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Cinnamon in the Treatment of Type II Diabetes

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Abstract

Objective

The purpose of this review of literature is to evaluate the effects of cinnamon on hemoglobin A1C (HbA1c) and fasting blood glucose/fasting plasma glucose (FBG/FPG) in various populations such as type II diabetes, prediabetics, metabolic syndrome, and overweight or obese individuals.

Research Design and Methods

A comprehensive literature review was done with the Cumulative Index to Nursing and Allied Health Literature (CINAHL) database using the keywords, cinnamon, type II diabetes, diabetes, HbA1c, and FBS. References used in previous meta-analysis were also searched and reviewed for inclusion. Studies were included in this review if they evaluated cinnamon effects on HbA1c and/or FBS/FPG. A total of 15 trials were incorporated in this literature review, 10 studied cinnamon's effect on HbA1c levels and 13 studied cinnamon's effect on the FBG.

Results

Six trials showed significant reductions in the HbA1c levels and 10 trials showed significant reductions in the FBG.

Conclusion

Based on this review of literature, cinnamon can be recommended as effective therapy for reducing HbA1c levels and FBG levels in type II diabetics. To reduce FBG and HbA1c levels, cinnamon can be dosed at 1 g to 6 g daily with meals (i.e. one to four 500 mg tablets BID or TID with meals).

Cinnamon in the Treatment of Type II Diabetes

Diabetes affects people of all races, ethnicities, ages, and genders and can significantly alter quality of life, especially when not well controlled. Conditions such as metabolic syndrome and prediabetes often result in diabetes within a few years. Controlling these syndromes and diabetes becomes a dilemma when it is coupled with the cost of medications, for those with health insurance as well as for those without. The United States Census Bureau stated that 42 million Americans did not have health insurance in 2013 (Smith & Medalia, 2014). These individuals have the full burden of paying for their own health care costs. The average cost of diabetic medications, supplies, and provider appointments, etc., is estimated at $13,700 per year (American Diabetes Association, 2015). Individuals suffering from the aforementioned prediabetic conditions and diabetes are often started on medications such as Metformin, and are seen quarterly by their providers; therefore, have increasing medical expenses as well. Piette, Heisler, and Wagner (2004) stated, “Out-of-pocket medication costs pose a significant burden to many adults with diabetes” (p. 384). As a result, 20% of diabetic patients forgo taking their medications, as prescribed, in an effort to reduce their out-of-pocket expenses (Piette, Heisler, & Wagner,

2004). If diabetes is not well controlled, the long term effects can be costly, as well as deadly, as diabetes can lead to comorbidities such as neuropathy, retinopathy, nephropathy, hypertension, dermatological problems, and amputations, etc. It is imperative that prediabetic states and diabetes be well controlled to improve the quality of life within these disease processes, and to reduce the long term cost of comorbidities associated with these illnesses. New cost effective alternatives, such as cinnamon supplementation, need to be identified to help reduce long term side effects and the out-of-pocket expenses for prediabetic states and diabetes.

Cinnamon has been widely used for decades as a dietary supplement for diabetes, especially in other countries like China, and there is increased awareness in the area of natural or alternative supplements in the United States due to costs and side effects associated with traditional pharmaceuticals, even though the Food and Drug Administration (FDA) does not regulate or manage the manufacturing of herbal remedies. Shane-McWhorter (2013) found that 67% of diabetics used herbal supplements such as cinnamon to lower their blood glucose levels, which may imply a desire to self treat their diabetes. Lu et al. (2012) found that "cinnamon supplementation is able to significantly improve blood glucose control in Chinese patients with type 2 diabetes" (p. 1). Cinnamon has been shown to reduce insulin resistance, reduce blood glucose and lipid levels, reduce inflammation, and increase antioxidant activity (Qin, Panicker, & Anderson, 2010). Despite these benefits and wide spread use of cinnamon and other natural supplements, most traditional providers in the United States do not prescribe or recommend cinnamon or other natural supplements. This may be due to the lack of regulation and approval by the FDA and the lack of evidence of efficacy, or may be due to their own belief or perceptions

about cinnamon and other natural supplements. Whatever the reason, there may not be enough information to influence providers to act. Increased studies that show support for cinnamon use in the treatment of type II diabetes, metabolic syndrome, and prediabetes may be the cue to action that is needed.

There are only a handful of studies that have been done on the effects of cinnamon in the treatment of type II diabetes and not all show positive results. A few studies have been done on the effects of cinnamon on other disease processes as well as healthy individuals. Wang et al. (2007) studied the effects of cinnamon on women with PCOS. Results showed significant reductions in insulin resistance in the cinnamon group but not in the placebo group. Solomon and Blannin (2007 & 2009) examined the effects of cinnamon on healthy individuals using OGTT. Their trails showed that cinnamon 5 g and 3 g, respectively, can reduce glucose responses to OGTT and improve insulin sensitivity in healthy individuals. Hlebowicz, Darwiche, Björgell, and Almér (2007) and Hlebowicz et al. (2009) also show the efficacy of cinnamon in healthy individuals on postprandial blood glucose, gastric emptying, satiety, serum insulin, GLP-1 concentrations, GIP, gherlin, and GER. Prior meta-analysis have focused primarily on the type II diabetic population or have excluded studies that did not report specific biochemical markers like fasting blood sugar (FBS) (Davis & Yokoyama, 2011). There is a need for a more comprehensive review of the effects of cinnamon on multiple biochemical measures as well as multiple disease processes. The purpose of this review of literature is to evaluate the effects of cinnamon on hemoglobin A1C

(HbA1c) and fasting blood glucose/fasting plasma glucose (FBG/FPG) in various populations such as type II diabetes, prediabetics, metabolic syndrome, and overweight or obese individuals.

