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The Effects of *Cinnamomum Cassia* on Blood Glucose Values are Greater than those of Dietary Changes Alone

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Abstract: Eighteen type II diabetics (9 women and 9 men) participated in a 12-week trial that consisted of 2 parts, a 3-week control phase followed by a 9-week experimental phase where half of the subjects received 1000 mg of *Cinnamomum cassia* while the other half received 1000 mg of a placebo pill. All of the subjects that were in the cinnamon group had a statistically significant decrease in their blood sugar levels with a P -value of 3.915×10^{-10} . The subjects in the cinnamon group had an average overall decrease in their blood sugar levels of about 30 mg/dL, which is comparable to oral medications available for diabetes. All subjects were educated on appropriate diabetic diets and maintained that diet for the entire 12 week study. Greater decreases in blood glucose values were observed in patients using the cinnamon compared to those using the dietary changes alone.

Keywords: cinnamon, type II diabetes, blood glucose

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Introduction

Control of blood glucose levels is essential for quality of life in patients with type II diabetes.¹ Connections between prolonged elevated blood glucose levels and blindness, kidney disease, and nerve damage are now well established.² Likewise, increased incidences of heart disease are also noted in uncontrolled type 2 diabetics.^{3–5} Oral medications including sulfonylureas, biguanides, thiazolidinediones, alpha-glucosidase inhibitors, meglitinides, and dipeptidyl peptidase IV inhibitors are capable of lowering hemoglobin A1C (HbA_{1c}) levels 0.5%–2%. Although traditional therapies such as insulin injections and oral medications are effective at decreasing blood glucose levels, some side effects and limitations in certain patient populations necessitate exploration of other options that complement dietary and lifestyle modifications. These side effects include the potential for lactic acidosis, weight gain, contraindication in people with heart failure, and gastrointestinal disturbances such as gas and diarrhea.⁶ Although effective, insulin injections may be needed several times a day and provide repeated discomfort for patients.

Cinnamon has long been linked to a decrease in blood glucose levels. Medicinal use of cinnamon dates back approximately 5000 years, when it was primarily used for the treatment of diarrhea, upset stomach, bad breath, and other digestive problems, as well as for relief of poor appetite, nausea, cramps, and gas.⁷ Interestingly, many of these conditions may also be related to improper use of glucose by the body.

Cinnamon has been shown to significantly help patients with type II diabetes manage their condition. It appears to help control and normalize the glucose levels of diabetics who have an inability to respond to insulin.^{8–12} The compound in cinnamon responsible for its insulin-like behavior is still up for debate. Originally the component of cinnamon that appeared to be responsible for decreasing blood glucose levels was methylhydroxy chalcone polymer (MHCP), which likely functions as a molecular mimic. In vitro experiments suggest that MHCP functions by activation of cell receptors, presumably insulin receptors.¹³ More recently, it has been suggested that the polyphenols in cinnamon, specifically polyphenol A, are responsible for decreases in blood glucose witnessed.^{9,14–16}

The original clinical trial involved sixty untreated type II diabetics and explored the fasting blood

glucose levels of each group supplementing with 0–0 grams of cinnamon at each meal for forty days. Fasting blood glucose values were measured on days zero, twenty, forty, and sixty. Results indicated a consistent decrease in glucose levels for subjects taking cinnamon supplements versus placebo.¹⁰

Results identified a decrease in blood glucose levels independent of the amount of cinnamon given relative to placebo. A decrease compared to values at day 0 was still evident 20 days after ceasing cinnamon supplementation. The majority of theories regarding mechanism of blood sugar reduction via cinnamon focus on the insulin-like properties of the compound, MHCP, and a variety of polyphenolic compounds.¹⁷ Thus far, insulin-like properties appear to be centralized to facilitating cellular uptake of glucose.^{13,18,19}

Considering that the active compound in cinnamon aqueous extracts likely binds the insulin receptors, long term effects from receptor sensitivity and receptor levels should also be explored.^{8,10,13,18,20,21} Likewise, MHCP or other cinnamon compounds may have additional activities that give cinnamon the ability to modulate serum glucose levels over time. The present study explores the immediate and long term effects of cinnamon supplementation on type II diabetics relative to the effects that are generally obtained from dietary modification. The study highlights significant decreases in both fasting and two hour postprandial blood glucose values, which become apparent within one week of the study and stabilize by the end of the study.

