JURNAL KEBIDANAN DAN KESEHATAN TRADISIONAL

Jurnal Kebidanan dan Kesehatan Tradisional
Volume 10, Number 1, March 2025
https://doi.org/ 10.37341/jkkt.v10i1.504

**Systematic Review**

# The Effect of Cinnamon Extract on Blood Sugar Levels in Type 2 Diabetes Mellitus Patients: A Meta-Analysis

**Dilma'aarij Agustia[1*], Sutan Sahala Muda Marpaung[2], Dita Anggriani Lubis[3]**

[1,3]Department of Midwifery, Universitas Satya Terra Bhinneka, Indonesia
[2]Department of Forestry, Politeknik Pertanian Negeri Kupang, Indonesia

**ABSTRACT**

***Background:*** *Diabetes Mellitus is still a global problem today. This is demonstrated by the 2018 global data, which indicates that diabetes mellitus is the ninth leading cause of mortality and that the number of people with the disease has quadrupled over the last three decades. This research aims to estimate the magnitude of the impact intervention in giving cinnamon extract based on the findings of several earlier research.*

***Methods:*** *This study uses secondary data sources with a systematic approach utilizing meta-analyses and PICO. The population consists of patients with type 2 diabetes. Intervention is giving extra cinnamon. The outcome is blood sugar levels. Keywords for the articles searched were as follows: "cinnamon" AND "Diabetes mellitus type 2" AND "randomized controlled trial". The articles that are part of it. This research uses a randomization-controlled trial study design and is a full-text article. Utilizing the PRISMA flow diagram, articles are gathered. They used the Review Manager 5.3 program to analyze.*

***Results:*** *Research indicates that giving individuals with type 2 diabetes mellitus additional cinnamon eating interventions significantly lowers their blood sugar levels (Standardized Mean Difference = -0.74; 95% CI = -1.67 to 0.18; p= 0.110).*

***Conclusion:*** *The consumption of cinnamon supplements has been shown to significantly lower blood glucose levels in individuals with type 2 diabetes mellitus. Therefore, cinnamon supplementation may be considered as a complementary strategy in the dietary management of type 2 diabetes, alongside standard pharmacological and lifestyle interventions.*

**ARTICLE HISTORY**
Received: January 9th, 2024
Accepted: April 4th, 2025

**KEYWORDS**
Cholinesterase, cinnamon, diabetes mellitus type 2

**CONTACT**
Dilma'aarij Agustia
✉
dilmaagustia@satyaterrabhinneka.ac.id
Jurusan Kebidanan Universitas Satya Terra Bhinneka, Jln. Sunggal Gang Bakul Jalan Tengku Amir Hamzah pekan I, Medan, Indonesia.

**Cite this as:** Agustia, D., Marpaung, S. S. M., & Lubis, D. A. (2025). The Effect of Cinnamon Extract on Blood Sugar Levels in Type 2 Diabetes Mellitus Patients: A Meta-Analysis. *Jurnal Kebidanan Dan Kesehatan Tradisional*, *10*(1), 29-42. https://doi.org/ 10.37341/jkkt.v10i1.504

## INTRODUCTION

Even now, diabetes mellitus (DM) remains a global issue. This is clear from the 2018 global data, which shows that the number of people with diabetes has doubled over the last three decades and that it is today the ninth leading cause of death. Ninety percent of people worldwide currently have type 2 diabetes, and one in eleven people have diabetes mellitus (Zheng & Ley, 2018). In contrast to national data, according to the International Diabetes Federation (IDF) report, Indonesia is the country with the highest number of people with DM in ASEAN (Federation, 2022; PCS INCHEM, 2018).

Data from the Central Bureau of Statistics shows that there were 249.519 DM patients in 2019 in North Sumatra and only 144.521 patients or 57.92% received health services. The remaining 104.998 did not seek health services (Dinas Kesehatan Provinsi Sumatera Barat, 2018). This shows that there are still many DM cases that have not been handled optimally. In Medan City, there are 92.540 DM patients with 34.13% who have received health services according to the standard (Badan Pusat Statistik, 2018).

