Effect of Cinnamon Supplementation on Lowering HBA1C in Patients with Diabetes Mellitus Type II

Afeefah Marfani

Pacific University

Follow this and additional works at: http://commons.pacificu.edu/pa

Part of the Medicine and Health Sciences Commons

Recommended Citation
Effect of Cinnamon Supplementation on Lowering HBA1C in Patients with Diabetes Mellitus Type II

Abstract
Background: For years cinnamon has been used in treating a variety of ailments, in addition to its use as a spice. Recently, researchers have been looking at supplementation of cinnamon and its affect on Diabetes Mellitus Type 2 (DM II), a chronic condition that many people suffer from across the globe. Cinnamon may help in reducing the HBA1C because of its insulin potentiating activity. The purpose of this systematic review was to investigate the efficacy of cinnamon on lowering HBA1C levels.

Methods: An extensive search using CINAHL, MEDLINE, Evidence Based Medicine Reviews Multifile and Web of Science was performed. Included in the search were non-insulin and insulin dependent DM II participants of either gender, any age, and from any country. Only randomized control trials were included in this systematic review. Studies that evaluated the effect of cinnamon on HBA1C, lipids, and fasting plasma glucose were included, only to extract the data in relation HBA1C.

Results: The initial search resulted in 30 articles. Of those, only 4 were randomized control trials that analyzed the efficacy of cinnamon supplementation on HBA1C levels were identified. Thus, 4 articles were included in this systematic review.

Conclusion: This systematic review illustrates that the efficacy of cinnamon supplementation on HBA1C is statistically insignificant, and the data thus far does not strongly support its use. Further research should analyze different variables, such as age, gender, race, insulin sensitivity, diet and diabetic regimen. Future research should also analyze any synergistic relationship that cinnamon supplementation may have with different diabetes medications. At this time, cinnamon supplementation for the purpose of controlling diabetes is not recommended. However, future studies may reveal that medicinal cinnamon is beneficial. As it is inexpensive, readily available, and potentially free of side effects, further investigation is warranted.

Degree Type
Capstone Project

Degree Name
Master of Science in Physician Assistant Studies

First Advisor
Anya Hill RN, PA-C, MS

Second Advisor
Anjanette Sommers MS, PAC

Third Advisor
Rob Rosenow PharmD, OD

This capstone project is available at CommonKnowledge: http://commons.pacificu.edu/pa/226
Copyright and terms of use

If you have downloaded this document directly from the web or from CommonKnowledge, see the “Rights” section on the previous page for the terms of use.

If you have received this document through an interlibrary loan/document delivery service, the following terms of use apply:

Copyright in this work is held by the author(s). You may download or print any portion of this document for personal use only, or for any use that is allowed by fair use (Title 17, §107 U.S.C.). Except for personal or fair use, you or your borrowing library may not reproduce, remix, republish, post, transmit, or distribute this document, or any portion thereof, without the permission of the copyright owner. [Note: If this document is licensed under a Creative Commons license (see “Rights” on the previous page) which allows broader usage rights, your use is governed by the terms of that license.]

Inquiries regarding further use of these materials should be addressed to: CommonKnowledge Rights, Pacific University Library, 2043 College Way, Forest Grove, OR 97116, (503) 352-7209. Email inquiries may be directed to: copyright@pacificu.edu

This capstone project is available at CommonKnowledge: http://commons.pacificu.edu/pa/226
NOTICE TO READERS

This work is not a peer-reviewed publication. The Master’s Candidate author of this work has made every effort to provide accurate information and to rely on authoritative sources in the completion of this work. However, neither the author nor the faculty advisor(s) warrants the completeness, accuracy or usefulness of the information provided in this work. This work should not be considered authoritative or comprehensive in and of itself and the author and advisor(s) disclaim all responsibility for the results obtained from use of the information contained in this work. Knowledge and practice change constantly, and readers are advised to confirm the information found in this work with other more current and/or comprehensive sources.

The student author attests that this work is completely his/her original authorship and that no material in this work has been plagiarized, fabricated or incorrectly attributed.
Effect of Cinnamon Supplementation on Lowering HBA1C in Patients with Diabetes Mellitus Type II

Afeefah Marfani

A Clinical Graduate Project Submitted to the Faculty of the School of Physician Assistant Studies
Pacific University
Hillsboro, OR
For the Masters of Science Degree, August 14, 2010

Faculty Advisor: Anya Hill RN, PA-C, MS
Clinical Graduate Project Coordinators: Annjanette Sommers MS, PAC & Rob Rosenow PharmD, OD
Biography
Afeefah Marfani is a native of Houston, Texas. She obtained her Bachelors of Science degree in Psychology and Biology at the University of Houston in 2005. Her work experience for the past 11 years includes dentistry, pharmacy, and investment banking. After 26 years of living in Houston, Texas she moved to Oregon to pursue her goal of become a Physician Assistant and plans to graduate in August 2010. After graduation she plans on moving back to Houston, to give back to her community. She is ever so grateful for the support of her family and friends throughout this journey.
Abstract

**Background:** For years cinnamon has been used in treating a variety of ailments, in addition to its use as a spice. Recently, researchers have been looking at supplementation of cinnamon and its affect on Diabetes Mellitus Type 2 (DM II), a chronic condition that many people suffer from across the globe. Cinnamon may help in reducing the HBA1C because of its insulin potentiating activity. The purpose of this systematic review was to investigate the efficacy of cinnamon on lowering HBA1C levels.

