

Effect of boiled and macerated cinnamon sticks and powder on diabetic and biochemical profile in patients with type 2 diabetes mellitus

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ABSTRACT

Aim: We examined possible impact of cinnamon on blood glucose and some biochemical parameters among type 2 diabetic patients treated with cinnamon in Najaf.

Materials and Methods: Patients with type 2 diabetes were received cinnamon (boiled branches, soaked branches, boiled powder and soaked powder) twice a day after meals. Fasting and random blood glucose in addition to urine biochemical markers; glucose, ketones, specific gravity, total protein, were measured.

Results: Our study support previous ones regarding the beneficial effect of cinnamon in lowering blood glucose levels in diabetic patients. However, there are several points that our study highlighted them. Firstly, it more effective in lowering fasting more than random blood glucose. Secondly, soaked parts are more effective than boiled parts. In addition, the only urine biochemical parameters that were affected by cinnamon (reduced urine concentration) were urine glucose and urine ketones with no effect on urine pH, specific gravity or total proteins. Further studies are required to extend the duration of treatment to a longer period, scheduling concentration series of cinnamon and using double blind study including placebo.

Conclusions: Fasting blood glucose, urine glucose and urine ketones were shown to be reduced by the treatment with cinnamon, with soaking more than boiling and branches more than powder. In conclusion, soaked cinnamon has potentially more effective than boiled on lowering fasting blood level.

KEY WORDS: type 2 diabetes, biochemical urine parameter, cinnamon

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INTRODUCTION

Diabetes is an epidemic of pandemic proportions, with over 100 million cases occurring annually worldwide and the estimated prevalence continuing to rise from 171 million in 2000 to 366 million in 2030 [1-2] and 642 million by 2040 [3] as the diabetic population is expected to increase significantly. Diabetes Mellitus is a metabolic disease that affects how fat, protein, and carbohydrates are metabolized. It is caused by abnormalities in the action or production of insulin, or both, which raise blood glucose levels [4]. Particularly in low-income nations, diabetes mellitus (DM) and its consequences have spread like an epidemic, posing a serious threat to world health and the economy [5]. Diabetes mellitus is classified into three main kinds based on clinical presentation: type 1 diabetes mellitus

(T1DM), type 2 diabetes mellitus (T2DM), and gestational diabetes mellitus (GDM) [6], T2DM makes up about 90% of DM cases [7]. Cinnamon is a spice that consists of the dried bark of *Cinnamomum*. The most common *Cinnamomum* species is *Cinnamomum verum* which belongs to *Cinnamomum Lauraceae* family. Approximately 250 species of cinnamon have been found in the world [8]. Nowadays cinnamon trees are cultivated in China, Indonesia, Vietnam, India, Lao, Seychelles, and Madagascar, especially in Sri Lanka. Numerous species are referred to as cinnamon, but true cinnamon is from the bark of *Cinnamomum* [9]. Because of its content (mainly polyphenols) cinnamon is suggested to clearly affect glucose homeostasis, though investigations on glucose fluctuations have generated contrasting findings [10-13]. It is not clear if

Table 1. Study design and the stages of study

Stage	Day	Supplement	Measurement
One	Day one	Boiled cinnamon sticks after dinner	Fasting blood sugar Components of urine Random blood glucose one hour after dinner
	Day two	Same above	Same above
	Day three	Same above	Same above
	Day four	Break	
Two	Day one	Soaked cinnamon sticks after dinner	Fasting blood sugar Components of urine Random blood glucose one hour after dinner
	Day two	Same above	Same above
	Day three	Same above	Same above
	Day four	Break	
Three	Day one	Boiled cinnamon powder after dinner	Fasting blood sugar Components of urine Random blood glucose one hour after dinner
	Day two	Same above	Same above
	Day three	Same above	Same above
	Day four	Break	
Four	Day one	Soaked cinnamon powder after dinner	Fasting blood sugar Components of urine Random blood glucose one hour after dinner
	Day two	Same above	Same above
	Day three	Same above	Same above
	Day four	Break	