Type 2 diabetes mellitus is a metabolic disease characterized by high blood sugar levels brought on by a decrease in insulin synthesis by pancreatic beta cells as a result of a confluence of lifestyle and hereditary variables. The handling and treatment of DM is mostly done with routine check-up treatment and pharmacy or the use of drugs that have side effects on the sufferer (Sarani et al., 2021). Treatment with complementary plants remains an option in modern times like today, because in addition to preventing side effects in DM sufferers, it also has a significant effect on reducing blood sugar levels in sufferers (Butt, 2022). This is in line with the vision and mission of the D3 Midwifery Study Program at Satya Terra Bhinneka University, which prioritizes complementary medicine in overcoming health problems and the results of this study need to be sustained by making this cinnamon product so that the benefits can be felt sustainably

Complementary types of traditional therapies are increasingly emerging, this is utilized for the treatment of chronic diseases, especially type 2 DM which has begun to develop both in Indonesia and in other countries. Cinnamon, which has another name cinnamomum cassia, is one type of plant that is easily found in the highlands. As many as 80% of plants that are widely distributed in West Sumatra and Jambi have become one of the leading export commodities in Indonesia. Cinnamon contains active ingredients such as cinnamat, cinnamaldehyde, polyphenols and flavonoids which are proven to be able to reduce sugar levels in patients with type 2 diabetes (Moridpour et al., 2024; Sarani et al., 2021; Shang et al., 2021).

Many studies have proven and evaluated the antidiabetic effect of cinnamon. Research conducted by Qin showed that cinnamon has an effect on reducing insulin resistance (Lu, 2019). Another study also mentioned that cinnamon also has an effect on patients with obesity and DM based on traditional medical theory. Research related to screening and prevention has been carried out, but therapy and treatment using natural plants (sustainable complementary) still need to be further researched. The researcher's goal is to identify the efficacy of giving cinnamon to patients with type 2 DM using the Randomized Controlled Trial (RCT) method, in an effort to contribute to the reduction of non-communicable diseases which are still the number one concern in the world and help improve the achievement of the target of (Sustainable Development Goals) SDGs goal 3.

## MATERIALS AND METHOD

This study followed the PRISMA flow diagram guidelines and used a systematic review and meta-analysis technique. For a month, publications were found using journal

databases like PubMed, Google Scholar, and Science Direct. The keywords used were "cinnamon" OR "cinnamon cassia" AND "Diabetes mellitus type 2" OR "Non-Communicable Disease" AND "RCT" OR "randomized controlled trial". Full text papers with an experimental study design a randomized controlled trial (RCT) meet the inclusion criteria for this research, articles in English, the analysis used is bivariate or multivariate with SD and mean, the research subjects are patients suffering from type 2 diabetes mellitus, the intervention is the administration of cinnamon extract, and the outcome is type 2 diabetes mellitus. The exclusion criteria include articles published before 2020, study designs other than RCTs, not full text and languages other than English.

PICO is used by researchers to formulate study problems. Patients having a diagnosis of type 2 diabetes mellitus comprise the population. The outcome is type 2 diabetes mellitus, and the intervention is the administration of cinnamon extract with a comparison of no treatment of cinnamon extract or placebo. The research instrument was assessed using critical appraisal skills program (CASP) for RCT. CASP is a program that provides tools and training to help users evaluate research studies, CASP is often used in healthcare.

Measurement of the patient's blood sugar level was carried out with a blood glucose meter. The review manager program was used to examine the study's data (Revman 5.3). By computing the mean difference, the study model that was combined to produce the final meta-analysis result was identified. The results will then be interpreted using fores plots and funnel plots based on the effect size values and study heterogeneity found in the data analysis.

## RESULTS

Three reviewers were involved in this study, screening and critically evaluating articles that were eligible for analysis based on the PICO that had been made and the background information on the topic. The reviewers used the meta-analysis method with appropriate stages, and if there were disagreements among the reviewers during the critical appraisal process, the same critical appraisal value was conducted on two reviewers, and all reviewers continued to discuss the matter until they came to a consensus that the articles selected for analysis were, in fact, eligible.

Primary research findings of how cinnamon extract affects individuals with type 2 diabetes mellitus' blood sugar levels. Eleven study publications from seven Asian continents, two from the American continent, one from Europe, and one from Africa make up this article. The area of articles selected based on the inclusion criteria is displayed in Figure 1. Next, the researchers evaluated the articles' quality (Tables 1). Table 2 lists 11 articles from RCT studies. The findings indicate that individuals with type 2 diabetes mellitus can lower their blood sugar levels by using cinnamon extract. Articles were found using a database based on the PRISMA flow diagram, which is depicted in Figure 1.

Using the critical appraisal criteria for RCTs, the study's quality was evaluated. After the study quality assessment, 11 articles were included in the quantitative meta-analysis process using Rev-Man 5.3. This table presents the findings from the evaluation of the study's quality with the intervention of cinnamon extract administration and the outcome of blood sugar levels.