**Methods:** An extensive search using CINAHL, MEDLINE, Evidence Based Medicine Reviews Multifile and Web of Science was performed. Included in the search were non-insulin and insulin dependent DM II participants of either gender, any age, and from any country. Only randomized control trials were included in this systematic review. Studies that evaluated the effect of cinnamon on HBA1C, lipids, and fasting plasma glucose were included, only to extract the data in relation HBA1C.

**Results:** The initial search resulted in 30 articles. Of those, only 4 were randomized control trials that analyzed the efficacy of cinnamon supplementation on HBA1C levels were identified. Thus, 4 articles were included in this systematic review.

**Conclusion:** This systematic review illustrates that the efficacy of cinnamon supplementation on HBA1C is statistically insignificant, and the data thus far does not strongly support its use. Further research should analyze different variables, such as age, gender, race, insulin sensitivity, diet and diabetic regimen. Future research should also analyze any synergistic relationship that cinnamon supplementation may have with different diabetes medications. At this time, cinnamon supplementation for the purpose of controlling diabetes is not recommended. However, future studies may reveal that medicinal cinnamon is beneficial. As it is inexpensive, readily available, and potentially free of side effects, further investigation is warranted.

**Keywords:** HBA1C, hemoglobin A1C, glycated hemoglobin A, cinnamon, cinnamomum, cinnamomum cassia, cinnamomum zeylanicum, diabetes mellitus type 2
Acknowledgements

To Ameen & Nargis Marfani, my beloved parents, my role models: First, I’d like to thank you for bringing me into this world, instilling good values and beliefs in me, providing me with all the necessities of life, and with an education—even when it surpassed geographical and linguistic boundaries. Thank you for believing in me. Thank you for your never-ending support, wisdom, prayers, and encouragement, for being a listening ear, for giving me advice—be it warranted or not, for being an outlet for my emotions, for making me laugh, and for wiping my tears. Thank you for ingraining the faith of almighty Allah in my heart. For without him, all of this would be null and void. Thank you for making me the person I am, because without you I wouldn’t be where I am today. My hope is that one day I become even half as good a parent as each of you has been to me. May Allah bless you with the best of this life and the hereafter—Amen.
# Table of Contents

Biography .................................................................................................................. 2  
Abstract ..................................................................................................................... 3  
Acknowledgements .................................................................................................... 4  
Table of Contents ....................................................................................................... 5  
List of Tables ............................................................................................................. 6  
List of Abbreviations ................................................................................................. 6  
Background ............................................................................................................... 7  
Methods ..................................................................................................................... 8  
Results ....................................................................................................................... 9  
Discussion ............................................................................................................... 13  
Conclusion .............................................................................................................. 19  
References ............................................................................................................... 21  
Tables ....................................................................................................................... 22
List of Tables

Table 1: Summary of Selected Review Articles

Table 2: Baseline and Post Trial HBA1C Comparison of the Reviewed Studies

List of Abbreviations

DM II.................................................................Diabetes Mellitus Type 2
HBA1C..........................................................Hemoglobin A1C
C. cassia......................................................Cinnamomum cassia
C. zeylanicum...............................................Cinnamomum zeylanicum
C. aromaticum..............................................Cinnamomum aromaticum
C. verum.....................................................Cinnamomum verum
Does Cinnamon Supplementation help lower HBA1C in Patients with Diabetes Mellitus Type II?

