Role of Cinnamon Supplementation on Glycemic Markers, Lipid Profile and Weight Status in Patients with Type II Diabetes

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***Abstract*—Type II diabetes has been on the rise for the past few decades and the current management plan of diabetes is challenging to individuals in keeping their blood glucose levels within normal limits. There is a constant search of new ways to tackle these challenges. Cinnamon is suggested to have antihyperglycemic and lipid lowering effect and has been proposed to be utilized in type II diabetes. The aim behind this review is to explore the role of cinnamon in improving the glycemic status, lipid profile, and weight status of patients with type II diabetes. PubMed and ScienceDirect databases have been searched for eligible studies conducted until February 2022, the outcomes measured were glycemic markers as primary outcome and lipid profile and weight status as secondary outcomes. A total of ten trials involving 861 patients were included in the study. Five studies have demonstrated reductions in glycemic markers (ranging between −0.56 and −1.9 mmol/L for fasting blood sugar and between −0.21% and −0.93% for glycated hemoglobin) whereas the remaining four did not show any significant reduction. The most improvements in glycemic markers are seen in patients with poorly controlled diabetes and patients with higher body mass index (BMI) values. The majority of the studies did not record improvement in lipid profile. Changes in weight status are only observed in overweight patient category (BMI between 25 and 30). Overall, there is no coherent evidence to decide about antihyperglycemic, lipid lowering, and weight reducing effects of cinnamon in type II diabetes. Further trials are needed to reach a definitive verdict.**

***Index Terms*—Cinnamon, Glycated hemoglobin, Lipid profile, Type II diabetes.**

I. Introduction

Type II diabetes mellitus cases have been on constant rise globally, especially in the 21st century. According to international diabetes federation, as of 2021, 1 in 10 adults is suffering from the disease (536 million people worldwide) and this number is expected to further rise to 783 million by 2045 (*IDF Diabetes Atlas 2021 | IDF Diabetes Atlas*, 2022; Sun, et al., 2022).

These growing rates translate to massive costs in terms of lives lost and money spent for example only in 2021, diabetes was responsible for 6.7 million deaths. In the same year, health spending due to diabetes has reached 966 billion dollars, which is more than a threefold increase over the past 15 years (*IDF Diabetes Atlas 2021 | IDF Diabetes Atlas*, 2022).

Due to this overwhelming growth of diabetes globally, there is an urgent need to enhance the diagnosis and management of the disease (Khan, et al., 2014). At present, the main goal in managing diabetic patients is to control blood sugar levels (target glycated hemoglobin [HbA1c] <7%) as any prolonged deviation from normal ranges can lead to macro and microvascular complications. Moreover, due to the increased risk of cardiovascular disease in diabetic patients, it is also important to keep blood pressure and lipid levels at normal ranges (Allen, et al., 2013).

In the attempt of maintain multiple variables at check, several challenges arise, polypharmacy can be considered as one of the major ones in type II diabetics. Polypharmacy can be defined as taking more than five medications per day and is currently the case in 57–84% of diabetic patients. (Alwhaibi, et al., 2018). This in turn, could be responsible for increased burden on the patients (mixing up of drugs and forgetting to properly take their medications) that result in decreased compliance and adherence to the treatment regimen.

Poor medication adherence is regarded as one of the major factors affecting glycemic control and is associated with increased morbidity and mortality. At best, 45% of all type II diabetic patients fail to achieve glycemic control (HbA1c <7%) (Polonsky and Henry, 2016). In addition, polypharmacy also puts patients at risk of developing drug related adverse effects (Bui, et al., 2021).

To tackle the current challenges, researchers have been in continuous search of alternative ways to manage the disease. There is increasing interest in herbal remedies to be incorporated into the care protocol of diabetic patients. Many herbs are thought to possess hypoglycemic effects and researches focusing on this topic have been constantly on the rise (Governa, et al., 2018; Sharma, et al., 2020). One of the herbs of interest is cinnamon.