Theoretical Framework

The theoretical framework utilized for this research proposal is the Health Belief Model applied mostly from the perspective of the provider. This model theorizes that belief and perceptions influence actions (Glanz, & Rimer, 2005). The researcher has predicted that there is a relationship between cinnamon therapy and reduction of some biochemical measures; however, providers do not currently prescribe or recommend its use.

The Health Belief Model describes how modifiable variables and perceived ideas such as severity of consequences, susceptibility, benefits versus barriers, and cues to action can bring about the likelihood of engaging in actions that can promote health (Glanz, & Rimer, 2005). Providers are aware of the susceptibility and severity of type II diabetes. They can be educated about the perceived benefits of cinnamon, i.e., efficacy in lowering HbA1c levels and blood glucose levels, low cost, and no side effects (unless there is an allergy to cinnamon). The perceived barriers to prescribing cinnamon are the lack of FDA regulation of cinnamon, lack of recommendation by the American Diabetic Association (ADA), lack of knowledge of the efficacy of cinnamon in lowering some biochemical measurements, and presumed lack of research to support its use. Cues to actions may be evidence-based trials that show benefits and effectiveness of cinnamon in the treatment of type II diabetes and other disease states, while reducing variables such as

the dosing amount of cinnamon. With knowledge of such trials, primary care providers may be influenced to act and prescribe this supplement. Providers, therefore, will be promoting health and self sufficiency in their patients, as their patients will be less dependent on multiple medications, have fewer medication-induced side effects, and fewer medication-induced medical problems.

Materials and Methods

A comprehensive literature review was done with the Cumulative Index to Nursing and Allied Health Literature (CINAHL) database using the keywords, cinnamon, type II diabetes, diabetes, HbA1c, and FBS. References used in previous meta-analysis were also searched and reviewed for inclusion. Studies were included in this review if they evaluated cinnamon effects on HbA1c and/or FBS/FPG. Studies on type I diabetes were excluded because type I diabetics have a deficiency of insulin rather than insulin resistance, and this literature review is focusing on insulin resistance. Another study excluded was done by Wainstein et al. (2011) on type 2 diabetics because the cinnamon tablet contained cinnamon, zinc gluconate and tri-calcium phosphate. Also not included in this review were studies done on rats.

A total of 15 trials were incorporated in this literature review. Thirteen of the trials studied the effects of cinnamon on type II diabetic participants, one trial assessed the effects of cinnamon on prediabetic and metabolic syndrome individuals, and one trial studied the efficacy of cinnamon use in overweight or obese individuals. Of these trials, 10 measured HbA1c levels and 13 measured FBG. Other biochemical markers were measured but are not part of this review.

Results

HbA1c

The HbA1c level measures the average blood sugars over a three month period, and is important in diabetic management because higher HbA1c levels denote greater risk of developing diabetes-related complications. Crawford (2009) studied whether 1 gram of cinnamon cassia taken daily for 90 days would lower HbA1c levels in poorly controlled type II diabetes. Cinnamon 1 g daily was found to have lowered HbA1c levels by 0.83% ($P < 0.001$). Usual care alone without cinnamon, lowered the HbA1c 0.37% ($P < 0.16$). Crawford concluded that cinnamon does lower HbA1c for this population. Lu et al. (2012) also studied the effect of cinnamon on HbA1c levels for participants with type II diabetes. Cinnamon extract prepared from the bark of Chinese Cinnamomum aromaticum was used. In this study, they compared a placebo, low dose cinnamon (120mg), and high dose cinnamon (360mg). The cinnamon or placebo tablets were taken every morning before breakfast for three months. After three months, they found that for those in the low dose group, their HbA1c was reduced an average of 0.67% (8.90 ± 1.24 to 8.23 ± 0.99), ($P = .003$), and in the high dose group an average of 0.92% (8.92 ± 1.35 to 8.00 ± 1.00), ($P = 0.0004$). In this study, the higher dose was more effective than the lower dose.

The effect of cinnamon supplementation was again studied by Sharma, Sharma, Agrawal, Agrawal, and Singhal (2012) in newly diagnosed type II diabetics. One hundred fifty newly diagnosed type II diabetics were stabilized with diet and exercise for one

month prior to beginning the cinnamon supplementation. The participants were randomized into: a 3 g cinnamon group, a 6 g cinnamon group, a placebo group. After three months, it was found that for the 3 g group (taking 1 g after each meal) the HbA1c went from 8.47 +/- 1.02 at baseline to 7.29 +/- 0.83 post intervention, $p < 0.005$. In the 6 g group (taking 2 g after each meal), the HbA1c went from 8.10 +/- 0.84 at baseline to 7.25 +/- 0.81 post intervention, $p < 0.005$. Both doses had equivalent efficacy. Vafa et al. (2012) treated type II diabetes with Cinnamomum zeylanicum. Participants took two 500 mg tablets of Cinnamomum zeylanicum at each main meal for eight weeks, for a total of 3 grams daily. The researchers concluded that cinnamon significantly decreased HbA1c ($P = 0.008$), of the treatment group, compared to the placebo group. It is noted that even though the HbA1c levels of these participants were well controlled at baseline (7.35 ± 0.51) the Cinnamomum zeylanicum was still effective in significantly reducing the mean level overall.

Al-Yasiry, Kathum, and Al-Ganimi (2014) studied the hypoglycemic effect of cinnamon on 40 poorly controlled male type II diabetics. The participants were given 0.5 g of ground crude cinnamon 15 minutes after each meal for a total of 1.5 g daily for three months. They found that using 1.5g of ground cinnamon daily decreased the HbA1c which went from 9.54 + 0.96 pretreatment to 8.22 + 0.65 post treatment, ($P < 0.01$).

