with existing food sensitivities. What future studies should explore is hypoallergenic formulations, or find safe consumption thresholds (Chandran et al., 2019).

Future Directions

1. **Long-Term Randomized Controlled Trials:** Only multicenter RCTs over several years will confirm the long-term benefits and safety of sesame for its management of diabetes and its complications.
2. **Development of Bioenhanced Products:** Bioavailability challenges could be addressed and clinical efficacy enhanced by novel strategies including perhaps encapsulated lignan supplements or sesame oil emulsions (Mahmoodi & Abbasi, 2023).
3. **Integration into Preventive Strategies:** Sesame has antioxidant and anti-inflammatory properties, and could help prevent diabetes in high-risk populations. Its use in prediabetes management could be evaluated in prospective cohort studies.
4. **Exploration of Genetic Variability:** Future research should investigate the effect of genetic differences between sesame varieties on their therapeutic potential, and region-specific dietary guidelines (Zhang et al., 2021).
5. **Safety and Tolerability Studies**: Broadening sesame clinical applications will require comprehensive studies aimed at the potential allergenicity and other dietary components or medication interactions.

Conclusion

Sesamum indicum L. is a promising natural adjuvant for diabetes management. Its antioxidant, anti-inflammatory and antihyperglycemic properties complement conventional treatments without which, they function as good supplement to end. Further validation of sesame seeds through rigorous trials may well make it a mainstay in integrative diabetes care.

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