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Cinnamon is a widely used culinary spice that can be generally divided into two species, Ceylon (or true) cinnamon (botanical name: *Cinnamomum verum*) or the more common *Cinnamomum cassia*. Both belong to lauraceae family. Cinnamon is available in a variety of forms including bark (or quills), powders, or extracts from cinnamon powder. Different forms of cinnamon have different phytochemicals and bioavailability. Volatile oils constitute 1–4% of various cinnamon products, and include 60-80% cinnamaldehyde; 10% eugenol; 5–10% trans-cinnamic acid; 5–10% phenolic compounds; and 4–10% of other compounds, and traces of coumarin (Costello, et al., 2016).

Both *in vitro* and *in vivo* evidences show that cinnamon may have benefits in enhancing insulin sensitivity and glycemic control (Governa, et al., 2018). The exact compound that is responsible for hypoglycemic actions of cinnamon is still under investigation (Costello, et al., 2016), but it has been suggested that this effect is due to cinnamaldehyde or phenolic compounds content (Governa, et al., 2018; Mandal, et al., 2021).

Cinnamaldehyde concentrations vary according to the species and form of cinnamon. *c. cassia* has a higher concentration than *C. verum* yet the high concentration of coumarin (a potential toxin) in *c. cassia* (as compared to *C. verum*) limits its use in large quantities. Considering this potential toxicity, *C. verum* might be the better choice for the management of long term conditions such as type II diabetes mellitus (Governa, et al., 2018).

Up to the present time, none of the authoritative bodies recommend any specific indication for cinnamon in diabetes management. Despite the availability of a fair amount of research on cinnamon, the evidence is not coherent and it is still controversial whether or not cinnamon possesses adequate glucose lowering effect to be incorporated in the treatment regimen of type II diabetes (Governa, et al., 2018).

There is a couple of review articles published on the effect of cinnamon on blood sugar levels in humans (Akilen, et al., 2012; Allen, et al., 2013; Namazi, et al., 2019). But since then, there have been several RCTs published on this topic, that is why a more recent overview is needed with the inclusion of the findings from the more recent studies to give a more up to date insight of the effect of cinnamon on blood sugar parameters.

Hence, the aim behind conducting this literature review is to gather evidence to find out where does exactly cinnamon stand in the management of diabetic patients in terms of its effect on blood sugar levels as well as if it has any influence on optimizing lipid profile and weight status in patients with type II diabetes.

II. Methodology

Through utilizing PICO model, the research question that is intended to be addressed in this review is "in adult type II diabetic patients, does the use of cinnamon cause a change/improvement in the glycemic control compared to similar patients that do not incorporate cinnamon in their treatment regimen? and if there is improvement, is it clinically significant?"

The PICO analysis components, that is, the population, intervention, comparator, outcome, and setting criteria used to perform this review are shown in the following Table I:

A. Selection of Papers

For the purpose of generating this literature review, PubMed and ScienceDirect databases were searched with several keywords to identify relevant studies to be included. The keywords used were the following:

1. Cinnamon
2. *Cinnamomum zeylanicum*
3. *C. cassia*
4. Type 2 diabetes mellitus
5. Fasting blood sugar (FBS)
6. HbA1c
7. Glycemic =control

The primary outcome measure was the blood sugar levels (either FBS or HbA1c or serum insulin) whereas changes in weight status and patients' lipid profile were secondary outcomes of interest.

The inclusion and exclusion criteria were designed in a way that would make it possible to precisely answer the research question. Since we are intending to evaluate the effect of an intervention in our literature review, the study design offering the most reliable and strong evidence would be randomized controlled clinical trials (RCTs), therefore full text clinical trials which were published till November 2022 involving adult patients and measuring changes in blood sugar levels as their primary outcome were searched for to be included.

Exclusion criteria were animal studies, studies not measuring outcomes of interest, studies done on non-diabetic adults, and systematic reviews. Studies involving pediatric and adolescent populations were also excluded from the study.

No limits were set for language or year of publication to gather most of the available evidence.