Source: compiled by the authors of this study

Table 2. Gender-related distribution of patients

Gender	n (%)
Male	67 (60%)
Female	43 (40%)

Source: compiled by the authors of this study

Table 3. Age-related distribution of patients

Age group (years)	n (%)
40–50	27 (24%)
51–60	62 (56%)
>60	23 (20%)

Source: compiled by the authors of this study

Table 4. Diabetic complications among patients

Complications	n (%)
None	78 (70%)
Cardiovascular disease	26 (23%)
Neuropathy	8 (7%)

Source: compiled by the authors of this study

cinnamon has any effect on glucose control. However, prior investigations have demonstrated that cinnamon reduced glucose and lipid levels in individuals with type 2 diabetes [14–17] Prediabetes [18–19] and healthy adults [20–21]. Other investigations have shown that

cinnamon improved the glycemic profile but not HbA_{1c} [10] Vanschoonbeek and colleagues, in other hand, reported no significant difference between placebo and cinnamon group. Their negative results may be because the participants involved in the study are postmenopausal diabetic patients [11]. Negative findings were also reported by Tang and co-workers, however, they used cinnamon powder as capsules, an administration method that is different from ours, boiling and maceration [13]. Cinnamon doses used in studies were of a wide range, from 0.5 g/d to 6 g/d, and the durations of the study differed from 4 to 12 weeks. Reappraisal of evidence shows that supplementation with cinnamon or cinnamon extracts might reduce blood glucose levels [22–29], but the inconsistent results regarding the effect of cinnamon on glycemic control, which were from studies with small effect sizes or very heterogeneous effects, reveal the need for further investigations.

AIM

We examined possible impact of cinnamon on blood glucose and some biochemical parameters among type 2 diabetic patients treated with cinnamon in Najaf. We performed a 4-week randomized, controlled crossover trial to determine the impact of cinnamon intake on glucose

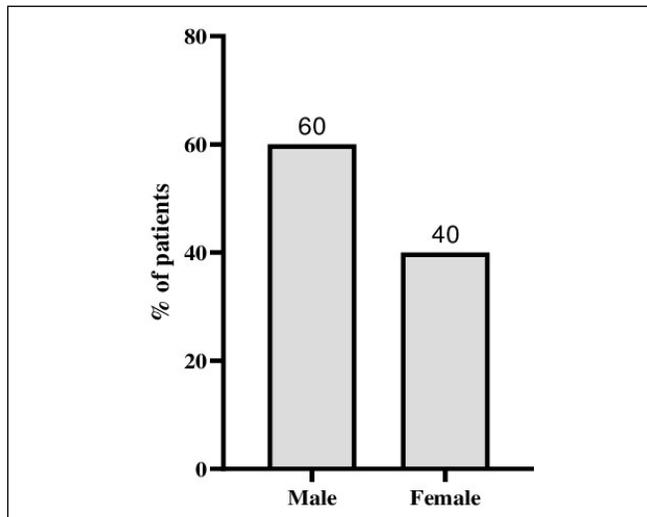


Fig. 1. Characterization of patients according to their age
Source: compiled by the authors of this study

amplitude throughout the day, determined by fasting and random glucose monitoring in patients with type2 diabetes. We also evaluated urine biochemical markers.

MATERIALS AND METHODS

STUDY DESIGN, DATA COLLECTION AND PARTICIPANTS

Table 1 shows the study design and the stages of our study

A total of 112 participants diagnosed with T2DM were involved in this study visiting outpatient clinics from three cities (Najaf, Diwaniya and Babylon). Participants were selected based on established diagnostic criteria for T2DM and were between the ages of more than 40 years. Informed consent was obtained from all individuals prior to their inclusion in the study. Exclusion criteria included patients with type 1 diabetes, those with end stage liver or kidney disease, pregnant or lactating women, individuals taking insulin or other herbal supplements, and those with a history of allergy to cinnamon. Participants with poor medication adherence or those involved in other clinical trials were also excluded to ensure the accuracy and consistency of the results. Patients for whom antidiabetic management program was modified during the study period were also excluded.