Cinnamon cassia usage in type II diabetics was studied by Akilen, Tsiami, Devendra, Robinson (2010). Participants were given one 500 mg tablet of cinnamon cassia with breakfast and dinner and two 500 mg tablets with lunch, for a total of 2 g daily. The

ingestion of 2 g of cinnamon each day was found to significantly reduce the HbA1c level, 8.22 $\pm$ 1.16 to 7.86 $\pm$ 1.42, $p < 0.05$. A moderate positive correlation was found between the baseline HbA1c level and the significant drop of the HbA1c level suggesting that cinnamon supplementation for poorly controlled diabetics may play a positive role in managing their disease, $r = 0.567$, $P = 0.008$.

Four studies found no significant difference in the HbA1c levels with the use of cinnamon. Vanschoonbeek, Thomassen, Senden, Wodzig, and van Loon (2006) investigated the effects of 1.5 g per day of cinnamon cassia on HbA1c levels of 25 postmenopausal women with well controlled type II diabetes over a six week time frame. No significant changes were found. It must be noted that an appropriate amount of time was not given for a change to be properly noted in the HbA1c level as this trial was done over six weeks instead of three months. Blevins, Leyva, Brown, Wright, Scofield, and Aston (2007) also showed no significant results of cinnamon on HbA1c levels. For three months, cinnamon cassia 1 g was given daily. It was found that this dosage of cinnamon given daily for three months produced no significant change in HbA1c levels ($P > 0.05$). Mang et al. (2006) studied the effects of 3 g cinnamon daily on 79 type II diabetics over 4 months. Their study showed no significant decrease in the HbA1c levels post treatment. Suppapitiporn and Kanpaksi (2006) examined the efficacy of cinnamon cassia 1.5 g daily on reducing the HbA1c levels of 60 type II diabetics. After 12 weeks of intervention, it was found that the HbA1c levels decreased in both the placebo group and the cinnamon group. There was a greater reduction of the HbA1c level in the cinnamon group, and more patients in the cinnamon group achieved a HbA1c level of < 7% as compared to the placebo group; however, the reductions were not statistically different, $p > 0.05$.

The participants in the Vanschoonbeek et al., 2006 trial, the Blevins et al., 2007 trial, and the Mang et al., 2006 trial were all well controlled diabetics with baseline HbA1c levels of 6.86 to 7.4. DeFronzo, Stonehouse, Han, and Wintle (2010) did a meta-analysis of 59 trials with a total of 8479 patients on the relationship of baseline HbA1c levels and the effectiveness of 10 different classes of hyperglycemic medications and produced a weighted $R2$ of 0.35 ($P < 0.0001$). These results show a positive correlation between the baseline HbA1c levels and magnitude of change of the HbA1c level after treatment with glucose-reducing therapies regardless of drug classification. They further state that "These observations should be considered when assessing clinical efficacy of diabetes therapies derived from clinical trials, particularly when evaluating data from clinical trials of patients with relatively low baseline HbA1c levels, 7.0 – 8.0% (DeFronzo, Stonehouse, Han, & Wintle, 2010, p.309, 314)." Lower baseline HbA1c levels prior to intervention produce smaller and less significant changes in the HbA1c levels post intervention.

FBG/FPG

The most common test used to diagnose diabetes is the fasting blood glucose level. This test is more definitive than random blood glucose tests because it measures the blood glucose level after a period of at least eight hours of fasting (no food or liquids except water) eliminating the chance that the results have been influenced by recent food or beverage intake (OneTouch, no date). Khan, Safdar, Ali Khan, Khattak, and Anderson (2003) conducted the first in vivo study on the use of cinnamon in improving FBG levels. Cinnamon cassia was given 1 g daily as one 500 mg table taken at lunch and dinner, 3 g daily as two 500 mg tablets taken at

breakfast, lunch, and dinner, or 6 g daily as four tablets taken at breakfast, lunch, and dinner. The researchers found that all three doses of cinnamon reduced the mean FBG serum levels (18-29%, $P < 0.05$) of the participants in the treatment groups after 20, 40, and 60 days.

Anderson et al. (2010) studied the effects of cinnamon cassia 250 mg given twice a day to participants with type II diabetes. After two months it was found that the FBS decreased from 8.85 $\pm$ 0.32 pretreatment to 8.19 $\pm$ 0.29 mmol/L post treatment, $p < 0.001$. Mang et al. (2006) evaluated the usage of cinnamon cassia 1 g daily for type II diabetics. Participants took the cinnamon as prescribed for four months. The cinnamon group was found to have a significant reduction in the FBG between baseline and post intervention levels (9.26 $\pm$ 2.26 to 8.15 $\pm$ 1.65 mmol/L, $p < 0.001$). Ziegenfuss, Hofheins, Mendel, Landis, and Anderson (2006) evaluated the effects of Cinnulin PF 500 mg once a day (which is equivalent to 10 g whole cinnamon powder) on the FBG of prediabetic and metabolic syndrome participants. After 12 weeks, the FBG levels decreased – 8.4% from 116.3 $\pm$ 12.8 mg/dl to 106.5 $\pm$ 20.1 mg/dL, $p < 0.01$. The efficacy of Cinnulin PF was also studied by Roussel, Hininger, Benaraba, Ziegenfuss, and Anderson (2009) in reducing the FBG of overweight or obese subjects. Cinnulin PF 250 mg was taken twice a day for 12 weeks. The FBG dropped from 114 $\pm$ 2.2 to 102 $\pm$ 4.3 mg/dL, $p < 0.05$, between pre and post treatment with Cinnulin PF. Khan, Khan, and Shah (2010) studied the effects of 1.5 g of ground cinnamon 1.5 g on the FBG of type II diabetic participants. For 30 days the participants ingested 0.5 g of cinnamon three times a day with meals. A significant reduction of the FBG was found with the use of cinnamon (216.3 $\pm$ 52.7 to 163.3 $\pm$ 44.9

mg/dL, $p < 0.05$). In a three month trial, Lu et al. examined the efficacy of cinnamon cassia 120 mg and 360 mg daily in reducing the FBS in 60 Chinese participants who were type II diabetics. Results showed a statistically significant decrease in both groups. Baseline FBG levels decrease from 9.00 to 7.99 mmol/L in the 120 mg group, and from 11.21 to 9.59 mmol/L in the 360 mg group, ($P = 0.00008$).