BACKGROUND

DM II is a disease that affects millions of people across the globe. It causes a number of comorbid conditions and complications; and also costs billions of dollars annually. With the increasing cost of pharmaceuticals and the risk of adverse reactions that come along with them, it is worthwhile to devote research to analyzing safe, naturally occurring, and relatively inexpensive alternative treatments for DM II. Herbal remedies have been passed down for generations to treat a variety of illnesses. One such remedy is the use of cinnamon. Cinnamon is a spice that is mainly cultivated in Asia, South America, and the Caribbean. There are two common types of cinnamon, *cinnamomum cassia* or *aromaticum* (*C. cassia* or *C. aromaticum*) and *cinnamomum verum* or *zeylanicum* (*C. verum* or *C. Zeylanicum*). Cinnamon has been used since ancient times to treat many ailments. Some common ailments that are alleviated by the use of cinnamon are nausea, diarrhea, fungus, and pain. Cinnamon is made up of many chemical components that are responsible for alleviating these symptoms. Some of these contributory constituents are eugenol, cinnamaldehyde, coumarins, and polyphenols. It is postulated by researchers that cinnamon has insulin-potentiating effects, thus allowing more insulin to be readily available for cellular glucose uptake. There have been many studies that have conducted in vivo and in vitro trials to analyze the relationship that cinnamon has with insulin. Such studies demonstrate that certain components of cinnamon increase insulin receptor kinase activity and glycogen synthesis, in addition to inducing phosphorylation of insulin receptors. This means that components in cinnamon stimulate insulin receptors, inhibit the enzyme that inactivates insulin receptors, and help the liver utilize glycogen, thus allowing for glucose to be taken up by the cells. Further research and investigation is needed to evaluate the chemical components of cinnamon and their effect on insulin activity. Thus far, there have been conflicting data on whether cinnamon
supplementation could be a worthwhile addition to the DM II treatment regimen. The purpose of this systematic review is to focus on cinnamon supplementation and its effect on hemoglobin A1C (HBA1C) in DM II. The hope is that cinnamon can be added to the diabetes treatment plan as a relatively safe and inexpensive supplement that may benefit patients who have difficulty gaining tight control of their HBA1C. It is also hopeful that cinnamon could reduce patient financial burden, the likelihood of complications of diabetes like nephropathy, neuropathy, and retinopathy, decrease the risk of potential unknown long term affects that new diabetes medications may have, and also reduce the likelihood of adverse effects associated with poly-pharmacy.

METHODS

A detailed search using MEDLINE, CINHAL, Web of Science, and Evidence Based Medicine Reviews Multi-file was conducted without restricting the date that the studies were done. The following keywords were used in the search: “HBA1C”, “Hemoglobin A1C”, “Glycated hemoglobin A”, in combination with: “Cinnamon”, “Cinnamomum”, “Cinnamomum Cassia”, “Cinnamomum aromaticum”, “Cinnamomum zeylanicum”, “Cinnamomum verum”, in combination with: “Diabetes Mellitus Type 2” and “DM II”. Results were limited to clinical trials in humans. A search of references was also conducted within the articles that were selected for review. Articles were evaluated for validity using the Jadad score. The method of randomization and blinding were evaluated for each of the articles included in this systematic review. Articles were also evaluated for similarity of participants amongst groups, equal treatment between groups, and that each of the participants was accounted for.

To be included in this systematic review the studies had to have been randomized control trials that evaluated the relationship of cinnamon and its efficacy in lowering HBA1C in DM II. These studies did not have to be double-blind in design. The type of cinnamon supplemented was not restricted; the search included c. cassia, c. aromaticum, c. verum, and c. zeylanicum. The formulation (i.e. pill, extract, or powder) and dosage of the cinnamon supplement was not restricted. Non-insulin
dependent and insulin dependent DM II patients of either gender and of any age were included. The search was not restricted by the country in which it was conducted. Due to the minimal research available in databases regarding this topic, studies were not restricted to just those analyzing the relationship of cinnamon supplementation and HBA1C alone. Therefore, studies that analyzed HBA1C and additional factors, such as lipids and fasting plasma glucose were included. The data that analyzed the relationship of HBA1C and cinnamon supplementation was then extracted from these studies. Minimal exclusion criteria were incorporated in this search. However, type I Diabetes Mellitus patients were excluded from this search.

RESULTS

The initial search resulted in 30 articles, from 4 databases: CINAHL, MEDLINE, Evidence Based Medicine Reviews Multi-file, and Web of Science. Of those, 4 were randomized control trials that evaluated the relationship of cinnamon supplementation to its affect on HBA1C levels were selected. The remaining 26 did not meet the population, exclusion, and/or inclusion criteria that were set prior to conducting the literature search. See Table 1 for a summary of the included studies.

The first study that was reviewed was conducted by Crawford,\(^9\) published in 2009. The study’s objective was to determine the efficacy of cinnamon supplementation on lowering HBA1C levels in Type II Diabetics. He recruited participants for the study via phone calls from volunteers to patients from the 96\(^{th}\) Medical Group, Eglin Air Force Base in Florida. Inclusion criteria for the participants were as follows, HBA1C of $\geq 7$ within 6 months prior to the study, greater than 18 years of age, and of either gender. Exclusion criteria were as follows, participants that were pregnant, $<$18 years of age, and those that had a cinnamon allergy. Other variables that were considered were race, BMI, insulin use, addition or removal of diabetic medication during the trial, and cinnamon intake prior to the study. Neither the participants nor the investigators were blinded, but the lab personnel were blinded to which samples belonged to either the control or treatment group. 109 participants were included in the study initially, 55 were assigned to the treatment group and 54 to the control group. Male and female
participants were noted for the original 109, but gender was not specified in each of the groups for the actual number who completed the trial. Out of the 109 participants there were 32 males and 23 females in the treatment group, and 32 males and 22 females in the control group. There were 9 participants disqualified from the treatment group for reasons of rash (1), relocation (1), inconvenience (2), and unknown (5). Therefore, a total of 46 participants in the treatment group completed the study. Of the 54 participants in the control group, 11 were disqualified because they forgot about enrollment in the trial (1), inconvenience (2), and unknown (8). This resulted in 43 participants in the control group completing the study. Average age in the treatment group was 60.5 +/- 10.7 and 59.9 +/- 9.2.9