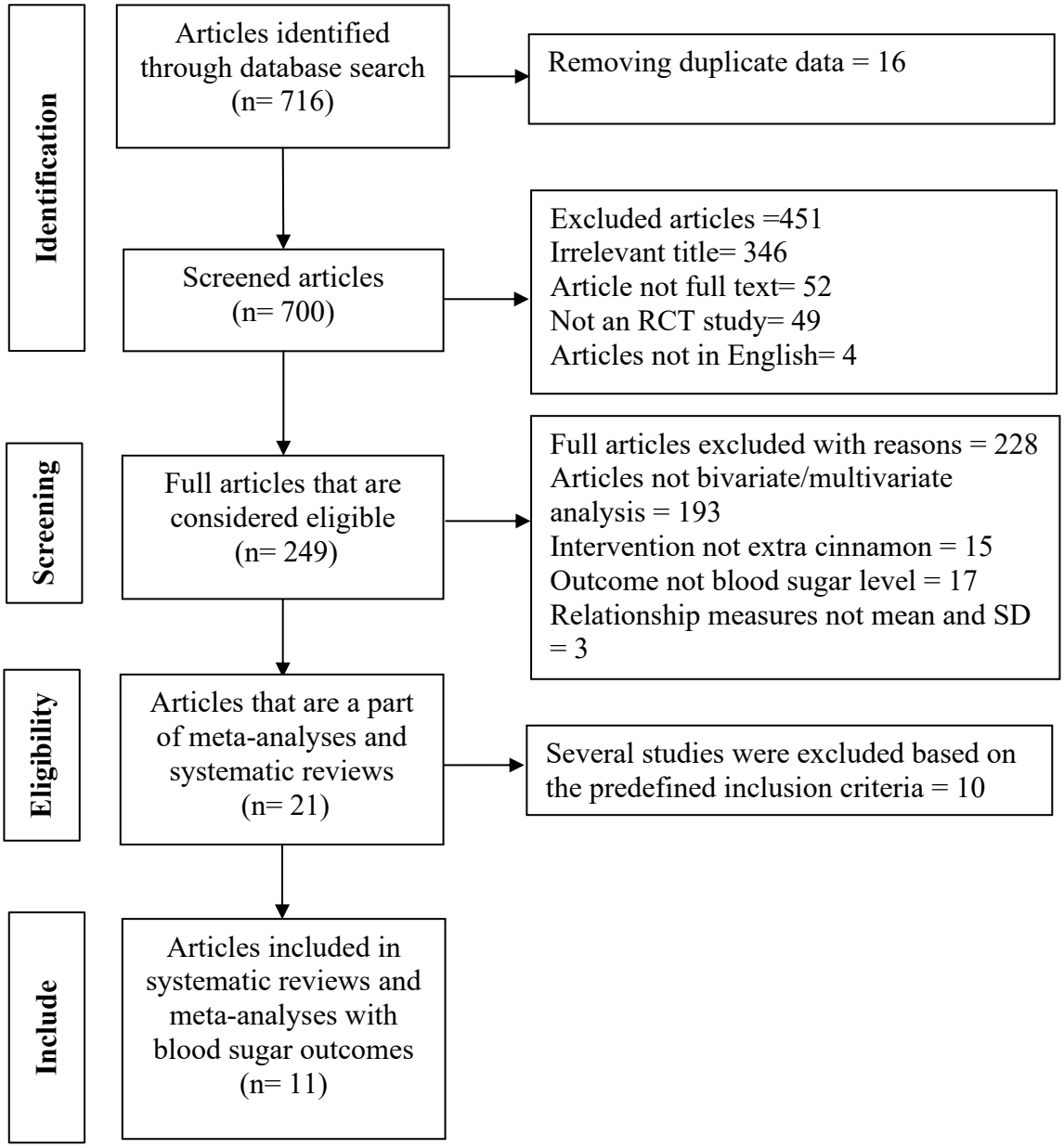


**Figure 1.** PRISMA Diagram Flow

**Tabel 1**. Evaluation of Research Quality

| Checklist Questions | Publication (Author and Year) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ana (2022)** | **Roghayeh (2018)** | **Jose (2023)** | **Navid (2020)** | **Jose (2021)** | **Eva (2021)** | **Mosaad (2019)** | **Bhashika (2022)** | **Komgrit (2021)** | **Sari (2023)** | **Safitri (2023)** |
| Is there a distinct scientific focus addressed by this study? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Can research questions be addressed with the Randomized Controlled Trial research method? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Does the study have a sufficient number of participants to prove that the results are not the result of chance? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Did participants get assigned at random to the experimental and control groups? If not, is this possibly biased? | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| Exist any criteria for inclusion or exclusion? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| When the two groups entered the study, were they similar? | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| Are the outcome criteria impartial and objective? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Checklist Questions | Publication (Author and Year) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ana (2022)** | **Roghayeh (2018)** | **Jose (2023)** | **Navid (2020)** | **Jose (2021)** | **Eva (2021)** | **Mosaad (2019)** | **Bhashika (2022)** | **Komgrit (2021)** | **Sari (2023)** | **Safitri (2023)** |
| Are the results measured using validated and objective assessment techniques? If not, was the grading mixed or was it done by someone who was unaware of the group assignment? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Does the effect size actually matter in practice? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| How accurate is the effect estimate? Is a confidence interval present? | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| Is it possible that confounding variables have not been considered? | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Are the findings relevant to what you're studying? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | **9** | **10** | **9** | **11** | **10** | **8** | **11** | **11** | **10** | **11** | **10** |