Dietary and lifestyle changes alone have the ability to decrease blood glucose levels. Our research indicates a comparable reduction in fasting and two hour postprandial blood glucose values with cinnamon supplementation. Our study compares dietary changes (placebo group) to decreases observed in the subjects supplementing dietary changes with cinnamon.

Materials and Methods

Subject selection

The subjects participating in the data experiment were all untreated type II diabetics between the ages of sixty and seventy. The group was a mixture of middle class Caucasian men and women who volunteered for the study. All of the subjects were asked to review a consent form and complete a questionnaire regarding the purpose for the study. The study



was reviewed and approved by the institutional review board. All subjects were notified of their right to withdraw from the experiment at any time. Upon completion of the consent form, the subjects were instructed on how to safely monitor their blood sugar levels using glucose meters, as well as how to record these values in the Clinilogs they were given. Additionally, the patients were instructed to record their dietary intake each day. The privacy of all of the subjects was protected. All of the data was kept anonymous; each subject was given a number so that his or her information could be tracked. The study was submitted and approved by the institutional review board.

Experimental design

Both of the subject groups completed a three week control by monitoring their fasting blood glucose (morning) and once two hours after finishing a meal (two hour postprandial). Once in the morning during weeks 4 to 12, Group 1 took a placebo capsule (1000 mg) formulated by placing sugar free instant pudding into a gel capsule. Group 2 took a 1000 mg *Cinnamomum cassia* capsule once every morning during weeks 4 to 12.

Data collection

Subjects were controlled for three weeks prior to the start of either placebo or cinnamon supplementation. During this time the subjects were instructed to follow a diabetic diet and monitor blood glucose values (both fasting and two hour postprandial). At the end of week 3, subjects were instructed to begin treatment (placebo or cinnamon). Subjects completed the twelve weeks of the experiment and Clinilogs were analyzed to determine if the cinnamon had a significant effect on blood glucose values. The weekly average was calculated for each subject.

Reported food intake

Subjects were instructed on how to complete a food diary and Clinilog containing measurements of their fasting blood sugar levels. Subjects were also educated on the type of diet to follow for the duration of the study and how to complete the food diary form found in the Clinilog. Subjects were supplied with either a *Cinnamomum cassia* capsule from a general nutrition store or a placebo capsule.

Physical activity assessment

The study required the subjects to maintain the same activity level that they had two months prior to the beginning of the study. The reason for this was to see if taking *Cinnamomum cassia* could lower blood glucose levels without need of changing typical habits and routines. We felt it was important to limit the variables for this initial study by eliminating any potential effects from physical activity. Future studies may include a larger sample size and should evaluate the effects of physical activity on blood glucose levels as well.

Statistics

The *P*-values for the placebo and cinnamon groups were computed using a *t*-test. The *t*-test was conducted using one-tailed distribution, two-sample unequal variance parameters on Microsoft Excel. The *P*-value gives one the probability of the percent change being due to chance. This study selected a *P*-value of less than 0.01 to make sure that there is less than a one percent chance that these results were random.

Results and Discussion

The average from week 1 and week 12 were reported as the beginning average and ending average, respectively. Weekly averages were completed for both fasting and two-hour post meal. Clinilogs and dietary journals were analyzed for each subject. All subjects recorded their fasting blood glucose levels following a 10 to 12 hour fast overnight. Breakfast was the most common meal used for the two-hour postprandial testing. The meals prior to the two-hour post meal values were examined for each subject in order to identify consumption of foods with high glycemic index. The most common food with a high glycemic index consumed during breakfast was orange juice. As expected, data trends suggested that two-hour post meal blood glucose was slightly elevated in subjects reporting meals with higher glycemic index values. Subjects reporting that they consumed fruit juices prior to the two-hour post meal glucose measurement did so consistently with very little variation in diet each day. Table 1A shows the overall percent change for each subject as well as the overall percent change for the placebo group. Table 1B summarizes the changes



Table 1. The average beginning and average ending values for each subjects' fasting and two-hour post-meal blood glucose are shown.