For the purpose of evaluation of outcomes, statistical significance was considered to be achieved when $p < 0.05$ and clinically significant changes were considered to be the following cutoff points for each of the variables:

Table 1
PICO Analysis

PICOs	Criteria
Population	Type II diabetic patients (adults)
Intervention	Cinnamon powder consumption
Comparator	Placebo/control group
Outcome	Primary outcomes: glycemic markers (FBS, HbA1c, serum insulin) Secondary outcomes: Body weight (BMI), lipid profile (TC, TG, LDL, HDL)
Setting	Randomized controlled trials

FBS: Fasting blood sugar, HbA1c: Glycated hemoglobin, BMI: Body mass index, TC: Total cholesterol, TG: Triglycerides, LDL: Low-density lipoprotein, HDL: High-density lipoprotein

a. 0.5% reduction on HbA1c levels.(Lameijer, et al., 2020)
b. 10% reduction in low-density lipoprotein (LDL) levels.
c. 10% increase in high-density lipoprotein levels.
d. 30% reduction in triglyceride levels (Bradley, et al., 2009).

B. Data Extraction

Data extracted from each of the included studies for authors, year of publication, study design, region where study is carried out, number of participants, participant gender and age distribution, oral medication use, duration of diabetes, insulin use, outcomes measured, amount and form of cinnamon used, duration of cinnamon intake, blood sugar readings, lipid profile values, and weight changes.

C. Quality Assessment of the Studies

The quality of the RCTs was assessed using the Jadad scale (Jadad, et al., 1996), based on three components, randomization, double blinding, and description of withdrawals with scores ranging from 0 to 5. Trials scoring three or greater were considered to be high in quality, whereas scores of two or less indicated low quality. Detailed description and the checklist of Jadad scale are shown in Appendix 1.

III. Results

A. Search Rsults, Study Characteristics and Quality Assessment

As a result of the initial searches, 44 clinical trials were identified from both PubMed and ScienceDirect databases, 12 of which were duplicates. By limiting the search to *in vivo* studies carried out on adults and screening the abstract of the studies against the remaining inclusion and exclusion criteria, ten studies were eligible to be included in this review.

The detailed strategy of study inclusion can be depicted in the following flowchart (Fig. 1).

B. Quality Assessment of Included Studies

According to Jadad scoring scheme, nine of the ten included studies were regarded to be high in quality, while the remaining one study being low in quality. The detailed scoring scheme of each study is shown in Table II.

C. Characteristics and Findings of Included Studies

The sample sizes among the studies ranged from 44 to 140 and collectively involved 861 diabetic patients. The studies were carried out across four continents in the following countries: Iran (n = 3), USA (n = 2), Brazil (n = 1), UK (n = 1), China (n = 1), Germany (n = 1), and Pakistan (n = 1).

Nine studies measured changes in FBS and HbA1c levels and five studies measured serum insulin levels. In terms of secondary outcome measures, seven studies measured lipid profile readings while only four studies looked into measuring body mass index (BMI) of the study subjects.

Four studies utilized *C. cassia* as their cinnamon species, whereas one study used cinnamomum verum species. The remaining studies did not mention what species they have used. Regarding the form of the cinnamon, the majority of studies used the powder form (n = 8) whereas the other