**Table 2.** An explanation of the Primary Studies Which Constitute Up the Primary Study Meta-analysis

| Author (year) | Country | Study Design | Sample | P (Population) | I (Intervention) | C (Comparison) | O (Outcomes) |
|---|---|---|---|---|---|---|---|
| Ana (2022) | Portugal | Randomized Controlled Trial | Cinnamon: 18 No intervention: 18 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Roghayeh (2018) | Iran | Randomized Controlled Trial | Cinnamon: 52 No intervention: 52 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Jose (2023) | Brazil | Randomized Controlled Trial | Cinnamon: 71 No intervention: 69 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Navid (2020) | Iran | Randomized Controlled Trial | Cinnamon: 16 No intervention: 16 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Jose (2021) | Brazil | Randomized Controlled Trial | Cinamon: 80 | DM Type 2 | To assess the effectiveness of extra cinnamon use | Not examining the efficiency of the intervention including | blood sugar concentrations |

| Author (year) | Country | Study Design | Sample | P (Population) | I (Intervention) | C (Comparison) | O (Outcomes) |
|---|---|---|---|---|---|---|---|
| | | | No intervention: 80 | | intervention in affecting TM2D glucose levels | the use of cinnamon in affecting TM2D glucose levels | |
| Eva (2021) | Indonesia | Randomized Controlled Trial | Cinnamon: 21<br>No intervention: 21 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Mosaad (2019) | Sudan | Randomized Controlled Trial | Cinnamon: 7<br>No intervention: 7 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Bhashika (2022) | Sri Lanka | Randomized Controlled Trial | Cinnamon: 10<br>No intervention: 10 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Komgrit (2021) | Thailand | Randomized Controlled Trial | Cinnamon: 10<br>No intervention: 10 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |

| Author (year) | Country | Study Design | Sample | P (Population) | I (Intervention) | C (Comparison) | O (Outcomes) |
|---|---|---|---|---|---|---|---|
| Sari (2023) | Indonesia | Randomized Controlled Trial | Cinnamon: 10 No intervention: 10 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |
| Safitri (2023) | Indonesia | Randomized Controlled Trial | Cinnamon: 18 No intervention: 18 | DM Type 2 | To assess the effectiveness of extra cinnamon use intervention in affecting TM2D glucose levels | Not examining the efficiency of the intervention including the use of cinnamon in affecting TM2D glucose levels | blood sugar concentrations |