The effects if cinnamon in newly diagnosed type II diabetics was studied by Sharma, Sharma, Agrawal, Agrawal, and Singhal (2012). One hundred and fifty participants were divided into three groups and given a placebo, 3 g cinnamon, or 6 g cinnamon daily spread out over three meals. FBG levels were drastically reduced in both cinnamon groups. Baseline FBG levels decreased 49% in the 3 g cinnamon group from 226.73 $\pm$ 21.43 to 115.5 $\pm$ 23.03, and 48% in the 6 g cinnamon group from 216.94 $\pm$ 26.27 to 112.26 $\pm$ 22.85, ($p < 0.001$). The effectiveness of Cinnamomum zeylanicum in the reduction of FBG was assessed by Vafa et al. (2012). Two 500 mg tablets were given to 37 subjects three times daily for eight weeks. Cinnamomum zeylanicum, also known as true cinnamon, significantly reduced the FBG in the cinnamon group 139.28 $\pm$ 9.11 to 126.47 $\pm$ 17.73, ($P < 0.05$). Al-Yasiry, Kathum, and Al-Ganimi (2014) determined the hypoglycemic effects of cinnamon on 40 poorly controlled male type II diabetics. Participants were given 1.5 g cinnamon daily for 3 months. Cinnamon cassia produced a 27.5% decline in the FBG of the participants, 174.70 $\pm$ 19.83 to 126.25 $\pm$ 17.85, ($P < 0.01$).

In contrast, some trials found no significant reduction in FBG levels after cinnamon supplementation. Vanschoonbeek, Thomassen, Senden, Wodzig, and van Loon (2006) investigated the effects of cinnamon 1.5 g on FBG levels of 25 postmenopausal women with well controlled type II diabetes over six weeks. Although there was some decline of the FBG in the cinnamon group, 8.37 ± 0.59 to 7.91 ± 0.71, it was not statistically significant, ($P > 0.05$). Suppapitiporn and Kanpaks (2006) evaluated the effects of cinnamon cassia 1.5 g daily, taken over 12 weeks, on type II diabetics. No statistical significance was found in the FBG. Blevins et al. (2007) explored the effects of 1 g cinnamon cassia on 57 non-insulin dependent type II diabetics. After a three month intervention phase, no significant change was noted in the FBG.

Discussion and Implications for Practice

The global prevalence of diabetes was estimated at 9% in 2014 in individuals 18 and over. That is over 350 million people worldwide (World Health Organization, no date) (WHO). Diabetes significantly affects quality of life and leads to death when not well controlled. Over 3 million people die of diabetes and its comorbidities yearly. Centers for Disease Control and Prevention (2014a, 2014b)(CDC) states that diabetes was the 7th leading cause of death in 2010. The American Diabetic Association estimates the cost of diabetes at $13,700 yearly per person, making diabetes costly as well as deadly. Controlling diabetes and its predecessor diseases, prediabetes and metabolic syndrome is imperative to improving the health of our country and reducing health care

expenditures. Finding safe, efficacious, and cost effective alternative treatments for diabetes is a must. Cinnamon is a promising alternative treatment that has been used for decades as a dietary supplement for diabetes.

Based on this review of literature, cinnamon can be recommended as effective therapy for reducing HbA1c levels and FBG levels in type II diabetics. Cinnamon was also found to be effective in lowering FBG levels in prediabetics, overweight and obese individuals. Cinnamon cassia, Cinnamomum zeylanicum, and Cinnulin PF have been shown to have similar efficacy in these populations; however, Cinnamomum zeylanicum may be more advantageous when diabetes is more controlled (Akilen, Tsiami, Devendra, and Robinson, 2010). This review of literature recommends cinnamon as an efficacious and cost effective treatment of uncontrolled type II diabetes which may potentially have some cardiovascular benefits. To reduce FBG and HbA1c levels, cinnamon can be dosed at 1 g to 6 g daily with meals (i.e. one to four 500 mg tablets BID or TID with meals). No adverse effects were seen with any of the cinnamon doses. Patients should be watched for cinnamon allergies, although none were reported in any of the studies reviewed.

Conclusion

Further research needs to be done to evaluate if cinnamon is as equally effective in reducing the HbA1c level and FBG level in the stable type II diabetic (HbA1c level < 8.0 or FBG < 183) versus the unstable type II diabetic (HbA1c $\geq$ 8.0 or FBG $\geq$ 183, as well as the effectiveness of various types of cinnamon such as, cinnamon cassia, Cinnamomum zeylanicum, and Cinnulin PF.

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Appendix A

Literature Review Matrix

Needs to be full reference	Purpose	Design	Independent	Dependent	Results
1. Khan, A., Safdar, M., Ali Khan, M. M., Khattak, K. N., & Anderson, R. A. (2003). Cinnamon improves glucose and lipids of people with type 2 diabetes. *Diabetes Care*, *26*(12), 3215-3218.	The objective of this study was to determine whether cinnamon improves blood glucose, triglyceride, total cholesterol, HDL cholesterol, and LDL cholesterol levels in people with type 2 diabetes.	A total of 60 people with type 2 diabetes, were divided randomly into six groups. Groups 1, 2, and 3 consumed 1, 3, or 6 g of cinnamon daily, respectively, and groups 4, 5, and 6 were given placebo capsules corresponding to the number of capsules consumed for the three levels of cinnamon. The cinnamon was consumed for 40 days followed by a 20-day washout period.	Cinnamon cassia one 500mg tablet taken at lunch and dinner for 1g dose. Cinnamon cassia two 500mg tablets taken at breakfast, lunch and dinner for 3g dose. Cinnamon cassia four 500mg tablets taken at lunch and dinner for 6 g dose.	• FBG levels • Lipid levels	After 40 days, all three levels of cinnamon reduced the mean fasting serum glucose (18–29%), triglyceride (23–30%), LDL cholesterol (7–27%), and total cholesterol (12–26%) levels; no significant changes were noted in the placebo groups. Changes in HDL cholesterol were not significant.
2. Lu, T.,	We hypothesized	To address this	Chinese adults >	• HbA1c levels	Placebo group had no