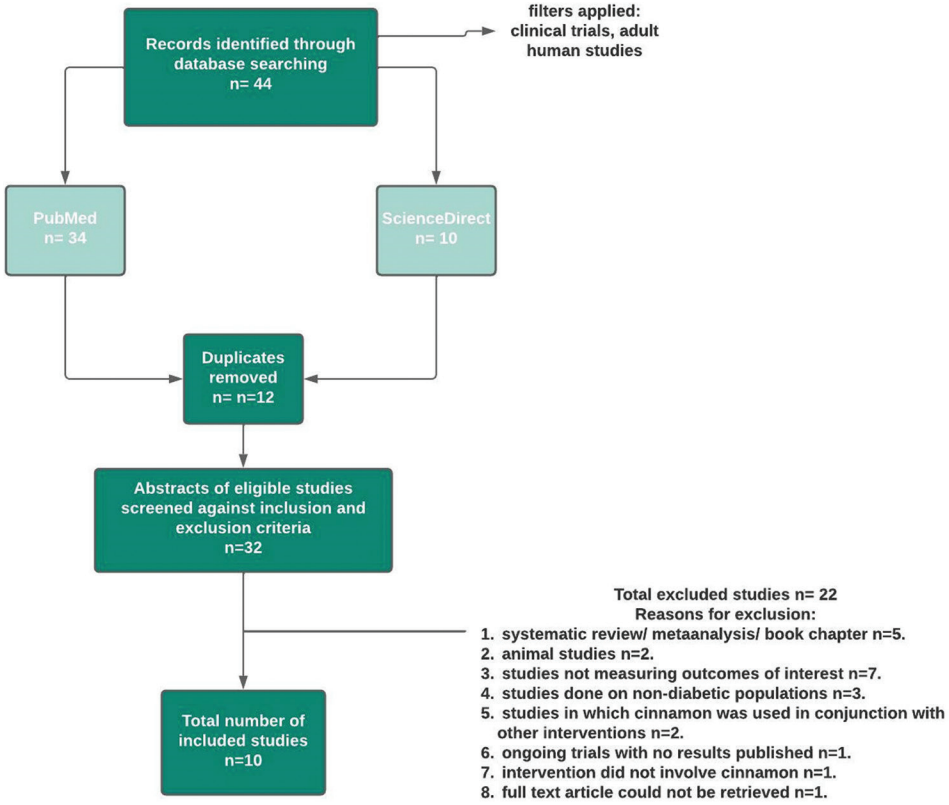

Fig. 1. The search strategy and identification of papers of interest.

ones used extracts (n = 2) with varying doses. The time of the interventions ranged from just over a month to up to 4 months, with most studies conducting their intervention over a period of 3 months. The full characteristics of the included studies and their main findings are depicted in Tables III and IV, respectively.

D. Effect of Cinnamon on Glycemic Control (Primary Outcome Measures)

FBS

Of the nine studies that measured FBS levels, the intake of cinnamon was successful in producing statistically significant reductions in five studies only. The reductions ranged between −0.56 and −1.9 mmol/L with most reductions being obtained from the study done by Khan, et al. in Pakistan (Khan, et al., 2003), in contrast, the four remaining studies only recorded none to very modest reductions that did not reach statistical significance.

Only two studies explored the intervention with cinnamon in different dosages, Khan, et al. have looked into three different quantities of cinnamon powder in their study, the patients showed similar reductions in FBS regardless of which dose was used (Khan et al., 2003). Conversely, Lu, et al. who have used cinnamon extract in their intervention, found that a greater reduction in FBS was observed when a higher dose of cinnamon was used (Lu, et al., 2012).

HbA1c

Similar to FBS values, HbA1c measured in five studies brought about significant reductions ranging between −0.21% and −0.93% as compared to the pre-intervention values, the remaining four studies failed to demonstrate significant changes in HbA1c levels. Only one study has tested the

Table II
Quality Assessment of Included Studies by Jadad Scale.

Study	Was the study randomized (0/1)	Was the randomization appropriate (0/1)	Was the study double blinded (0/1)	Was double blinding method appropriate (0/1)	Description of withdrawals and dropouts	Total score
(Khan, et al., 2003)	1	0	0	0	0	1
(Mang, et al., 2006)	1	0	1	1	1	4
(Blevins, et al., 2007)	1	0	1	1	1	4
(Crawford, 2009)	1	1	0	0	1	3
(Akilen, et al., 2010)	1	1	1	1	1	5
(Lu, et al., 2012)	1	0	1	1	1	4
(Mirfeizi, et al., 2016)	1	1	1	1	1	5
(Talaei, et al., 2017)	1	0	1	1	1	4
(Zare, et al., 2019)	1	1	1	1	1	5
(Lira Neto, et al., 2021)	1	1	1	1	1	5

