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Cinnamon as a Natural Modulator of Metabolic Health: A Review of Contemporary Research

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Abstract

Introduction and purpose of the work:
The objective of this study is to evaluate the influence of cinnamon supplementation on glucose regulation, metabolic indicators, and anthropometric parameters in individuals with metabolic syndrome, including type 2 diabetes (DM2). The conducted studies suggest a positive effect on the individual parameters

Materials and methods: An extensive literature search was conducted using the PubMed database. The review primarily included randomized controlled trials (RCTs) and pilot studies, focusing on the impact of cinnamon supplementation on cardiometabolic and glycemic markers.

Summary: The collected clinical evidence indicates a significant positive effect of cinnamon on key glycemic indicators. Cinnamon supplementation led to a statistically significant reduction in glycated hemoglobin (HbA1c) (up to 0.596%) and fasting blood glucose (FBS), with the largest FBS decrease observed in individuals with DM2. Studies using continuous glucose monitoring (CGM) showed lower 24-hour glucose concentrations. Furthermore, an aqueous cinnamon extract significantly improved markers of oxidative stress in plasma and demonstrated strong antioxidant activity.

Regarding metabolic indicators, a decrease in the concentration of LDL, total cholesterol (TC), and triglycerides (TG), and an increase in HDL were observed after the intervention. In studies involving complex supplementation (containing cinnamon), a significant reduction in body weight (a decrease of 3.66 kg), BMI, and waist circumference was observed, although anthropometric changes in monotherapy studies with cinnamon were often statistically insignificant. The most frequently reported adverse event was mild gastrointestinal symptoms.
Conclusions: The evidence suggests that cinnamon supplementation has a positive impact on metabolic health, particularly on glycemic control (HbA1c and FBS) and lipid profile. However, it is important to emphasize the limitations of individual studies, including their short duration (e.g. 12 weeks) and the fact that they were often conducted on a small number of individuals in a specific population, which may affect the consistency of the results obtained. Longer and larger studies are needed to fully evaluate cinnamon's potential in the context of long-term cardiovascular risk.

Keywords: Healthy lifestyle, Quality of life, Cinnamomum, Diabetes Mellitus type 2, Insulin resistance, Blood glucose, Metabolic Syndrom

Introduction:

Cinnamon is obtained from the bark of the cinnamon tree (*Cinnamomum*), belonging to the family Lauraceae. The most popular species include *Cinnamomum zeylanicum*, *Cinnamomum cassia*, and *Cinnamomum camphora* (Kędzia A, 2011). In the pharmaceutical industry, the bank of Ceylon cinnamon is used to produce essential oil; this process utilizes uncleaned bark or waste products from cinnamon sorting. This results in an oil rich in cinnamaldehyde, which is one of the more important bioactive substances isolated from this spice (Góra J, Lis A, 2005).

Cinnamon has been a valued spice for centuries, not only for its flavor. In Hindu medicine, it was used to treat diabetes and alleviate gastrointestinal disorders, such as indigestion. To this day, it is used as an ingredient in Chai tea to improve digestion (Góra J, Lis A, 2005, Sztaba D. 2009).

Metabolic syndrome (MetS) is recognized as obesity, which is a necessary condition, plus two of the following: impaired glucose metabolism, elevated non-HDL cholesterol, and elevated blood pressure (Piotr Dobrowolski et al., 2022). Weight reduction is a key in the treatment of MetS (Baska A et al., 2021). Furthermore, in patients with metabolic syndrome, the risk of developing type 2 diabetes can increase up to fivefold (Ford ES, 2008).

Currently, we are observing an epidemic of obesity and overweight among the pediatric population worldwide. A pooled analysis including 31.5 million children aged 5–19 years indicates increasing BMI values (NCD Risk Factor Collaboration, 2017). Excess adipose tissue in childhood leads to an increased risk of obesity, which is the main component of metabolic syndrome in adulthood and is associated with hypertension, dyslipidemia, and impaired glucose metabolism (Gregory JW, 2019).