	Beginning average		Ending average		Percent change	
	Fasting	Post-meal	Fasting	Post-meal	Fasting	Post-meal
(A) Placebo group						
Subject 1	139.6	164.9	140.0	166.9	0.3%	1.2%
Subject 2	140.0	163.3	141.3	169.1	1.0%	3.6%
Subject 3	143.6	159.0	142.2	166.2	-1.0%	4.5%
Subject 4	140.9	159.9	140.9	167.9	0.0%	5.0%
Subject 5	141.1	159.0	136.9	167.0	-3.0%	5.0%
Subject 6	140.5	157.0	137.4	166.9	-2.2%	6.3%
Subject 7	136.3	153.7	138.2	159.5	1.4%	3.8%
Subject 8	143.5	164.5	142.4	167.0	-0.7%	1.5%
Subject 9	141.2	158.5	138.4	165.7	-2.0%	4.5%
Group	140.7	160.0	139.7	166.2	-0.7%	4.0%
(B) Cinnamon group						
Subject 10	143.5	163.5	121.3	135.1	-15.5%	-17.4%
Subject 11	136.2	150.5	110.9	125.2	-18.6%	-16.8%
Subject 12	150.9	170.2	115.1	133.1	-23.7%	-21.8%
Subject 13	146.5	165.5	112.5	136.7	-23.2%	-17.4%
Subject 14	134.4	148.5	111.6	127.2	-17.0%	-14.3%
Subject 15	140.0	156.0	113.0	138.8	-19.2%	-11.0%
Subject 16	143.8	161.3	113.0	138.7	-21.4%	-14.0%
Subject 17	133.4	151.6	110.9	137.0	-16.9%	-9.6%
Subject 18	135.1	151.5	108.5	126.0	-19.7%	-16.8%
Group	140.4	157.6	113.0	133.1	-19.5%	-15.5%
Weeks 1–3						
(C) The <i>P</i> values for the paired <i>t</i>-test						
Subject 1—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 2—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 3—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 4—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 5—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 6—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 7—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 8—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 9—Placebo			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 10—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 11—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 12—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 13—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 14—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 15—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 16—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 17—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	
Subject 18—Cinnamon			<i>P</i> < 0.0001		<i>P</i> < 0.0001	

Notes: (A) corresponds to the placebo group and (B) corresponds to the cinnamon group. (C) shows the results of the paired *t*-test.

analyzed for the cinnamon treatment group. The placebo group did not have statistically significant decreases. The average fasting blood glucose value for the placebo group decreased by approximately 0.1 mg/dL per week, a decrease of approximately

0.7%. The two-hour post meal blood glucose value increased for the placebo group an average 0.6 mg/dL per week, an increase of 3.9%.

Subjects in the cinnamon group had significant decreases. The group as a whole had a *P*-value of



1.591×10^{-16} for their fasting blood sugar levels and a P -value of 3.915×10^{-10} for their post-meal values. These values correspond to a decrease in fasting blood glucose of nearly 19.5% and a decrease in post-meal blood glucose of on average 15.5%. A decrease in HbA_{1c} of 1%–2%, as seen with the oral, corresponds to approximately 30–60 points off the average blood glucose.⁶ An obvious limitation to the study was the inability to obtain HbA_{1c} at the beginning and end of the study for each patient. Measurements of insulin levels would have also been preferred, but it was not possible to get these due to financial constraints. Future work should include both measurements. Although patients in this study declined an HbA_{1c} test prior to and following the test, we averaged the beginning fasting and post-meal group average, and compared this figure to the ending averages. We estimated our HbA_{1c} percent decreases in the same way physicians estimate the average blood sugar values from actual HbA_{1c} measurements. Given the reliability of these estimates, we would expect future studies to have the predicted effects on HbA_{1c}. Our results suggest an average decrease of about 30 points, comparable to what can be observed with the oral medication.⁶ A potentially interesting measurement for future studies is the insulin level in comparison to the blood glucose value. These measurements would provide information about insulin sensitivity, important for extrapolating these results to a population with insulin resistance that has not yet developed type 2 diabetes.