The participants in treatment and control group were measured for their baseline HBA1C at the beginning and also at 90 days. Follow-up HBA1C was obtained from days 90 to 95. The treatment group was treated with 2 tablets of 500mg C. cassia for a 3 month period, in addition to continuing their normal diabetic therapy. The control group participants were not given any form of placebo, but were to continue their normal diabetic therapy. Compliance in the groups was monitored via phone interview towards the end of the trial period. Crawford carried out an intention to treat analysis of the initial 109 participants. The baseline HBA1C in the treatment group was 8.47 +/- 1.8 and post treatment HBA1C was 7.64 +/- 1.7. Cinnamon lowered HBA1C 0.83% (95% CI, 0.45-1.20). This produced a p value of <.001. The baseline HBA1C in the control group was 8.28 +/- 1.3 and the post treatment HBA1C was 7.9 +/- 1.5. The usual care lowered HBA1C by 0.37% (95% CI, 0.15-0.59), producing a P value of 0.16. Values between baseline and final HBA1C were compared with an unpaired 2 sample t-test. This study found that cinnamon supplementation may be worthwhile to initiate in patients with poor control of their DM II.9

The second study reviewed led by Mang et al10 was published in 2006. In this study, the objectives were to analyze the effect of cinnamon extract on plasma glucose, HBA1C, and serum lipids in patients with DM II. For the purpose of this review, HBA1C was the only result that was analyzed. There were 79 patients from Hannover, Germany selected for the study. Included in the study were
patients with DM II on oral anti-diabetic medication or those who had diet controlled diabetes. Excluded were those on insulin therapy. It is assumed that there were no specific inclusion or exclusion criteria with regard to any demographic data, since no such criteria were mentioned in the methods section. Variables that were taken into account in addition to participant demographics, were time since diagnosis, height, weight, BMI, and waist circumference. The study stated that a double blind method of randomization was used. Of the 79 patients selected for the study, 2 were withdrawn from the study because of weight changes of ≥5% during the trial period, 7 withdrew consent, 4 had serious disease, and 1 for irregular intake of the study preparation. Therefore, 65 participants actually were included in the trial. 33 patients were assigned to the treatment group and 32 to the control group. In the treatment group there were 21 men and 12 women, and in the control group there were 23 men and 9 women. Average age of the treatment group was 62.8 +/- 8.37 and 63.7 +/- 7.17 in the control group.

The treatment group was assigned to take one 112mg capsule of cinnamon extract (equal to 1 gram of cinnamon) 3 times daily. The control group was given an identical tablet that contained crystalline cellulose and they were to take it 3 times daily. The trial period lasted 4 months. Baseline and end of trial HBA1C were obtained in each of the groups. Compliance was monitored by capsule count and missed pills were logged into a diary. The baseline HBA1C in the treatment group was 6.86 +/- 1.00 and the post trial result was 6.83 +/- 0.83. Thus resulting in a difference of 0.05 +/- 0.43. The baseline HBA1C in the control group was 6.71 +/- 0.73 and the post trial result was 6.68 +/-0.70. Thus resulting in a difference of 0.03 +/-0.79. No significant results were observed within or between the groups with regard to HBA1C levels.

The third study that was reviewed was conducted by Blevins et al and was published in September 2007. This study was conducted at the University of Oklahoma and analyzed cinnamon supplementation and its affect on fasting plasma glucose, cholesterol, HBA1C, and insulin levels. BMI was also taken into account for each of the groups. For the purpose of this review, only the HBA1C
results will be analyzed. Participants were contacted via a campus listserv and also through the local paper. Inclusion criteria were as follows, people of any age with DM II. Excluded were those that had insulin dependent DM II, those already using cinnamon supplementation, if they had an HBA1C of <6%, or if they had an acute illness. Also, participants were not able to initiate or withdraw from certain medications during the trial period.¹¹

There were 77 participants selected for the trial. This study stated that participants were assigned to groups in a randomized fashion, but the method of randomization was not explained. Out of the 77 participants selected, 17 were disqualified. 14 people had HBA1C level <6% and 3 participants had acute illnesses. Out of the remaining 60 participants, only 43 completed the study. Participants that did not complete the trial were those that had a change in their diabetic or cholesterol regimen (5), began to take cinnamon supplementation not authorized by the study (1), motor vehicle accident (1), inconvenience (1), dissatisfaction with the trial (1), and relocation (1). There were 57 participants included in the intention to treat analysis. This study did not specify the number of men and women in each of the groups, nor did it give the average age of the participants. The treatment group was given 500mg *C. cassia* capsules and the control group was given 500mg placebo wheat flour capsules, to be taken twice daily for 3 months. HBA1C were measured at baseline and at 3 months, which was the end of the trial period. Pretrial A1C was 7.2 +/- 0.3 and 7.1 +/- 0.2, respectively in the treatment and control group (p=0.60). The change in HBA1C in the treatment group was 0.2 +/- 0.1 and 0.1 +/- 0.2 in the control group (p=0.63). No significant change in HBA1C between the treatment and the control group was observed.¹¹