Table III
Characteristics of Included Studies

Author/Year of publication	Country	Study design	No. of participants	Mean age/ Gender	Oral medication use for diabetes	Insulin use	Duration of diabetes	Outcomes measured
Khan, et al., 2003	Pakistan	RCT	60	52.2 50% female	Yes	No	7 years	FBS TC, TG, LDL, HDL
Mang, et al., 2006	Germany	RCT	79	63.25 32% female	Some patients took oral medications	No	7 years	FBS, HbA1c TC, TG, LDL, HDL
Blevins, et al., 2007	USA	RCT	57	Not given 51% female	Yes	No	Not mentioned	FBS, HbA1c TC, TG, LDL, HDL, serum insulin
Crawford, 2009	USA	RCT	109	60.3 42% female	Yes	Some patients used insulin	Not mentioned	HbA1c
Akilen et al., 2010	UK	RCT	58	54.9 57% female	Yes	No	Not mentioned	FBS, HbA1c TC, TG, LDL, HDL WC, BMI
Lu, et al., 2012	China	RCT	69	62 62% female	Yes	No	Not mentioned	FBS, HbA1c TC, TG, LDL, HDL
Mirfeizi, et al., 2016	Iran	RCT	105	54 77% female	Yes	No	Not mentioned	FBS, HbA1c TC, TG, LDL, HDL, serum insulin, BMI
Talaei, et al., 2017	Iran	RCT	44	57.6 61.5% female	Yes	Some patients used insulin	<8 years	FBS, HbA1c Serum insulin
Zare, et al., 2019	Iran	RCT	140	52.5 46% female	Yes	No	Not mentioned	FBS, HbA1c TC, TG, LDL, HDL, serum insulin, BMI
Lira Neto, et al., 2021	Brazil	RCT	140	61.3 69.3% female	Yes	No	Not mentioned	FBS, HbA1c, serum insulin

FBS: Fasting blood sugar, TC: Total cholesterol, TG: Triglycerides, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, BMI: Body mass index.

Table IV
Main Findings of Included Studies

Author/Year of publication	Form of cinnamon used	Amount of cinnamon consumed	Duration of cinnamon use	Glycaemic status	Lipid profile (all units in mmol/L)	Weight status
Khan, et al., 2003	*C. cassia* powder	1 g 3 g 6 g	40 days	FBS 1 g: −1.9 mmol/L 3 g: −1.5 mmol/L 6 g: −1.6 mmol/L (p<0.05)	TG: 1g: -0.58, 3g: -0.59, 6g: 0.41 TC: 1 g: −0.82, 3 g: −1.48, 6 g: 0.44 LDL: 1 g: −0.31, 3 g: −0.8, 6 g: 0.15 HDL: Significant changes only in 3 g group	N/A
Mang, et al., 2006	Aqueous cinnamon extract	1 g	4 months	FBS: −1.11 mmol/L (p<0.05) HbA1c: NS	TC, TG, LDL, HDL: NS	N/A
Blevins, et al., 2007	*C. cassia* powder	1 g	3 months	FBS, HbA1c, serum insulin: NS	TG, TC, LDL, HDL: NS	BMI: NS
Crawford, 2009	*C. cassia* powder	1 g	3 months	HbA1c: −0.83% (p<0.05)	N/A	N/A
Akilen, et al., 2010	*C. cassia* powder	2 g	3 months	FBS: NS HbA1c: −0.36%(p=0.002)	TC, TG, LDL, HDL: NS	BMI: NS
Lu, et al., 2012	Cinnamon extract	Low dose: 120 mg (from 4.8 g cinnamon) High dose: 360 mg (from 14.4 g cinnamon)	3 months	FBS: Low dose: −1.02 mmol/L (p<0.01) High dose: −1.62 mmol/L (p<0.01) HbA1c: Low dose: −0.67% (p<0.01) High dose: −0.93% (p<0.01)	TG reduced in low dose group only (-0.78 mmol/L) TC, LDL, HDL: NS	N/A
Mirfeizi, et al., 2016	Cinnamon powder	1 g	3 months	FBS: NS HbA1C: NS Serum insulin: NS	TG, TC, LDL, HDL: NS	BMI: −0.6 kg/m^2 (p=0.026)
Talaei, et al., 2017	Cinnamon powder	3 g	2 months	FBS: NS HbA1c: NS Serum insulin :NS	N/A	N/A
Zare, et al., 2019	Cinnamon powder	1 g	3 months	FBS: −0.73 mmol/L (p<0.001) HbA1c: −0.27% (p<0.001) Serum insulin: −1.77 mIU/L (p<0.001)	TG: NS TC: −0.41 (p<0.001) LDL: −0.15 (p=0.018) HDL: +0.03 (p=0.038)	BMI: −0.53 kg/m^2 (p<0.001)
Lira Neto, et al., 2021	Cinnamomun verum powder	3 g	3 months	FBS: −0.56 mmol/L (p=0.001) HbA1c: −0.21% (p=0.001) Serum insulin: NS	N/A	N/A