An interesting consideration for future work would be to determine if cinnamon and available oral therapies would have an additive decrease on the HbA_{1c} values. We completed a literature search for this type of information and have not found any studies with cinnamon in conjunction with available oral drugs. This is an obvious necessity for future work, but the current study completes the first step in this process.

Another goal of the study was to determine how rapidly a decrease would be observed following initiation of cinnamon therapy. Figure 1 charts the results from the cinnamon group's weekly average. The two-hour post-meal blood glucose group average (squares) and fasting blood glucose (diamonds) both showed significant decreases. The average decrease rate was 2.9 mg/dL per week for the two-hour post-meal and 3.2 mg/dL per week for the fasting blood glucose.

Interestingly, the most significant decrease occurred between weeks 3 and 4, the time during which the cinnamon treatment began. The rate of decrease was maintained for approximately two weeks despite the continued use of cinnamon. The rate of decrease between weeks 3 and 4 was about 10 mg/dL for fasting and approximately 8 mg/dL for the two-hour post-meal measurement. This week corresponds to the first week in which patients took the cinnamon capsule. The chart shows that the individual averages of the subjects in the cinnamon group ranged from -7.143 to -13.143 mg/dL.

The final goal of the experiment was to look at the P -values from a paired t -test. The P -values from this calculation would show that the difference between the fasting and two-hour post-meal blood glucose readings were statistically significant ($P < 0.01$) for each subject. The null hypothesis was that the mean difference between the fasting and two-hour post-meal blood glucose levels would equal zero. This means that these two values for each subject should be equal because of the paired design of the data. The P -values shown in Table 1C demonstrate that all of the subjects were statistically significant with a $P < 0.01$. Our results clearly demonstrate that dietary changes alone do not make a significant decrease in either postprandial or fasting blood glucose levels, while a combination of dietary modification and cinnamon supplementation results in a significant decrease in blood glucose levels. Although these results are clearly significant the following limitations should be considered for future studies: inclusion of individuals with pre-diabetes or insulin resistance in the population, assessment of insulin sensitivity, and confirmation of expected HbA_{1c} values.

Discussion

Our data demonstrate that diet alone cannot reduce blood glucose values as significantly as a combination of diet and cinnamon supplementation. Furthermore, our data demonstrate that cinnamon supplementation can be as effective as some oral diabetic medications in terms of control over HbA_{1c} levels. Our study was unique in that it was also designed to examine the rates of decrease in blood glucose values. We observed a rapid decrease in both the fasting and postprandial blood glucose values within approximately 1 week after beginning the cinnamon supplementation. These