Sheng, H., Wu, J., Cheng, Y., Zhu, J., & Chen, Y. (2012). Cinnamon extract improves fasting blood glucose and glycosylated hemoglobin level in Chinese patients with type 2 diabetes. *Nutrition Research (New York, N.Y.), 32*(6), 408-412. doi:10.1016/j.nutres.2012.05.003.	cinnamon should be effective in improving blood glucose control in Chinese patients with type 2 diabetes. This study was done to to analyze the effect of cinnamon extract on glycosylated hemoglobin A_{1c} and fasting blood glucose levels.	hypothesis, we performed a randomized, double-blinded clinical study in Chinese patients with type 2 diabetes. A total of 66 patients with type 2 diabetes were recruited and randomly divided into 3 groups: placebo and low-dose and high-dose supplementation with cinnamon extract at 120 and 360 mg/d, respectively. Patients in all 3 groups took gliclazide during the entire 3 months of the study.	age 48 with type II diabetes. Low dose cinnamon 120mg. High dose cinnamon 360mg. Cinnamon extract tablets, 60 mg each, prepared from the bark of Chinese Cinnamomum aromaticum	• FBG levels • triglycerides • HDL • LDL • total cholesterol • liver transaminase	significant change in pre & post HA1C or FBG. Both the HbA1c and FBG levels were significantly reduced in post treatment in the low and high dose groups. HbA1c reduced an average of 0.67% (P = .003) in the low dose group and reduced an average of 0.92% (P = 0.0004) in the high dose group. The FBG reduced an average of 1.10 mmol/L (P = .002)in the low dose group and reduced an average of 1.62 mmol/L (P = .00008) in the high dose group. Triglyceride levels were reduced in the low dose group (P = .007). Total cholesterol, HDL, LDL, and liver transaminases remained unchanged in the 3 groups.
3. Crawford, P. (2009).	Multiple trials in the past have shown	109 type 2 diabetics (HbA1C >7.0) were	Cinnamon Cassia 500 mg 2	• HbA1c levels	Cinnamon lowered HbA1c 0.83% (95% Cl, 0.46 - 1.20)

Effectiveness of cinnamon for lowering hemoglobin A1C in patients with type 2 diabetes: A randomized, controlled trial. *Journal of the American Board of Family Medicine : JABFM, 22*(5), 507-512. doi:10.3122/jabfm.2009.05.080093	conflicting results of whether cinnamon lowers glucose or hemoglobin A1C (HbA1C). The purpose of this study was to determine whether cinnamon lowers HbA1C in patients with type 2 diabetes. In this study a randomized, controlled trial was performed to evaluate whether daily cinnamon plus usual care versus usual care alone lowers HbA1c.	randomized from 3 primary care clinics caring for pediatric, adult, and geriatric patients at a United States military base. Participants were randomly allocated to either usual care with management changes by their primary care physician or usual care with management changes plus cinnamon capsules, 1g daily for 90 days. HbA1c was drawn at baseline and 90 days and compared with intention-to-treat analysis. This study was approved by an institutional review board.	tabs daily Usual diabetic medications, no placebo		(P < .001) compared with usual care alone lowering HbA1c 0.37% (95% Cl, 0.15 - 0.59) (P < .16).
4. Sharma, P., Sharma, S., Agrawal,	The aim of this study was to evaluate efficacy of cinnamon	One hundred and fifty newly diagnosed	• Cinnamon 1 g capsules at breakfast, lunch	• HbA1c levels • FBG levels • SBP	After three months of supplementation there was a significant improvement in

R., P., Agrawal, V., & Singhal, S. (2012). A randomized double blind placebo control trial of cinnamon supplementation on glycemic control and lipid profile in type 2 diabetes mellitus. *Australian Journal of Herbal Medicine, 24*(1), 4-9. Retrieved from	supplementation on blood sugar, HbA1c, serum cholesterol, triglyceride, LDL, and HDL levels in newly diagnosed type 2 diabetes mellitus (T2DM).	individuals with T2DM were selected randomly. After one month stabilization period, 150 patients were divided into three groups 1, 2, and 3 given type A, B, C capsules blindly bearing distinctive code number. All three groups were also given conventional treatment i.e. diet and exercise for 3 months. Antropometric parameters, blood pressure, blood sugar, HbA1c and lipid profiles were preformed initially after 1 and 3 months of treatment. After 3 months decoding was done and analyzed data by ANOVA, t and r	and dinner for 3g daily • Cinnamon 2 g capsules at breakfast, lunch, and dinner for 6g daily (Type - extract or cassia not specified) • Time – 0, 1, and 3 months • Conventional treatment of diet and exercise	• Cholesterol • HDL • LDL • Triglycerides • BMI	FBS and HbA1c in both groups (3 gm FBS was 226.73 +/- 21.43 to 115.6 +/- 23.03, $p < 0.001$, in HbA1c 8.47 +/- 1.02 to 7.29 +/- 0.83, $p < 0.005$, in 6 gm FBS was 216.94 +/- 26.27 to 112.26 +/- 22.85 and HbA1c was 8.10 +/- 0.84 to 7.25 +/- 0.81, $p < 0.005$). In BMI no significant difference was observed. There was a significant difference in systolic blood pressure (3 gm doses 130.75 +/- 14.10 to 126.60 +/- 13.16, $p < 0.005$, and in 6 gm 126.8 +/- 13.73 to 121.65 +/- 11.34, $p < 0.001$). In 3 gm doses changes in cholesterol level, LDL, triglyceride and HDL were significant (190.16 +/- 25.19 to 164 +/- 17.82; 109.69 +/- 14.89 to 96.80 +/- 8.77; 213.5 +/- 40.14 to 146.04 +/- 38.34 and 40.148 +/- 6.16 to 45.43 +/- 0.27, $p < 0.001$, respectively). In 6 gm cholesterol was 188.04 +/- 20.83 to154.31 +/- 17.94;