NS: Non-significant

effect of different doses of cinnamon on HbA1c levels and has found a dose response relationship i.e. as the dose of cinnamon increased, a greater reduction of HbA1c value was observed (Lu, et al., 2012). Zare, et al. have found that baseline BMI value of the subjects influenced the reduction in HbA1c levels by cinnamon, subjects with BMI higher than 27 had better HbA1c reductions as compared to lower BMI subjects (Zare, et al., 2019).

Serum insulin

The majority of the studies (four out of five) have failed to find any role of cinnamon in reducing serum insulin levels. On the contrary, in the study by Zare, et al., cinnamon was successful in reducing serum insulin by -1.77 mIU/L (Zare, et al., 2019).

E. Effect of Cinnamon on Secondary Outcome Measures

Lipid profile

The vast majority of studies failed to show significant changes in lipid profile values for cinnamon intervention. Merely in the studies of Khan, et al. and Zare, et al., cinnamon had a significant effect on lipid profile (Khan, et al., 2003; Zare, et al., 2019). Similar to HbA1c status, Zare, et al. have noticed that the efficacy of cinnamon in decreasing lipid parameters was also influenced by baseline BMI of the subjects, subjects with a BMI of 27 or more had greater reductions in lipid profile as compared to subjects with BMI lower than 27 (Zare, et al., 2019). In regards to clinical significance, only the study done by Khan, et al. had satisfactory reduction percentages to indicate clinically significant results (Khan, et al., 2003).

Weight status (BMI)

Four studies have explored the role of cinnamon in controlling weight status in diabetic subjects. Blevins, et al. and Akilen, et al. whose subjects had a baseline BMI in the obese category (BMI > 30 kg/m^2) did not record a significant decrease in BMI in their interventions (Blevins, et al., 2007; Akilen, et al., 2010). Conversely, Mirfeizi, et al. and Zare, et al. have demonstrated a positive impact of cinnamon on BMI levels of their subjects, it is worth to mention that the subjects in both studies had a baseline BMI in the overweight category (BMI between 25 and 30 kg/m^2) (Mirfeizi, et al., 2016; Zare, et al., 2019).

IV. Discussion

This literature review aimed to explore the effect of cinnamon on the glycemic status of diabetic patients as well as its effect on lipid profile and weight status.

A. Effect of Cinnamon on Glycemic Control

Overall, from the data available, it is difficult to draw a definite conclusion about the effect of cinnamon in improving glycemic control in type II diabetic patients. The conflicting results obtained from the different studies may have been due to the different sources, doses, and forms of which cinnamon was used in each study as well as the different patient profile including their age, diabetes status, and baseline values. Another reason would be the variability of diet, exercise patterns, pharmacotherapy and poor drug compliance of the patients among the studies, all those could have acted as confounders that led to dissimilar results.

The number and type of antihyperglycemic medications taken by study subjects were highly variable among the studies despite the attempt of some studies to control that by distributing subjects with similar medication number and type to both intervention and control groups, and excluding subjects that had a medication type/dosage change. This may have acted as a confounding factor in influencing the final outcomes.

Looking into the findings of all studies, its noticeable than Khan, et al. have recorded the highest reductions in FBS. The population of Khan's study compared to all other studies had very high baseline FBS levels indicating that their diabetes was poorly controlled, this may have been the reason why such great reductions were observed after intervention with cinnamon. This is an indication that cinnamon may be more effective in reducing FBS in poorly controlled diabetic patients rather than patients with well controlled diabetes. However, the findings from Khan et al. should be interpreted with caution because of the poor methodological and reporting quality of the study (Jadad score = 1) as the dropouts and exclusion rates of the subjects was not reported, the adherence of the subjects to take cinnamon tablets were not assessed, and the study was not blinded. All of these issues may have given rise to various biases and affected the outcomes of the study (Khan, et al., 2003).