PREPARATION AND ADMINISTRATION OF CINNAMON

Preparation of cinnamon: 3 grams of cinnamon sticks or powder were either boiled for 30 minutes until a total

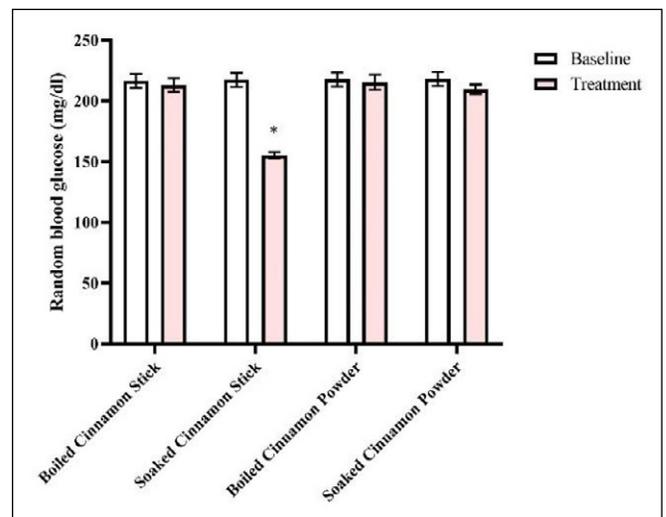


Fig. 2. Effect of cinnamon on fasting glucose level. Data presented as mean \pm SEM, n=112, *: significant $p < 0.05$ when compared to the baseline (before treatment), t-test
Source: compiled by the authors of this study

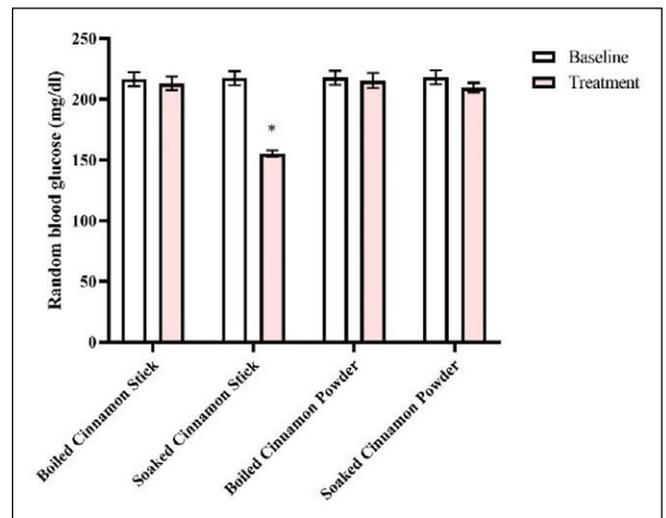


Fig. 3. Effect of cinnamon on random glucose level. Data presented as mean \pm SEM, n=112, *: significant $p < 0.05$ when compared to the baseline, t-test
Source: compiled by the authors of this study

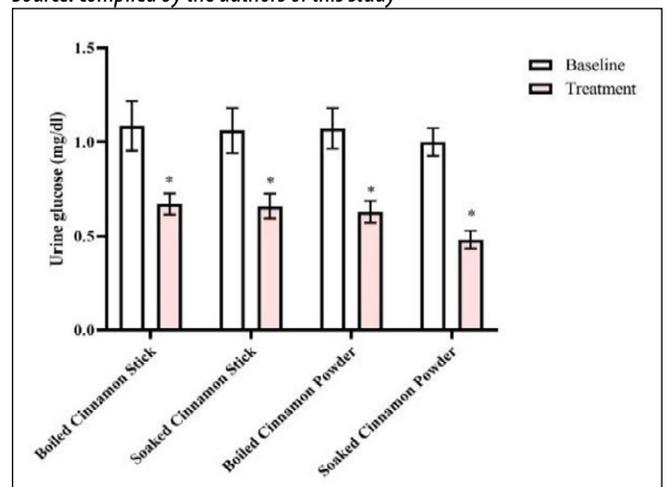


Fig. 4. Effect of cinnamon on urine glucose level. Data presented as mean \pm SEM, n=112, *: significant $p < 0.05$ when compared to the baseline, t-test
Source: compiled by the authors of this study