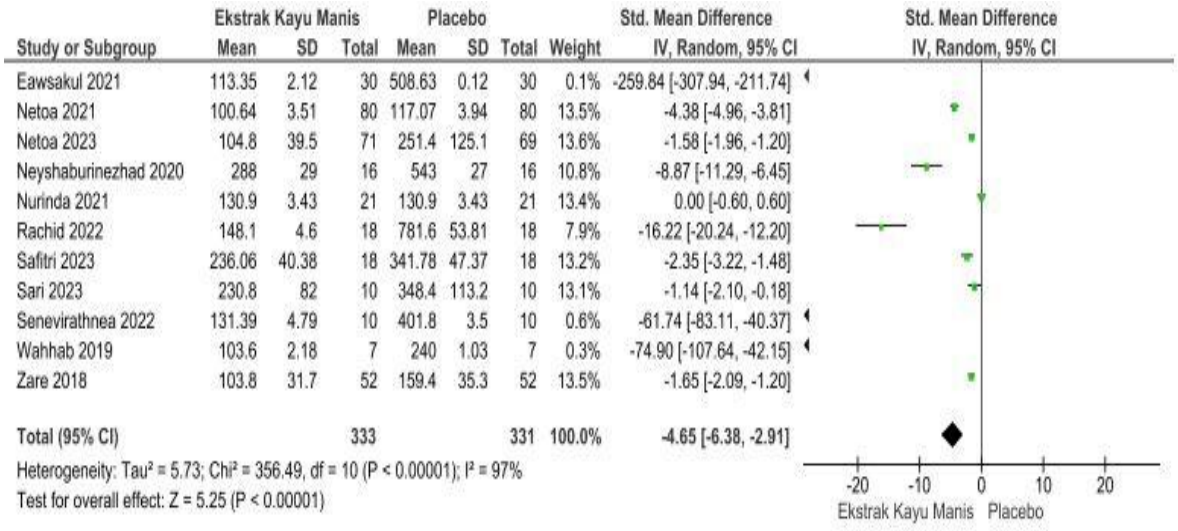


**Figure 2.** Forest Plot of the Effect of Giving Extra Cinnamon on Blood Sugar Levels of Type 2 Diabetes Mellitus Patients

The forest plot illustrates how the meta-analysis method's findings were interpreted. According to Figure.3, the analysis of the RCT study's data indicates that providing extra cinnamon to patients with Type 2 Diabetes Mellitus has a 4.65-fold increased risk of lowering blood sugar levels in comparison to those who do not receive extra cinnamon. This difference is statistically significant ($p < 0.005$). I2 = 97% was the study data's heterogeneity. such that heterogeneous data distribution is expressed (random effect model).

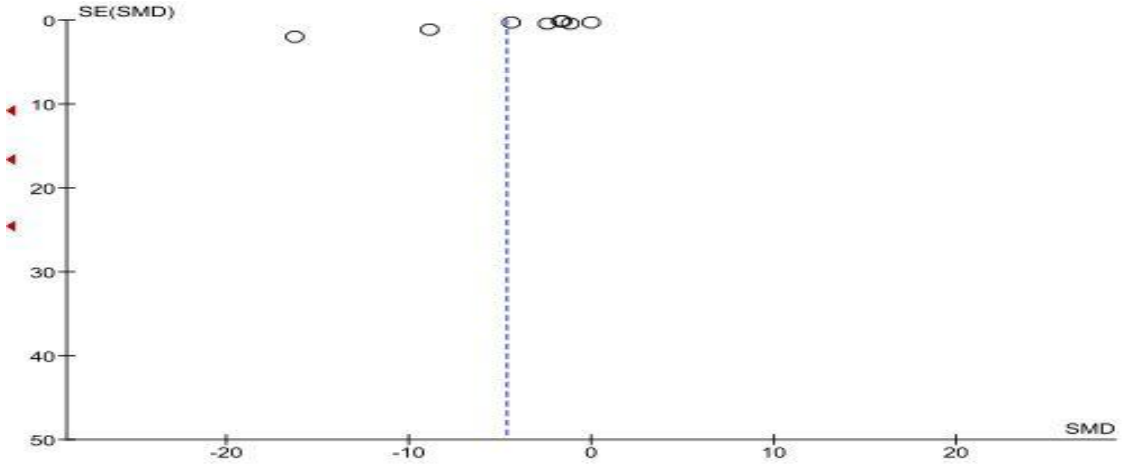


**Figure 3.** Funnel Plot of the Effect of Giving Extra Cinnamon on Blood Sugar Levels of Diabetes Mellitus Type 2 Patients

Each study's estimated effect size is represented in a funnel plot versus its estimated precision, usually the standard error. With 9 plots on the right and 2 on the left, the unequal distribution of the right and left plots in Figure 4 suggests publication bias in the RCT trial. Standard errors appear to be between 0 and 10 for the plots on the left side of the graph and between 0 and 5 for the plots on the right.

## DISCUSSION

This meta-analysis and systematic study examine how adding more cinnamon affects type 2 diabetic patients' blood sugar levels. Given the high prevalence of diabetes mellitus, statistics on the condition are discussed in this study, which is deemed significant, especially in type 2 diabetes mellitus. The study's estimated (predicted) connection or outcome of being exposed to disease occurrence is influenced by confounding factors, which may cause the relationship or effect to differ from what really occurs in the target population or invalidate the results of the study (Murti, 2018). The research included in this thorough investigation and meta-analysis has been adjusted for confounding variables, as evidenced by the inclusion of research standards. Specifically, the discrepancy in the standardized means.