Several mechanisms have been proposed to explain the antihyperglycemic effect of cinnamon. Studies have shown that cinnamon can act as an insulin secretagogue stimulating insulin release as well as activating enzymes that are responsible for glucose metabolism, glycolysis, and gluconeogenesis. It also enhances glucose uptake by the cells, all of which contribute to its hypoglycemic effect (Gupta Jain, et al., 2017; Governa, et al., 2018).

A systematic review and meta-analysis which was carried out in 2012, has shown cinnamon to be effective in significantly reducing FBS by −0.84 mmol/L and HbA1c by 0.09% (Akilen, et al., 2012), they have stated that cinnamon could be a promising adjunct in diabetes management. However, since 2012, there have been several RCTs published in this field and if taken into account, may alter their final conclusions. Furthermore, from a clinical point of view, a decrease of 0.09% is much <0.5% cut off value and is unlikely to induce much improvement clinically.

Similarly, in another systematic review of 10 RCTs, Allen, et al. have found that cinnamon had a significant effect on reducing FBS whereas they could not find any influence of cinnamon on the long term control of blood sugar levels as they could not detect any significant changes in HbA1c levels (Allen, et al., 2013).

Conversely, according to a more recent review, cinnamon was ineffective in having any effect on glycemic markers (FBS and HbA1c) (Mandal, et al., 2021). The major drawback from this review was the sole inclusion of studies using whole cinnamon or its powder, studies utilizing cinnamon extracts as well as studies using *C. zeylanicum* species as their cinnamon were excluded from their analysis.

B. Effect of Cinnamon on Lipid Profile

Close to the findings of glycemic status, cinnamon intervention also had conflicting outcomes in its influence of lipid profile parameters. In the seven studies measuring lipid profile, three have shown that cinnamon had an effect in reducing triglyceride (TG) levels and two only were successful to show an impact on total cholesterol (TC) and low-density lipoprotein (LDL).

One of the factors that may have possibly affected this dissimilarity is the baseline lipid profiles of the patients. In three studies, lipid profile values were either within the normal ranges or very near to normal levels to begin with, and this may have been the reason that cinnamon had no effect in improving the lipid profile readings (Blevins, et al., 2007; Akilen, et al., 2010; Mirfeizi, et al., 2016).

A recent systematic review and meta-analysis of 19 RCTs have showed significant lipid lowering effect (TG, TC, and LDL-C) of cinnamon in type II diabetes patients (Jamali, et al., 2020). However, they have shown this effect to be more pronounced in studies that have lasted for <2 months. This may be a reason why our results are not in alignment with their findings as most of the included studies in this review have durations of more than 2 months.

In vitro studies have demonstrated lipid lowering activity of cinnamon and it has been attributed to its cinnamate content, which is a phenolic compound found in the inner bark. Cinnamate has reduced cholesterol levels in rats by

inhibiting HMG Co-A reductase enzyme activity as well as suppressing lipid peroxidation through enhancing the activity of hepatic antioxidant enzyme (Lee, et al., 2003; Amin and Abd El-Twab, 2009).

Only a few systematic reviews have been carried out to assess the effectivity of cinnamon in improving lipid profile in diabetic patients. A review by Allen et al. have concluded that cinnamon had no significant effect on lipid profile in patients with type II diabetes (Allen, et al., 2013). In 2018, another systematic review was carried out and the added evidence from randomized controlled trials carried out in that 5 year gap were still unsuccessful in showing an overall improvement in lipid profile (Santos and da Silva, 2018).

C. Effect of Cinnamon on Weight Status (BMI)

Tackling obesity in patients with type II diabetes not only improves their glycemic control, but also lowers their risk of morbidity and mortality; therefore, weight management is an integral part in the management plan of type II diabetes (Ross, et al., 2011).

Zare, et al. and Mirfeizi, et al. have found similar reductions in BMI values in their interventions (−0.53 kg/m^2 and −0.6 kg/m^2, respectively). These results come in alignment with the findings of a systematic review of 12 trials which has quantified the decrease of BMI value due to cinnamon supplementation to be −0.51 kg/m^2 (Mousavi, et al., 2020).