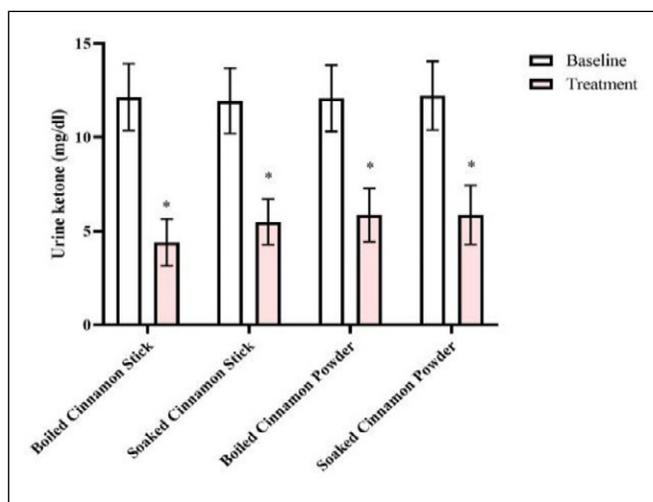


Fig. 5. Effect of cinnamon on urine ketone level. Data presented as mean \pm SEM, n=112, *: significant $p < 0.05$ when compared to the baseline, t-test
Source: compiled by the authors of this study

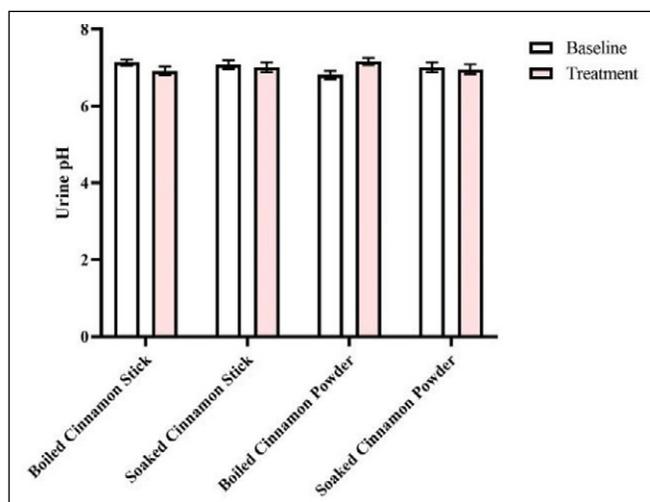


Fig. 6. Effect of cinnamon on urine pH, data presented as mean \pm SEM, n=112
Source: compiled by the authors of this study

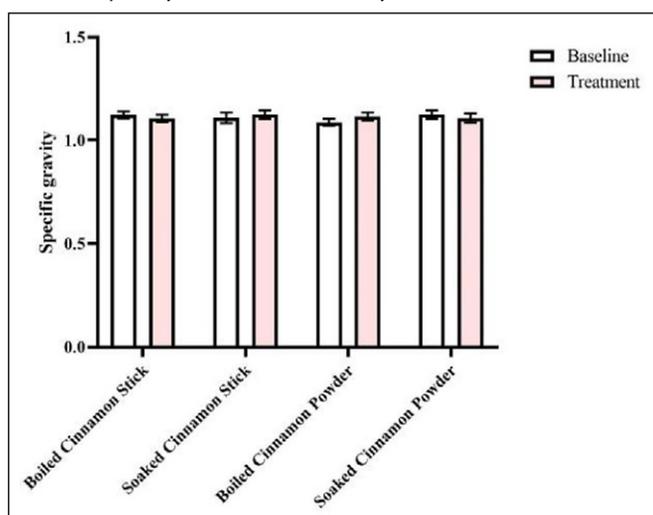


Fig. 7. Effect of cinnamon on urine specific gravity. Data presented as mean \pm SEM, n=112
Source: compiled by the authors of this study