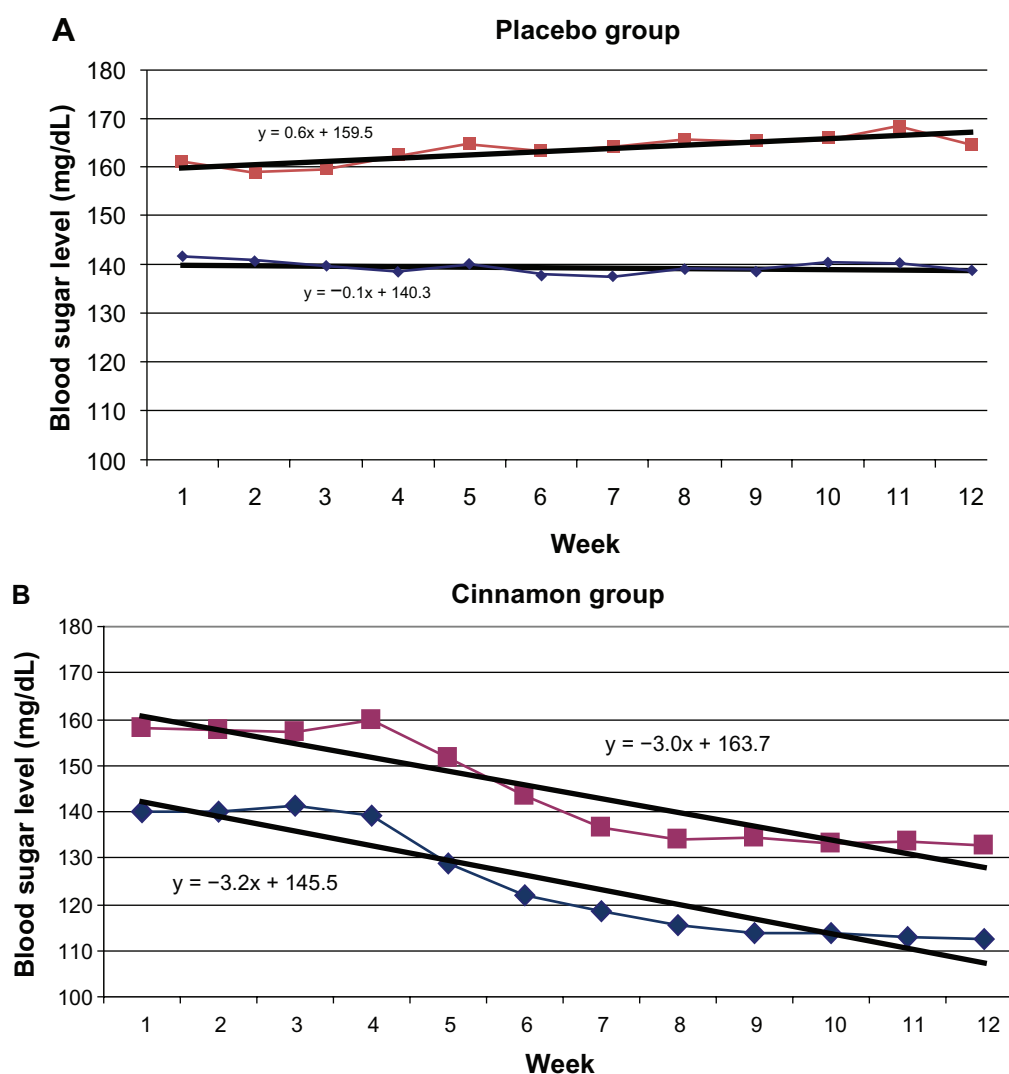


Figure 1. (A) The average blood glucose values for the placebo groups' fasting (diamonds) and two-hour post-meal (squares) values. (B) The average blood glucose values for the cinnamon groups' fasting (diamonds) and two-hour post-meal (squares) values.

values continued to decrease at approximately that same rate until two weeks after beginning supplementation, when the rate of decrease slowed considerably until reaching a stable level at week 8 (two-hour post-prandial) and week 9 (fasting). Our data strongly support available literature suggesting that one or more of the compounds in cinnamon functions to alter control over carbohydrate metabolism as opposed to only increasing glucose uptake.^{8,13,14,19,22,23} The data indicates the need for further research in the area of metabolic signaling sensitive to cinnamon extracts.

Author Contributions

Conceived and designed the experiments: AS, AH. Analyzed the data: AS, AH. Wrote the first draft of the manuscript: AS. Contributed to the writing of the

manuscript: AH. Agree with manuscript results and conclusions: AS, AH. Jointly developed the structure and arguments for the paper: AS, AH. Made critical revisions and approved final version: AS, AH. All authors reviewed and approved of the final manuscript.