Cinnamaldehyde, the compound that gives cinnamon its flavor, is thought to be responsible of the antiobesogenic effect of cinnamon (Camacho, et al., 2015). The antiobesogenic effect of cinnamon has been explained by several mechanisms. Animal studies have shown that cinnamon could inhibit the differentiation of adipocytes, induce fatty acid oxidation, act as an antagonist at cannabinoid receptors, and may also affect intestinal lipid absorption (Mollazadeh and Hosseinzadeh, 2016).

D. Strengths and Limitations

The main strength of the study is its inclusiveness, no time or language limits were set in including the studies for this review, and this allowed for the most relevant evidence to be collected. Furthermore, the included studies are divided across four continents which enhance the diversity of the population and make the finding more generalizable/applicable to the global population.

Quality wise, as it is also evident from the Jadad scores, the majority of the studies were of very high quality, hence their findings can be depended upon to assess the impact of cinnamon in type II diabetes. Additionally, the greater part of the included studies had robust follow-up strategies to ensure that all their subjects adhered to the intervention for the full duration. They have excluded any subject who have been incompliant to efficiently reflect the impact of the intervention.

This review is not void from limitations, starting with addressing the stage of diabetes, most of the studies did not mention for how long their subjects had diabetes, also patients with complications or on insulin therapy were mostly excluded. Another limitation was that none of the interventions assessed the long term effectivity of cinnamon nor its safety in prolonged use.

V. Conclusion and Recommendations

There is no coherent evidence to decide about the antihyperglycemic, lipid lowering, and weight reducing effects of cinnamon in type II diabetic patients. Cinnamon has been effective in improving glycemic markers only in patients with poor baseline values, cinnamon also achieved better results in patients with higher BMI (>27) compared to the lower BMI (<27).

We recommend further studies to be carried out in different stages of diabetes to draw definite conclusions about the effect of cinnamon in glycemic control. In addition, studies with longer durations are required to determine the long-term effect and toxicity of cinnamon supplementation in type II diabetes.

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Appendix

Jadad score for assessing the quality of randomized controlled trials (RCT)

The Jadad scale is calculated using the seven items in the table below. The first five items are indications of good quality, and each counts as one point towards an overall quality score. The final two items indicate poor quality, and a point is subtracted for each if its criteria are met. The range of possible scores is 0–5.

1. Was the study described as randomized (this includes words such as randomly, random, and randomization)?
   Yes=1, No=0
2. Was the method used to generate the sequence of randomisation described and appropriate (table of random numbers, computer-generated, etc.)?
   Yes=1, No=0
3. Was the study described as double blind?
   Yes=1, No=0
4. Was the method of double blinding described and appropriate (identical placebo, active placebo, dummy, etc.)?
   Yes=1, No=0
5. Was there a description of withdrawals and dropouts?
   Yes=1, No=0
6. Deduct one point if the method used to generate the sequence of randomization was described and it was inappropriate (for example, patients were allocated alternately, or according to date of birth, and hospital number).
   Described but inappropriate = -1, Described and appropriate = 0
7. Deduct one point if the study was described as double blind but the method of blinding was inappropriate (for example, comparison of tablet vs. injection with no double dummy).
   Described but inappropriate = -1, Described and appropriate = 0

Randomization

A method to generate the sequence of randomization will be regarded as appropriate if it allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which treatment was next. Methods of allocation using date of birth, date of admission, hospital number or alternation should be not regarded as appropriate.

Double blinding

A study must be regarded as double blind if the word “double blind” is used. The method will be regarded as appropriate if it is stated that neither the person doing the assessments nor the study participant could identify the intervention being assessed, or if in the absence of such a statement the use of active placebos, identical placebos or dummies is mentioned.

Withdrawals and dropouts

Participants who were included in the study but did not complete the observation period or who were not included in the analysis must be described. The number and the reasons for withdrawal in each group must be stated. If there were no withdrawals, it should be stated in the article. If there is no statement on withdrawals, this item must be given no point.