https://ezproxy.southern.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=2011688521&site=ehost-live&scope=site		test.			LDL 102.51 +/- 21.70 to 90.85 +/- 19.10; triglyceride 206.50 +/- 72.50 to147.28 +/- 51.29 and HDL was 43.73 +/- 11.77 to 69.78 +/- 8.66, p < 0.001.
5. Anderson, R. A., Zhan, Z., Luo, R., Guo, X., Guo, Q., Zhou, J., . . . Stoecker, B. J. (2010). Cinnamon extract lowers glucose, insulin and cholesterol in people with	The purpose of this study was to evaluate the effects of cinnamon on circulating glucose, lipids, insulin, and insulin resistance in the Chinese population.	A total of 137 Chinese participants with type 2 diabetes were randomly assigned to two groups in this double blind placebo-controlled trial. The cinnamon group took one 250 mg cinnamon capsule BID for a total of 500 mg. The control group received placebo capsules	• Cinnamon cassia water dried extract 250 mg BID for a total of 500 mg for 2 months • 100 g of white steamed bread (equivalent to 75 g of carbohydrate)	• Fasting and 2 hour serum blood glucose • Insulin resistance • Serum lipids • Fructosamine • SBP & DBP	After 2 mo, fasting glucose decreased ($p < 0.001$) in the cinnamon extract-supplemented group (8.85 ± 0.36 to 8.19 ± 0.29 mmol/L) compared with the placebo group (8.57 ± 0.32 to 8.44 ± 0.34 mmol/L, $p = 0.45$). Glucose 2 h after a 75 g carbohydrate load, fasting insulin, and HOMA-IR also decreased with cinnamon extract compared with placebo. Total and LDL-

elevated serum glucose. *Journal of Traditional and Complementary Medicine*, doi: 10.1016/jtcme.2015.03.005		which contained 250 mg of dark brown (baked) wheat flour and were very similar in appearance to the cinnamon extract.			cholesterol decreased with cinnamon extract and HDL-cholesterol decreased in both the cinnamon-extract and placebo groups. In conclusion, supplementation with 500 mg of water-extract of cinnamon for two months reduced fasting insulin, glucose, total cholesterol, and LDL cholesterol and enhanced insulin sensitivity of subjects with elevated blood glucose.
6. Vafa, M., Mohammadi, F., Shidfar, F., Sormaghi, M. S., Heidari, I., Golestan, B., & Amiri, F. (2012). Effects of cinnamon consumption on glycemic status, lipid	The purpose of this study was to evaluate the effects of the daily intake of three grams cinnamon over eight weeks on glycemic status, lipid profiles and body composition in type 2 diabetic patients.	A double blind, randomized, placebo controlled, clinical trial was conducted on 44 patients with type 2 diabetes. Participants were randomly assigned to take either a three g per day cinnamon supplement (*n*=22) or a placebo (*n*=22)	• Cinnamon zeylanicum (cinnamon verum or "true cinnamon") 500 mg 2 tabs at each main meal daily for total of 3 g daily for eight weeks	• FBG levels • HbA1c • Triglyceride • Weight • BMI and body fat mass	From 44 subjects participated in this study 37 completed the study. There were no significant differences in baseline characteristics, dietary intake and physical activity between groups. In the treatment group, the levels of fasting blood glucose, HbA1c, triglyceride, weight, BMI and body fat mass decreased significantly

profile and body composition in type 2 diabetic patients. *International Journal of Preventive Medicine*, *3*(8), 531.		for eight weeks. Weight, height, body fat mass and systolic and diastolic blood pressure were measured at baseline and after intervention. The fasting blood glucose, insulin, HbA1c, total cholesterol, LDL C, HDL C, Apo lipoprotein A I and B were measured at baseline and endpoint.			compared to baseline, but not in placebo group. No significant differences were observed in glycemic status indicators, lipid profile and anthropometric indicators between the groups at the end of intervention.
7. Vanschoonbeek, K., Thomassen, B. J., Senden, J. M., Wodzig, W. K., & van Loon, L. J. (2006).	The objective of this study was to investigate the effects of cinnamon supplementation on insulin sensitivity and/or glucose tolerance and blood lipid profile in patients with type 2	A total of 25 postmenopausal women diagnosed with type 2 diabetes were selected to participate in this study. Subjects were assigned to a control (n = 13) or placebo group (n =	• Cinnamon Cassia 1 500 mg capsule at breakfast, lunch, and dinner daily for total of 1500 mg daily • Time – 0, 2, and 6 weeks	• FPG levels • Whole-body insulin sensitivity • Glucose tolerance • Blood lipid levels	No significant changes were noted in whole-body indices, fasting plasma glucose, HbA1c, glucose tolerance, or blood lipid profile compared to placebo group after cinnamon supplementation ($P > 0.05$). We conclude that cinnamon supplementation of 1.5 g/d does not improve

Cinnamon supplementation does not improve glycemic control in postmenopausal type 2 diabetes patients. *The Journal of Nutrition, 136*(4), 977-980. doi:136/4/977 [pii]	diabetes.	12), matched for age, BMI, years since diagnosis with type 2 diabetes, fasting blood glucose concentration, and medication. Subjects were studied over a 6- to 7-wk period in a double-blind, placebo-controlled trial. Whole-body insulin sensitivity or oral glucose tolerance were estimated by performing an OGTT before (wk 0) and after 2 (wk 2) and 6 wk (wk 6) of supplementation.			whole-body insulin sensitivity or oral glucose tolerance and does not modulate blood lipid profile in postmenopausal patients with type 2 diabetes.