The last of the studies in this systematic review was conducted by Suppapitiporn et al¹², published in 2006. The participants were from the King Chulalongkorn Memorial Hospital in Thailand. The study focused on the effect *C. cassia* powder has on plasma glucose, lipid profile and HBA1C. Other variables that were taken into account were body weight, BMI, and number of years since diagnosis. BUN, creatinine, SGOT, SGPT, and blood pressure were monitored during the trial.
For the purpose of this review, only HBA1C data was extracted for analysis. Inclusion criteria were as follows, participants had to take their regular diabetes medications at least for 3 months prior to enrollment in the study, needed to be between the age of 30-70, have a HBA1C >7% within one month prior to enrolling in the study, with a fasting plasma glucose of 120-180mg/dl, and those that were females of childbearing age were to have proper form of contraception. Excluded were those with DM I; or DM II patients treated with insulin within 3 months prior to the study, diabetes linked to chronic pancreatitis, hemochromatosis, genetic defect in insulin action, disorders of b-cell function, renal disease, liver disease, or those with poorly controlled DM II due to concurrent illness, infection, or surgery.12

The study included 60 participants, 20 were assigned to the treatment group and 40 to the placebo group. There were 32 women and 28 men participating in the study. There were 8 men and 20 women in the treatment group and 20 of each gender in the control group. The average age for participants in the treatment group was 59.90 (+/-8.65) and 58.53 (+/-8.69) in the control group. The study lasted 3 months, the treatment group was given 1.5 grams of C. cassia capsules 3 times a day with meals and the control group took a placebo capsule three times a day. Pre and post trial HBA1C were obtained for all participants. Compliance was logged by capsule count and interviewing the participants. The baseline HBA1C in the treatment group was 8.14 (Mean SD=1.10) and 8.06 (Mean SD =1.05) in the control group. The post trial HBA1C in the treatment group was 7.76 (Mean SD=0∑95) and 7.87 (mean SD=0∑96) in the control group. The p value was 0.08, which was calculated using analysis of covariance- baseline value as covariate for the change from the baseline HBA1C. The decrease in the HBA1C of the treatment group was larger than that of the control group, but it did not have a statistically significant effect.12