The estimated cumulative effect of cinnamon extract on blood sugar levels in patients with type 2 diabetes mellitus was processed using RevMan 5.3 and the Continous technique. Using randomization to control confounding variables, the bivariate data of two groups were analyzed for effect magnitude or standardized mean difference. A forest plot and a funnel plot are used to show the findings of the systematic investigation and meta-analysis. Forest plots include estimates of the overall results as well as a summary of data from each study that was looked at in the meta-analysis (Murti, 2018).

The visual representation of the heterogeneity (variation) between study outcomes is provided by the forest plot (Murti, 2018). In a metaanalysis, a funnel plot is a graphic that illustrates potential publication bias. The impact size of the research, the sample size, or the standard error of the impact magnitude over several investigations examined are related, as the funnel diagram illustrates. The funnel plot visually displays heterogeneity, or degree of variety. The funnel plot, which may be assessed in a variety of ways, illustrates the link between the study's impact size and the sample size of the many research it examined (Murti, 2018).

The results of this study showed a significant effect in reducing blood sugar levels in patients with type 2 diabetes. Another study showed differently, the consumption of cinnamon extract of burmannii species did not significantly change the glucose level compared to the control group. However, the effect of cinnamon became effective in patients with type 2 diabetes mellitus after being consumed for a longer period of time (Rachid et al., 2022). This cinnamon extract has ingredients that can regulate an important role in fatty acid or glycolipid metabolism. This by promoting glucose absorption and blocking glycogen synthase kinase, cinnamon extract can stimulate glycogen synthase, so that this process that helps patients with diabetes mellitus can lower their blood sugar levels (Zare et al., 2019).

Non-pharmacological treatment has been widely done to reduce blood glucose levels in patients with type 2 diabetes mellitus, for example the use of aromatherapy and relaxation techniques and proven to reduce glucose levels. In this study, pharmacological treatment was carried out using herbs (Ratnawati & Hanani, 2020). Other studies have also shown that this cinnamon spice has a phytochemical composition that can provide hypoglycemic effects with the potential to be able to make the treatment of individuals with type 2 diabetes (Wang et al., 2020). Giving therapy with extra cinnamon in accordance with the recommended dose, has been proven to reduce and regulate glucose metabolism in the blood sugar levels of diabetic patients. Cinnamon supplementation can cause improvements in all anthropometric systems such as BMI, body fat content and glycemic levels in individuals suffering from type 2 diabetes (Zare et al., 2019; Xiang et al., 2019).

In line with research conducted by Heitor (2018) shows that the administration of extra anis wood reduces blood glucose levels in type 2 diabete smelitus patients by 12.9, so this can be claimed to reduce fat mass and increase serum antioxidants (Santos HO, 2018). As there are no negative effects from pharmaceuticals, herbal treatment should be taken into consideration. Conversely, a few anti-diabetic medications can be used to treat long-term conditions like diabetes, a metabolic disorder. Diabetics must take long-acting medications. Unfortunately, the patient's long-term safety profile makes successful therapy elusive. Pharmaceuticals on the market might cause adverse effects include hypoglycemia, weight gain, and gastrointestinal problems (Zare et al., 2019). A study revealed under the use of cinnamon as an antidiabetic can improve glucose uptake, modulate insulin sensitivity and response, prevent digestive enzyme activity and gluconeogenesis (Hayward et al., 2019).

In this investigation, the analysis's findings of existing data recommend the use of extra cinnamon for herbal therapy in individuals with type 2 diabetes. Future research may address the use of pharmaceutical drugs and herbal medicines such as extra cinnamon for the purpose of managing individuals with type 2 diabetes. Researchers recommend that future studies use a larger sample in the intervention to strengthen the internal part of the study because they found that publication bias is present in the results of the funnel plot analysis, which highlights the study's weakness. This is partly because of the small sample size in the analysis results.

## CONCLUSION

The use of cinnamon supplements can help lower blood sugar in individuals with type 2 diabetes. People who have been diagnosed with type 2 diabetes can use cinnamon extract to lower their blood glucose levels. To manage blood sugar levels in people with type 2 diabetes mellitus, we advise using cinnamon in accordance with dose guidelines and under a doctor's supervision if used to make herbal medical therapy.

## ACKNOWLEDGEMENT

The authors are grateful to Satya Terra Bhinneka University for supporting this research.

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