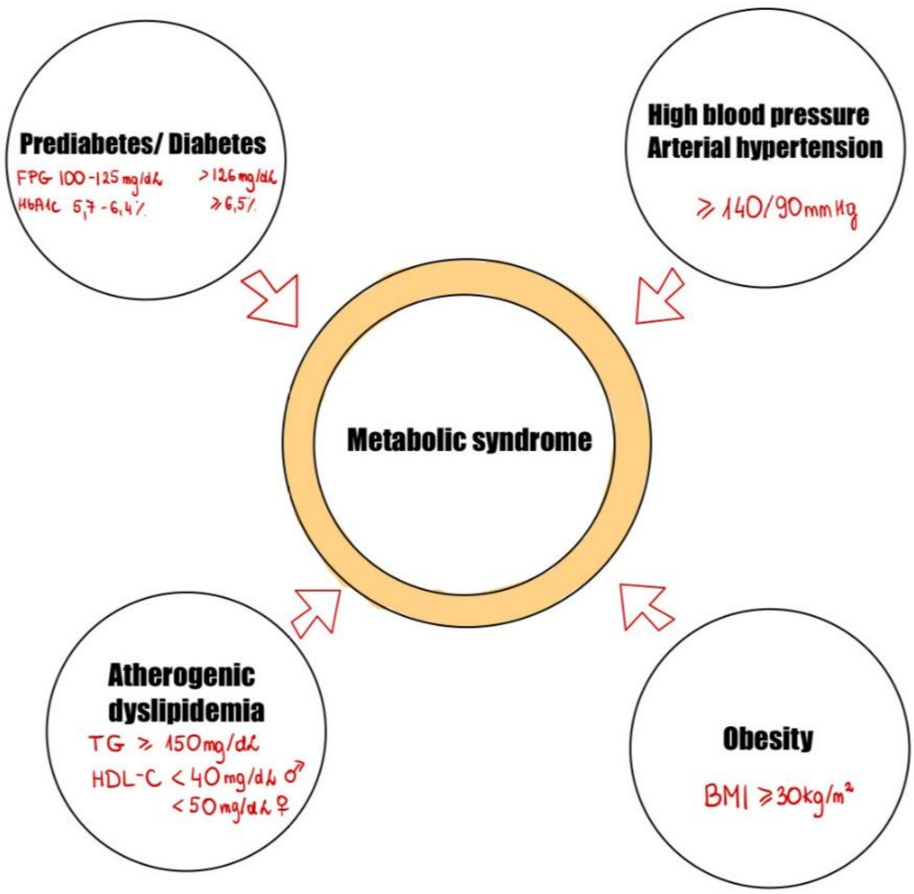

Figure 1. Authors' illustration based on Dobrowolski P. et al., 2022

Nowadays, there are no complete data regarding the epidemiology of metabolic syndrome due to difficulties in measuring its components in a representative population of each nation (Ferrari CKB, 2024).

Saklayen MG. et al. (2018) reports that metabolic syndrome occurs three times more frequently in the population than diabetes, which corresponds to approximately 1.428 billion people suffering from this condition. Moreover, metabolic syndrome occurs in about 40% of patients with type 2 diabetes, and its prevalence is higher among women (James M, et al., 2020). According to the WHO, the number of people with diabetes increased to 830 million in 2022, and impaired glucose tolerance and impaired fasting glucose are intermediate states between normal glucose levels and diabetes. To prevent both diabetes and metabolic syndrome and their complications, achieving and maintaining a healthy body weight, engaging in regular physical activity, and avoiding saturated fats and sugar in the diet is recommended (Global Burden of Disease Collaborative Network. Global Burden of Disease Study Results. Institute for Health Metrics and Evaluation, 2024; Ferrari CKB., 2024).

Both metabolic syndrome and type 2 diabetes are characterized by excess body weight and an increased waist circumference, indicating excessive adipose tissue. Abdominal obesity in particular leads to complications, including hypertension and lipid abnormalities (Ostrowska OL. et al., 2021).

Hyperglycemia present in diabetes leads to the formation of AGEs (advanced glycation end-products) and reactive oxygen species, which contribute to inflammation and endothelial dysfunction. As a result, microvascular and macrovascular complications develop (Lima JE et al., 2022).

Results:

Antioxidant activity and glycemic response

Rachid et al. (2022) analyzed antioxidant activity using two assays: FRAP and DPPH. They proved strong antioxidant activity and polyphenol content in the extract at a concentration of 1554.9 mg/L. However, in this study, the OGTT test did not show significant differences between the cinnamon-treated group and the control group (Anne-Marie Roussel et al., 2009).
Furthermore, continuous glucose monitoring revealed that 24-hour glucose concentrations were significantly lower after cinnamon administration (4 g/day) compared to placebo, with a lower peak glycemic value (Zelicha H et al., 2024).