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Disclosures and Ethics

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References

1. Barendse S, Singh H, Frier BM, Speight J. The impact of hypoglycaemia on quality of life and related patient-reported outcomes in Type 2 diabetes: a narrative review. *Diabetic Med.* 2012;29(3):293–302.
2. Deshpande AD, Harris-Hayes M, Schootman M. Epidemiology of Diabetes and Diabetes-Related Complications. *Phys Ther.* 2008;88(11):1254–64.
3. Home P. Cardiovascular disease and oral agent glucose-lowering therapies in the management of type 2 diabetes. *Diabetes Technol The.* 2012;14: S33–42.
4. Bower JK, Appel LJ, Matsushita K, et al. Glycated Hemoglobin and Risk of Hypertension in the Atherosclerosis Risk in Communities Study. *Diabetes Care.* 2012;35(5):1031–7.
5. Brown NJ. Cardiovascular effects of antidiabetic agents: focus on blood pressure effects of incretin-based therapies. *J Am Soc Hypertens.* 2012;6(3): 163–8.
6. Lexicomp®. Hudson (OH): American Academy of Clinical Toxicology; 2012. <http://0-online.lexi.com.polar.onu.edu/lco/action/home>. Accessed Jun 4, 2012.
7. Meletis CD. *Complete Guide to Safe Herbs*. New York: DK Publishing, Inc.; 2002.
8. Baker WL, Kluger J, Gutierrez-Williams G, Coleman CI, White CM. Effect of cinnamon on glucose control and lipid parameters. *Diabetes Care.* 2008;31(1):41–3.
9. Davis PA, Yokoyama W. Cinnamon intake lowers fasting blood glucose: meta-analysis. *J Med Food.* 2011;14(9):884–9.
10. Khan A, Safdar M, Khan MMA, Khattak KN, Anderson RA. Cinnamon improves glucose and lipids of people with type 2 diabetes. *Diabetes Care.* 2003;26(12):3215–8.
11. Kirkham S, Akilen R, Sharma S, Tsiami A. The potential of cinnamon to reduce blood glucose levels in patients with type 2 diabetes and insulin resistance. *Diabetes Obes Metab.* 2009;11(12):1100–13.
12. Pham AQ, Kourlas H, Pham DQ. Cinnamon supplementation in patients with type 2 diabetes Mellitus. *Pharmacotherapy.* 2007;27(4):595–9.
13. Jarvill-Taylor KJ, Anderson RA, Graves DJ. A hydroxychalcone derived from cinnamon functions as a mimetic for insulin in 3T3-L1 adipocytes. *J Am Coll Nutr.* 2001;20(4):327–36.
14. Anderson RA. Chromium and polyphenols from cinnamon improve insulin sensitivity. *P Nutr Soc.* 2008;67(1):48–53.
15. Curtis PJ, Sampson M, Potter J, Dhataria K, Kroon PA, Cassidy A. Chronic ingestion of flavan-3-ols and isoflavones improves insulin sensitivity and lipoprotein status and attenuates estimated 10-year CVD risk in medicated postmenopausal women with type 2 diabetes A 1-year, double-blind, randomized, controlled trial. *Diabetes Care.* 2012;35(2):226–32.
16. Jia Q, Liu X, Wu X, et al. Hypoglycemic activity of a polyphenolic oligomer-rich extract of *Cinnamomum parthenoxylon* bark in normal and streptozotocin-induced diabetic rats. *Phytomedicine.* 2009;16(8):744–50.
17. Islam M, Jafar TH, Wood AR, et al. Multiple genetic variants explain measurable variance in type 2 diabetes-related traits in Pakistanis. *Diabetologia.* 2012;55(8):2193–204.
18. Kim W, Khil LY, Clark R, et al. Naphthalenemethyl ester derivative of dihydroxyhydrocinnamic acid, a component of cinnamon, increases glucose disposal by enhancing translocation of glucose transporter 4. *Diabetologia.* 2006;49(10):2437–48.
19. Plaisier C, Cok A, Scott J, et al. Effects of cinnamaldehyde on the glucose transport activity of GLUT1. *Biochimie.* 2011;93(2):339–44.
20. Kim SH, Choung SY. Antihyperglycemic and Antihyperlipidemic Action of *Cinnamomi Cassiae* (Cinnamon Bark) Extract in C57BL/Ks db/db Mice. *Arch Pharm Res.* 2010;33(2):325–33.
21. Akilen R, Tsiami A, Devendra D, Robinson N. 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 Med.* 2010;27(10):1159–67.
22. Babu PS, Prabuseenivasan S, Ignacimuthu S. Cinnamaidehyde—A potential antidiabetic agent. *Phytomedicine.* 2007;14(1):15–22.
23. Beecher GR. Proanthocyanidins: Biological activities associated with human health. *Pharm Biol.* 2004;42:2–20.