8. Blevins, S. M., Leyva, M. J., Brown, J., Wright, J., Scofield, R. H., & Aston, C. E. (2007). Effect of cinnamon on glucose and lipid levels in non insulin-dependent type 2 diabetes. *Diabetes Care, 30*(9), 2236-2237. doi:dc07-0098 [pii]	The purpose of this study was to report the effects of cinnamon on lipid levels and glucose in the Western diabetic population.	This trial was randomized double blinded placebo controlled trial with 57 subjects. Enrolled subjects received either 500 mg of cinnamon cassia or placebo (wheat flour) capsules. Subjects were instructed to ingest one capsule with breakfast and one with dinner for 3 months.	• Cinnamon Cassia one 500 mg capsule at breakfast and dinner totaling 1g daily • Time – 1, 2, 3 months	• FBG levels • Lipid levels • HbA1c • Insulin levels	Cinnamon intake of 1g daily for 3 months produced no significant change in fasting glucose, lipids, HbA1c, or insulin levels from baseline to 1, 2, and 3 months ($P > 0.05$).

9. Akilen, R., Tsiami, A., Devendra, D., & Robinson, N. (2010). Glycated haemoglobin and blood pressure-lowering effect of cinnamon in multi-ethnic Type 2 diabetic patients in the UK: a randomized, placebo-controlled, double-blind clinical trial. *Diabetic Medicine*, *27*(10), 1159-1167.	The purpose of this study was to determine the blood glucose lowering effect of cinnamon on HbA1c, blood pressure, and lipid profiles in people with type 2 diabetes.	Fifty eight type 2 diabetic patients (25 males and 33 females) treated only with hypoglycemic agents and with a HbA1c more than 7% were randomly assigned to receive either 2 g of cinnamon or placebo daily for 12 weeks.	• Cinnamon cassia four 500 mg capsules daily, one with breakfast, two with lunch, and one with dinner for 12 weeks • Four 500 mg starch-filled placebo capsules daily, one with breakfast, two with lunch, and one with dinner for 12 weeks	• HbA1c • SBP • DBP	After intervention, the mean HbA1c was significantly decreased ($P<0.005$) in the cinnamon group (8.22% to 7.86%) compared with placebo group (8.55% to 8.68%). Mean systolic and diastolic blood pressures (SBP and DBP) were also significantly reduced ($P<0.001$) after 12 weeks in the cinnamon group (SBP: 132.6 to 129.2 mmHg and DBP: 85.2 to 80.2 mmHg) compared with the placebo group (SBP: 134.5 to 134.9 mmHg and DBP: 86.8 to 86.1 mmHg). A significant reduction in fasting plasma glucose (FPG), waist circumference and body mass index (BMI) was observed at week 12 compared to baseline in the cinnamon group, however, the changes were not significant when compared to placebo group. There were no significant differences in serum lipid

					profiles of total cholesterol, triglycerides, HDL and LDL cholesterols, neither between nor within the groups.

10. Al-Yasiry, K., Kathum, W., & Al-Ganimi, Y. (2014). Evaluation of Anti-Diabetic Effect of Cinnamon in Patients with Diabetes Mellitus Type Ii in Kerbala City. *Journal of Natural Sciences Research*, *4*(4), 43-45.	This study aimed to determine the hypoglycemic effect of cinnamon in patients with type 2 diabetes as adjuvant therapy.	Forty male patients with type 2 diabetes taking oral anti-diabetic drug(s) were randomly selected for this quasi-experimental trial. They were given a crude grind cinnamon 15 minutes after each meal for 3 months.	• 0.5 gm Cinnamon (crude, ground) after each meal, totaling 1.5 gm daily for 3 months	• FBS • RBS • HbA1c • Weight	Results showed cinnamon had a significant antidiabetic effect in reduction of FBS, RBS, & HbA1c. No significant results were seen in reduction of body weight ($P < 0.01$).
11. Mang, B., Wolters, M., Schmitt, B., Kelb, K., Lichtinghagen, R., Stichtenoth, D. O., &	The aim of this trial was to determine whether an aqueous cinnamon purified extract improves glycated haemoglobin A1c (HbA_{1c}), fasting	A total of 79 patients with diagnosed diabetes mellitus type 2 not on insulin therapy but treated with oral antidiabetics or diet were randomly	• Cinnamon cassia (aqueous cinnamon extract) 112 mg capsules which corresponds to 1 g of cinnamon for a total of 3 g	• FPG • HbA1c • Lipid levels	The mean absolute and percentage differences between the pre- and post-intervention fasting plasma glucose level of the cinnamon and placebo groups were significantly different. There was a significantly higher

Hahn, A. (2006). Effects of a cinnamon extract on plasma glucose, HbA1c, and serum lipids in diabetes mellitus type 2. *European journal of clinical investigation*, *36*(5), 340-344.	plasma glucose, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL) and triacylglycerol concentrations in patients with type 2 diabetes.	assigned to take either a cinnamon extract or a placebo capsule three times a day for 4 months in a double-blind study. A total of 65 subjects completed the study. The amount of aqueous cinnamon extract corresponded to 3 g of cinnamon powder per day.	daily for 4 months • Placebo capsules containing microcrystalline cellulose only		reduction in the cinnamon group (10·3%) than in the placebo group (3·4%). No significant intragroup or intergroup differences were observed regarding HbA_{1c}, lipid profiles or differences between the pre- and postintervention levels of these variables. The decrease in plasma glucose correlated significantly with the baseline concentrations, indicating that subjects with a higher initial plasma glucose level may benefit more from cinnamon intake. No adverse effects were observed.
12. Ziegenfuss, T. N., Hofheins, J. E., Mendel, R. W., Landis, J., & Anderson, R. A. (2006). Effects of a	The purpose of this study was to determine the effects of supplementation with a water-soluble cinnamon extract (Cinnulin PF®) on body composition and features of the metabolic syndrome.	Twenty-two subjects with prediabetes and the metabolic syndrome were randomly assigned to supplement their diet with either Cinnulin PF® (500 mg/d) or a placebo for 12-weeks. Main	• Cinnulin PF two 250 mg capsules BID with breakfast and dinner daily for a total of 1g daily (500 mg of Cinnulin is equivalent to 10 g of whole	• FBG • SBP • Body mass	Subjects in the Cinnulin PF® group had significant decreases in FBG (-8.4%: 116.3 ± 12.8 mg/dL [pre] to 106.5 ± 20.1 mg/dL [post], $p < 0.01$), SBP (-3.8%: 133 ± 14 mm Hg [pre] to 128 ± 18 mm Hg [post], $p < 0.001$), and increases in lean mass (+1.1%: 53.7 ± 11.8 kg [pre]