Effect on key glycemic markers (HbA1c and FBS)

Studies show a statistically significant reduction in glycated haemoglobin - by 0.2% after 90 days of supplementation with 3 g of cinnamon daily in combination with oral antidiabetic medications (Lira Neto JCG et al., 2022). In another study, cinnamon had the greatest effect on HbA1c reduction, causing a decrease of 0.596% (Moreira FD, 2024).
Additionally, cinnamon supplementation combined with berberine significantly reduced HbA1c and fasting blood glucose levels (Mansour A et al., 2025). *Cinnamomum cassia* significantly improved HbA1c compared to baseline values, which is associated with predicted improvement in arterial stiffness and, consequently, long-term cardiovascular risk (Delgadillo-Centeno JS et al., 2023).
Fasting glucose (FBS) showed significant reductions, with the largest effect observed with *C. zeylanicum* in patients with type 2 diabetes and a smaller effect in individuals with prediabetes (Al Dhaheri AS et al., 2024; Moreira FD et al., 2024; Zelicha H et al., 2024). Moreover, in a study supplementing cinnamon combined with glucomannan, D-chiro-inositol, and inulin for 16 weeks, reductions in insulin levels and HOMA index were observed (Citarrella R et al., 2024).

Effect on cardiometabolic markers

Collected studies indicate a positive effect of cinnamon supplementation. Zelicha et al. (2024) noted a reduction in postprandial triglycerides. One study reported slight decreases in HDL-C, triglycerides, and total cholesterol after supplementation with *Cinnamomum zeylanicum*, specifically bark extract containing cinnamaldehyde, eugenol, and cinnamyl acetate (Al Dhaheri AS et al., 2024; Muthukuda D et al.,2025).
Furthermore, cinnamon combined with berberine significantly reduced LDL-C without changes in total cholesterol, HDL-C, or triglycerides (Mansour A et al., 2025). However, some studies reported no significant effect of cinnamon on lipid profile (Delgadillo-Centeno JS et al., 2023, Moreira FD et al., 2024). Delgadillo-Centeno JS et al. (2023) observed a reduction in diastolic pulmonary artery pressure in the *C. cassia* group.

Anthropometric indices

No significant differences: A study with *C. verum* showed reductions in body weight (-0.8 kg), BMI, and circumferences; however, none of these changes were statistically significant ($p > 0.05$) (Lira Neto JCG et al., 2025). Another study also noted no differences in anthropometric parameters (Mansour A et al., 2025).

Positive differences: In the *C. cassia* study, a reduction in body weight was observed, associated with expression of the UCP3 protein gene (Delgadillo-Centeno JS,, et al., 2023). Notably, in a study using the combination supplement (glucomannan, DCI, inulin, *C. zeylanicum*), patients receiving the supplement reported significant reductions in body weight (-3.66 kg), BMI, and waist circumference (-1.85 cm) compared to the control group (Citarrella R et al., 2024).

Discussion

The sources consistently support the hypothesis that the positive effect of cinnamon on glycemic control results from its strong antioxidant properties. Reactive oxygen species and oxidative stress are the main factors contributing to impaired insulin secretion and the pathophysiology of type 2 diabetes. Therefore, it can be inferred that cinnamon may be used as an adjunct in oxidative-stress-targeted therapy, preventing diabetes and reducing HbA1c and FBS (Kanwal Rehman et al., 2017).

A water extract of cinnamon demonstrated strong antioxidant activity and high polyphenol content. Daily administration of 500 mg for 12 weeks significantly improved oxidative stress markers in individuals with fasting glycemic disorders (Rachid AP et al., 2022). Statistically significant reductions in HbA1c and fasting glucose were also observed in studies involving cinnamon (Lira Neto JCG et al., 2022; Delgadillo-Centeno JS et al., 2023; Zelicha H et al., 2024; Moreira FD et al., 2024).

Moreover, cinnamon in combination with other supplements - berberine, or glucomannan, D-chiro-inositol, and inulin - also demonstrated significant positive effects on HbA1c and FBS. However, current sources do not provide sufficiently comparable data to determine which supplementation strategy had a greater impact. Patients receiving berberine combined with cinnamon not only showed reductions in individual parameters but also had their doses of antidiabetic medications, mainly insulin, reduced during the study (Mansour A et al., 2025).

One study reported inconsistencies between CGM and OGTT results: CGM showed that 24-hour glucose concentrations were significantly lower compared to placebo, and the peak glycemia was also lower, but glucose measured 120 minutes after oral glucose loading did not show significant differences (Zelicha H et al., 2024). A previous study also showed no significant differences in OGTT (Rachid AP et al., 2022). This may be due to the lower reliability, accuracy, and reproducibility of the OGTT compared to optimal measurement methods (Ko GTC et al., 1998). CGM, which measures glycemia over an extended period, may be superior to OGTT in detecting dysglycemia in metabolic syndrome or diabetes (Danne T et al., 2017). Its main advantage is capturing glycemic fluctuations, making it a more sensitive measurement (Bergman M et al., 2020).