DISCUSSION

This literature review was conducted to assess the efficacy of cinnamon supplementation on lowering HBA1C levels. For the most part, this review illustrates that cinnamon supplementation does
not have a statistically significant effect on lowering HBA1C (Table 1 and Table 2). The results obtained through this review show that much more research needs to be conducted. In order to add cinnamon supplementation to diabetic therapy, larger studies need to be conducted and need to be longer in duration than the 3 to 4 month studies examined here. Future research should focus on reducing the risk of bias, increase in the number of randomized control trials, and need to be better at clearly defining method of blinding to have stronger validity and to eliminate the likelihood of bias. These studies also need to conduct and document post trial follow up care in order to assess any potential long term effects of cinnamon supplementation. Therefore, monitoring routine labs and vital signs is necessary throughout and after the trial period. Participants should be monitored closely for medication additions or changes in dosage in their current therapies during trials, to reduce the likelihood of these changes affecting the HBA1C and masking the true results of cinnamon supplementation therapy. Obtaining information on comorbid conditions or genetic disorders of insulin activity that may play a factor in the participant’s DM II will also advance research. Additional research should analyze if there is a relationship between the different types and forms of cinnamon supplementations and lowering HBA1C levels. Another factor to consider is if certain races have differing results with cinnamon supplementation. Also, it would be beneficial to focus on insulin sensitivity levels and glucose tolerance prior to enrolling participants in these trials, thus assessing the degree of control in DM II. Furthermore, information about diet, activity level, and lifestyle of the participants may provide better data when assessing the treatment effect. Another thing to consider is whether or not participants in the control group were aware that the placebo was not cinnamon, simply due to the smell. Finally, one can realize that further research is needed, and better studies need to be conducted in the future to deduce whether cinnamon supplementation has a significant effect on lowering HBA1C levels. Adding cinnamon to the diabetic regimen at this point in research seems futile. The four studies that were included in this review will individually be analyzed hereafter.
The study led by Crawford\textsuperscript{9} was the first to be reviewed. This study had some definite strengths and weaknesses. One of the strengths of this study was that it was the largest analyzed in this review. However, the actual number of participants completing the study was much lower than the number they used—since they used the results of the intention to treat analysis. The study selected participants from a patient database at the Eglin Air Force Base in Florida.\textsuperscript{9} This means that those that were selected had a documented history of disease and that it was fairly easy to recognize that they met the inclusion criteria for the study. This is far better than relying on patient self-reporting. All participants attended an information session about the study and also signed an informed consent form. The participants were to complete an 11 question survey regarding their prescription drug therapy, insulin use, and prior cinnamon intake (type, form, dose, supplement, and/or through diet).\textsuperscript{9} The results to the questionnaire were compared to the participant’s medical record for accuracy. This questionnaire is helpful in confirming the inclusion criteria of the participants. One downside to this trial was that those that were taking cinnamon prior to the trial were not excluded, but were rather encouraged to continue their pretrial cinnamon regimen. To see the true effect, participants that had never tried cinnamon supplementation and those not taking cinnamon regularly in their diet should have been the only ones to have been included in the trial. Furthermore, participants were randomized using a method called blocking. This method put the names of the participants in groups of 10 on a piece of paper, half were designated as treatment group and the other half as control group. The lists were created by a person not involved in the trial and so it was less likely to cause bias in the assignment of participants to the treatment versus control group.\textsuperscript{9} However, within the blocks of 10, the study does not specify if the participants allocated to the treatment and control group were similar in inclusion criteria. Allocation to each of the groups was revealed after drawing the participant names from a box. Neither the investigators nor the participants were blinded to the group assignment and this poses risk for bias. However, the lab personnel were blinded to group assignment of the patients and in a sense is a method of blinding. Another downside to the study, was that patients were allowed to change their
medications and adjust doses during the trial and this makes it hard to assess if the change in 
medication and/or dose adjustment or cinnamon supplementation is responsible for the effect on the 
HBA1C. Although, there were few participants who had such changes to their medications so it might 
not have influenced the results significantly. It would still have been beneficial to disqualify those 
participants from the study, in order to assess cinnamon’s true effect on HBA1C. Furthermore, since 
the participants knew their group assignment and those in the control group had no intervention, it is 
difficult to detect if the act of taking the supplement had an effect on HBA1C or if the actual cinnamon 
supplement affected the HBA1C. This would have been a stronger study if the participants had been 
blinded to the group assignment and if both groups had been given some form of intervention. 
Compliance was measured by a phone call within the last 10 days of the study9, but it would have been 
better to monitor compliance throughout the trial by capsule count and/or capsule intake diary. 
Monitoring dietary intake and activity level would have been helpful as well. The study also did not 
mention that patients had any sort of follow up care after the trial was complete. They did mention that 
HBA1C was obtained days 90 to 95 after the trial, but is not clear to the reader if it was to obtain the 
post trial HBA1C or if it was for follow up; and if HBA1C was obtained daily on days 90 thru 95 to 
see any residual effect on HBA1C level. However, in this review it was assumed that post trial HBA1C 
levels were obtained any time between days 90 to 95.9

The next study reviewed was conducted by Mang et al.10 This study mentioned that it was a 
randomized placebo-controlled trial, but it did not mention the method of blinding or randomization. 
Also, the daily doses in the treatment and control group differed, 3 times daily and once daily, 
respectively.10 It is possible that participants among the groups could have communicated with each 
other in regards to the difference in daily dosing and this could have affected the results of the study. 
Although compliance was accounted for by capsule count and logging daily intake in a diary, it is 
difficult to confirm if all missed doses and capsule counts were truly accounted for and the reported 
number had to have been accepted in good faith. Furthermore, this study included diet and exercise
controlled DM II and drug controlled DM II patients. It can be postulated that those with diet and exercise controlled DM II may have a larger treatment effect because they are probably more insulin sensitive than the drug controlled DM II participants. It would have been interesting to separate them into 2 treatment groups and then compare their HBA1C results after cinnamon supplementation. Also, the participants were on many different anti-diabetic medications and it would have been beneficial to subdivide the participants within the treatment group according to the drug they were taking to compare the results at the end of the trial. This would provide insight on whether certain drugs work synergistically with cinnamon to have a larger treatment effect. The next thing that was considered was the years since diagnosis with DM II. It would have been helpful to see what relationship, if any, between years of diagnosis and insulin sensitizing effect of cinnamon supplementation. Perhaps those with longstanding disease may have a greater treatment effect with cinnamon supplementation. To go even a step further would be to test insulin sensitivity prior to enrollment of participants into the study, and then subdividing them into groups according to their sensitivities to evaluate the efficacy of cinnamon supplementation on lowering HBA1C. Next, the study took BMI, weight, and waist circumference into account. Perhaps if participants were organized by their respective levels into different subgroups and then given cinnamon supplementation, it may reveal what target metabolic levels are optimal for this therapy. Another variable that should have been evenly distributed was gender. Gender in the treatment group was 63.6% (n=21) male and 36.4% (n=12) female, and 71.9% (n=23) male and 28.1% (n=9) female in the control group. The results may be obscured since gender distribution does not seem close to equal in both groups. Sample size was quite small, and gender could also play a role in efficacy of cinnamon supplementation in lowering HBA1C, yet this still remains to be seen.