water-soluble cinnamon extract on body composition and features of the metabolic syndrome in pre-diabetic men and women. *Journal of the International Society of Sports Nutrition*, *3*(2), 45.		outcome measures were changes in FBG, SBP, and body composition measured after 12-weeks of supplementation.	cinnamon powder, i.e., 20:1 extract) • Placebo two 250 mg capsules BID with breakfast and dinner daily for a total of 1g daily (substance of placebo capsule not specified)		to 54.3 ± 11.8 kg [post], $p < 0.002$) compared with the placebo group. Additionally, within-group analyses uncovered small, but statistically significant decreases in body fat (-0.7%: 37.9 ± 9.2% [pre] to 37.2 ± 8.9% [post], $p < 0.02$) in the Cinnulin PF® group. No significant changes in clinical blood chemistries were observed between groups over time.
13. Suppapitiporn, S., & Kanpaksi, N. (2006). The effect of cinnamon cassia powder in	The objective of the present study was to investigate the anti-diabetic effect of cinnamon cassia powder in type 2 diabetic patients	Sixty type 2 diabetic patients were randomized either 1.5 g/d of cinnamon cassia powder or placebo. Both groups were in combination with their current	• Cinnamon cassia 1.5 g daily (frequency not specified) • Placebo 1.5 g daily(frequency and substance of placebo not specified)	• HbA1c • FPG • Lipids • LFT	After a 12-week period, HbA1c was decreased similarly in both groups from 8.14% to 7.76% in the cinnamon group and from 8.06% to 7.87% in the placebo group. This was not found statistically significantly different.

type 2 diabetes mellitus. *Journal of the Medical Association of Thailand= Chotmaihet thangphaet*, *89*, S200-5.		treatment (metformin or sulfonylurea) according to single blind randomized, placebo-control trial in a 12-week period. Efficacy was evaluated by HbA1c fasting plasma glucose, Lipid profile, BUN, creatinine, liver function test and adverse effects were recorded.			However the proportion of patients achieving HbA1c < or = 7% was also greater in patients receiving cinnamon compared with patients receiving placebo, nevertheless, it was not found statistically significantly different (35% vs 15%, x2 = 3.14, p > 0.05). No significant intergroup differences were observed in lipid profile, fasting plasma glucose except in SGOT 27.1 (8.75) to 22.1 (5) in cinnamon group and 24.08 (8.5) to 23.63 (8.88) in the placebo group (p = 0.001).
14. Khan, R., Khan, Z., & Shah, S. (2010). Cinnamon may reduce glucose, lipid and cholesterol level in type 2 diabetic individuals.	This study was initiated to confirm the researcher's previous findings that cinnamon intake reduces glucose, triglycerides and cholesterol in type 2 diabetic individuals.	This study consisted of 14 type 2 diabetics randomly divided into two equal groups. One group was assigned 1.5 g cinnamon daily and the was assigned 1.5 g of placebo daily	• Ground cinnamon one 0.5 g capsule at breakfast, lunch, and dinner for total of 1.5 g daily • Placebo of maze flour one 0.5 g capsule at breakfast, lunch, and	• FBG • Lipids	Results show significant reduction in FBG (P, 0.05), triglycerides (P < 0.05) and cholesterol levels (P < 0.05), but no significant reduction in HDL and LDL levels.

Pakistan J Nutr, 9(5), 430-433.			dinner for total of 1.5 g daily		
15. Roussel, A. M., Hininger, I., Benaraba, R., Ziegenfuss, T. N., & Anderson, R. A. (2009). Antioxidant effects of a cinnamon extract in people with impaired fasting glucose that are overweight or obese. *Journal of the American College of Nutrition, 28*(1), 16-21.	To determine the effects of a dried aqueous extract of cinnamon on antioxidant status of people with impaired fasting glucose that are overweight or obese.	Twenty-two subjects, with impaired fasting blood glucose with BMI ranging from 25 to 45, were enrolled in a double-blind placebo-controlled trial. Subjects were divided randomly into two groups and given capsules containing either a placebo or 250 mg of an aqueous extract of cinnamon (Cinnulin PF) two times per day for 12 weeks.	• Cinnamon cinnulin PF 250 mg BID for 12 weeks • Placebo 250 mg BID for 12 weeks (substance in placebo not specified) • Blood sample times – 0, 6, and 12 weeks	• FBG • Fasting insulin • Plasma malondialdehyde (MDA) concentrations • Plasma antioxidant status (evaluated by FRAP assay)	FRAP and plasma thiol (SH) groups increased, while plasma MDA levels decreased in subjects receiving the cinnamon extract. Effects were larger after 12 than 6 weeks. There was also a positive correlation ($r = 0.74$; $p = 0.014$) between MDA and plasma glucose. Significant reduction was seen in the fasting glucose of the cinnamon group compared to the placebo group ($P < 0.05$). No significant reduction was seen in the fasting insulin in either group.