In the pathogenesis of metabolic syndrome, increased glucose production by hepatocytes occurs concurrently with reduced uptake by skeletal muscle cells, leading to hyperglycemia and increasing the risk of type 2 diabetes (Fahed G, et al., 2022). Cinnamon, primarily due to its cinnamaldehyde content, exhibits antioxidant, anti-inflammatory effects and enhances tissue insulin sensitivity, contributing to this effect (Gutowska G, Jakubczyk A, 2023).

Regarding lipid profiles, studies show mixed results, ranging from significant improvements to no effect. Supplementation with *C. verum* caused reductions in LDL, TC, TG, and an increase in HDL in the study group after 90 days of administration of four capsules of 750 mg *Cinnamomum verum* in two doses - before breakfast and lunch (Lira Neto JCG et al.,, 2023). Similarly, a study on a combination supplement observed significant reductions in total cholesterol (-6.91%), triglycerides (-7.89%), and LDL (-9.40%) (Efficacy of a Dietary Supplement Containing Glucomannan, D-Chiro-Inositol, Cinnamomum zeylanicum Extract, and Inulin in Patients with Metabolic Syndrome, 2024). In contrast, supplementation with 3 g of *C. cassia* for 12 weeks showed no changes in lipid profile (Delgadillo-Centeno JS et al., 2023). Inconsistencies in lipid results are likely related to differences in cinnamon species (*C. verum* vs. *C. cassia*) and the dosages and formulations used (monotherapy vs. combination supplement).

Regarding anthropometric parameters, analysis indicated that the best effects, especially body weight reduction, were achieved through synergy of ingredients rather than cinnamon alone. Monotherapy studies (*C. verum*) showed reductions in body weight (-0.8 kg), BMI (-0.36 kg/m²), and circumferences, but none of these changes were statistically significant (Lira Neto JCG et al., 2025). However, a combination supplement (glucomannan, D-chiro-inositol, inulin, and *C. zeylanicum*) led to significant reductions in body weight (-3.66 kg), BMI (-5.80 kg/m²), and waist circumference (-1.85 cm) compared to the control group (Citarrella R et al., 2024). These differences indicate that combination supplementation is significantly more effective in controlling anthropometric and lipid parameters than monotherapy with cinnamon.

It is important to note research limitations highlighted by some authors as reasons why some promising results did not reach statistical significance. One major limitation is the short duration of studies. Authors of a *C. cassia* study themselves indicated that the study duration was a limitation, as differences might have been significant in the context of cardiovascular risk, but changes over a short period were statistically non-significant, though prognostically meaningful. No serious adverse events were reported during the studies. However, mild gastrointestinal symptoms were noted in some studies, both with berberine-cinnamon supplementation and the combination supplement.

Conclusions

In conclusion, the existing body of evidence highlights the promising therapeutic potential of cinnamon, driven by its rich array of bioactive compounds, including cinnamaldehyde, cinnamic acid, and polyphenols. Through an extensive review of current clinical evidence, including randomized controlled trials and pilot studies, it can be observed that cinnamon has a positive effect on glycemic control, as evidenced by improvements in key markers such as HbA1c, FBS, and CGM. Its antioxidant activity and support for glycemic control are attributed to its biochemical properties, reducing the risk not only of type 2 diabetes but also of metabolic syndrome, considering its impact on other metabolic parameters.

Evidence also suggests a favourable effect of cinnamon on lipid profiles, reflected by reductions in LDL, total cholesterol, and triglycerides, as well as an increase in HDL following intervention. Moreover, combination supplementation with cinnamon contributes to significant reductions in body weight, BMI, and waist circumference, which may lower the risk of obesity and other components of metabolic syndrome.
Despite these promising results, the studies have limitations due to short duration, small sample sizes, and the fact that they were conducted in specific populations, indicating the need for further research. In summary, this review suggests that cinnamon may serve as a valuable adjunctive agent in the management of individuals with metabolic disorders and type 2 diabetes, primarily by improving glycemic control and lipid profile. Longer and larger studies are needed to fully assess its clinical potential and long-term benefits.

Authors' Contributions:
Conceptualization was done by Natalia Popczyk; methodology by Natalia Popczyk and Sylwia Bryksy; software by Jakub Kaźmierczyk; checking by Michał Popczyk; formal analysis by Martyna Świątecka; investigation by Aleksandra Marciszewska; resources by Hanna Tymchenko; data curation by Agnieszka Piechowicz; writing-rough preparation by Jakub Jopek; writing-review and editing by Michał Popczyk; visualization by Natalia Popczyk and Martyna Świątecka; supervision by Ewa Buczkowska; project administration by Jakub Jopek;

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In preparing this work, the authors used chatGPT for the purpose of linguistic corrections, i.e. grammatical and stylistic corrections in English
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