The third study that was reviewed was by Blevins et al. This study was better than the others at monitoring changes to diabetic therapy by starting, stopping, or adjusting medications during the trial period, and those that had medication changes were disqualified from the trial. The study
mentions that participants were randomized and that participants and investigators were blinded to group assignment, but does not describe the method of randomization or blinding. Without an explanation for blinding and randomization, there is a margin for bias. This study was good in that it kept intervention dose similar, as twice daily and for three months in each of the groups. Another strong aspect of the study was compliance and follow-up were assessed with capsule count and a follow up appointment at 1,2, and 3 months. Another helpful part about the study was that it monitored dietary intake. Dietary intake was monitored by a monthly, 3 day food journal. It would have been more helpful to have type of food, amount, and calorie count recorded daily, in order to get a better idea of what sort of diet the participants had and if that had any bearing on the efficacy of cinnamon supplementation in lowering the HBA1C. However, compliance might be difficult in trying to obtaining this type of food journal. The groups differed in age by 5 years, it would have been a better study had the age between groups been similar. Also, 77% of the treatment group was on anti-diabetic therapy, whereas 91% of the control group was on such therapy. Since the results between the groups were very similar, it is hard to detect what factor influenced the decline in HBA1C, the anti-diabetic therapy in addition to cinnamon supplementation or if there was a larger effect in the control group because more people in that group were on anti-diabetic therapy. This study had only 42 participants and even with the intention to treat analysis being done for 57 participants, a true treatment effect may not have been observed due to the small sample size.

The last of the studies evaluated was conducted by Suppapitiporn et al. This study stood apart from the rest of the studies reviewed, in that it excluded persons with endocrinopathies and genetic insulin defects and those with poorly controlled DM II due to concurrent illness, infection, or surgery. Another positive aspect of this trial that other trials that were reviewed did not attempt to do was that it monitored liver function, BUN, creatinine, blood pressure, and monitored for adverse effects. This is a very important aspect, and routine labs and vitals should be monitored in all trials. These are also vital to obtain, in order to rule out other causes of higher HBA1C levels. A big area of concern was
that the study mentions no method of blinding; also it states that the trial was randomized, but does not mention a method of randomization. Another downside to this trial was inequality between groups in reference to group size and gender. The control group consisted of 40 people, and 20 were in the treatment group. There were 12 women and 8 men in the treatment group and 20 men and 20 women in the control group. It would have been ideal to have gender in similar numbers amongst the groups in order to observe any differences in treatment effect between genders. Compliance was monitored by capsule count and interview, but this process was not described in detail. It would have been better to describe when capsule count and interview were conducted, and how often. Also, other measures to ensure compliance could have been taken.

CONCLUSION

Cinnamon is widely used in many foods and as a supplement to treat many ailments. People have used it for many years for this purpose, but there has never been strong research supporting its efficacy. Thus far, research in the efficacy of cinnamon supplementation on lowering HBA1C has not yielded statistically significant results and the data does not strongly support its use. In order to see the true effect, future studies need to be larger in size and of longer duration to see long term effects of cinnamon on HBA1C. Researchers need to analyze cinnamon’s efficacy in relation to age, race, gender, diet, controlled DM II versus uncontrolled DM II, insulin sensitivity, comorbid conditions and different diabetic medications. Also, it is important to see if there is a synergistic relationship between cinnamon and certain DM II medication. Another interesting topic would be to see if there were different types and formulations of cinnamon are better at lowering HBA1C than others, as well as exploring what doses produce optimal results. Until all these variables are evaluated, it seems that adding cinnamon to a diabetic regimen is futile. Although, it can be considered in those that have tried diet, exercise, and multiple anti-diabetic medications, and still have difficulty attaining their goal HBA1C level. Cinnamon is inexpensive, potentially free of adverse effects, and is readily available. In
the future evidence may support its use in the diabetic regimen, but until then, it cannot the standard of care for patients with DM II.
REFERENCES

<table>
<thead>
<tr>
<th>Study</th>
<th>Year Published</th>
<th>Patients/Population</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcome</th>
<th>Study Type</th>
<th>Validity (JADAD Score)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawford</td>
<td>2009</td>
<td>Any age, male/female, non insulin or insulin dependent, DM II patient with a HBA1C ≥7 within past 6 mos, not pregnant before the age of 18, and not allergic to cinnamon</td>
<td>1 gram daily of cinnamon x 3 months</td>
<td>No cinnamon supplementation and no placebo</td>
<td>Over a 90 day period of 1g cinnamon supplementation, HBA1C dropped by 0.83% in the tx group, as compared to 0.37% in the control group</td>
<td>Randomized control trial</td>
<td>3/5</td>
<td>The investigators nor the patients were blinded, but the actual outcome assessor- the laboratory personnel were unaware of which group each of the results belonged to. Therefore, one could argue that it is somewhat of a single blind study</td>
</tr>
<tr>
<td>Mang et al</td>
<td>2006</td>
<td>Any age, male/female, non-insulin dependent, included those that take oral anti-hyperglycemic meds or even those controlled by their diet alone, type 2 diabetes</td>
<td>112 mg of aqueous Cinnamon extract (= to 1 gram of cinnamon) were given to the tx group daily x 4 months</td>
<td>No cinnamon supplementation (Cinnamomum Cassia)- i.e.- placebo group received identical pill containing crystalline cellulose TID x 4 months</td>
<td>No significant changes were noted between pre and post trial HBA1C</td>
<td>Randomized placebo-controlled, double blind trial</td>
<td>3/5</td>
<td>This study does state the participants were randomly assigned, but does not describe the method of randomization. It also describes itself as a double blind but does not describe how it met criteria for a double blind trial.</td>
</tr>
<tr>
<td>Blevins et al</td>
<td>2007</td>
<td>Any age, male/female, non-insulin dependent type II diabetics with a HBA1C &gt;6.0, that were not acutely ill, and those with no prior use of cinnamon supplementation</td>
<td>500 mg cinnamon cassia BID x 3 months</td>
<td>No cinnamon supplementation, but received a placebo of wheat flour capsules, bid x 30 days</td>
<td>No significant changes were noted between the pre and post trial HBA1C</td>
<td>Randomized placebo-controlled double blind trial</td>
<td>3/5</td>
<td>This study states the subjects were randomized, but the method used for randomization was not described. It says the investigators and subjects were blinded to group assignment &amp; capsule content but does not describe how.</td>
</tr>
<tr>
<td>Suppapitiporn et al</td>
<td>2006</td>
<td>Ages 30-70, male/female, non-insulin dependent type II diabetics with HBA1C &gt;7.0 within 1 month prior to study, those of child-bearing age had to be on contraception, those without diabetes linked to genetic defects of insulin, pancreatitis, hemochromatosis, endocrinopathies, poorly controlled DM II due to concurrent illness, infection, or surgery, or those with liver or renal disease</td>
<td>1.5 g cinnamon cassia powder capsule TID x 3 months</td>
<td>Placebo pill TID x 3 months</td>
<td>No significant changes were noted between pre and post trial HBA1C</td>
<td>Randomized placebo control trial</td>
<td>1/5</td>
<td>This study states that randomization was used, but does not describe method of randomization. It does not mention any form of blinding.</td>
</tr>
</tbody>
</table>
Table 2 Baseline and Post Trial HBA1C Comparison of the Reviewed Studies *

<table>
<thead>
<tr>
<th>Author, Date</th>
<th>Number of Participants in treatment group</th>
<th>Treatment, dosage, and formulation</th>
<th>Baseline HBA1C Treatment group</th>
<th>Post trial HBA1C Treatment group</th>
<th>Number of Participants in control group</th>
<th>Placebo yes/no dosage and form</th>
<th>Baseline HBA1C Control group</th>
<th>Post trial HBA1C Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawford, 2009¹²</td>
<td>55</td>
<td>C. cassia 500mg capsules, 2 daily with food</td>
<td>8.47 +/- 1.8</td>
<td>7.64 +/- 1.7</td>
<td>54</td>
<td>No, usual care only</td>
<td>8.28 +/- 1.3</td>
<td>7.91 +/- 1.5</td>
</tr>
<tr>
<td>Mang et al, 2006</td>
<td>33</td>
<td>C. cassia extract capsule 112mg, (1g cinnamon) 3 times daily with food</td>
<td>6.86 +/- 1.00</td>
<td>6.71 +/- 0.73</td>
<td>32</td>
<td>Yes, 1 capsule microcrystal line cellulose 2 times daily with food</td>
<td>6.83 +/- 0.83</td>
<td>6.68 +/- 0.70</td>
</tr>
<tr>
<td>Blevins et al, 2007</td>
<td>29</td>
<td>C. cassia 500mg capsules, 2 times daily with food</td>
<td>7.2 +/- 0.3</td>
<td>7.0 +/- 0.1</td>
<td>28</td>
<td>Yes, 1 capsule wheat flour 2 times daily with food</td>
<td>7.1 +/- 0.2</td>
<td>7.0 +/- 0.2</td>
</tr>
<tr>
<td>Suppapitiporn et al, 2006</td>
<td>20</td>
<td>Cinnamon powder capsule 1.5 g 3 times daily with food</td>
<td>8.14 +/- 1.10</td>
<td>7.76 (0Σ95)</td>
<td>40</td>
<td>Yes, 1 placebo capsule 3 times daily with food</td>
<td>8.06 +/- 1.05</td>
<td>7.87 (0Σ96)</td>
</tr>
</tbody>
</table>

* Data are means +/- Standard deviation