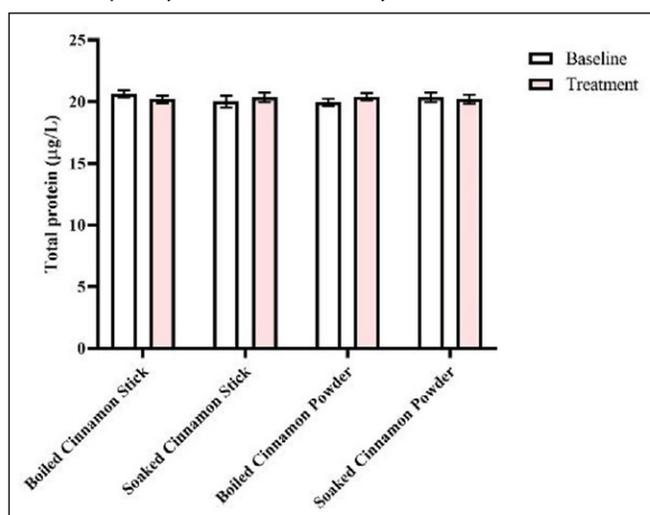


Fig. 8. Effect of cinnamon on urine total protein. Data presented as mean \pm SEM, n=112
Source: compiled by the authors of this study

volume of 20 ml or soaked overnight in 20 ml of water and given 10 ml twice a day. Conventional methods were used to mimic the usual consumption of cinnamon as an herbal product not a pharmaceutical product.

MEASUREMENT OF STUDY PARAMETERS

Blood glucose was measured using On Call plus Glucometer (ACON/USA) while urine biochemical markers were measured using a commercial kit (urine glucose; 120916-0018, urine protein; 4015630019069, urine pH; 120916-0019, urine specific gravity and urine ketones; URISIGN/China).

PLACE AND TIME OF DATA COLLECTION

The study was conducted and data were collected during the period (25th of August to 25th of December

2024) for patients with T2DM visiting outpatient clinic in the center of endocrinology in Najaf.

ETHICAL APPROVAL

Data were collected officially after permission achieved from the health directorate as a part of coordination between the University of Alkafeel and the health directorate of Najaf. Written consents from participants were obtained and an ethical approval was obtained from the College of Pharmacy at the University of Alkafeel.

DATA ANALYSIS AND PRESENTATION

Both data analysis and presentation were performed using the latest GraphPad Prism software (version is 9.3.1), USA. Data are presented as percent or mean \pm

SEM and t-test was used to test any significant difference between groups. Those data with p value <0.05 was considered significantly different.

CHARACTERIZATION OF PATIENTS ACCORDING TO THEIR GENDER

The gender-related distribution of demographic details in Table 2 and Fig. 1. is explained here in this study. Of the total sample (n = 112) males comprised 60%, and females 40%. This male preponderance may be due not only to higher prevalence of diabetes among men in this cohort but also because presentation with complications was chosen in some uncommon instances.

CHARACTERIZATION OF PATIENTS ACCORDING TO THEIR AGE

According to age distribution, most of the patients were in the 51–60 years age group (56%). Next were patients between 40 and 50 years (24%) and those above 60 years accounted for 20% (Table 3). The higher prevalence in middle-aged and older adults is consistent with the established increase in prevalence of type 2 diabetes with age, with risk rising steeply after the age of 40 and reaching a peak in the sixth decade of life.

CHARACTERIZATION OF PATIENTS ACCORDING TO DIABETIC COMPLICATIONS

On assessing diabetic related complications, 70% of patients had no complications at time of study. Of those who did develop complications, cardiovascular disease was the most common, affecting 23% of patients, followed by diabetic neuropathy in 7% of patients (Table 4). The greater extent of cardiovascular involvement is also in line with the well-established position of diabetes as a leading risk factor for cardiovascular morbidity and mortality.

RESULTS

EFFECT OF CINNAMON ON FASTING BLOOD GLUCOSE LEVEL

A differential effect on fasting glucose levels to cinnamon preparations was identified in the intervention. Fasting blood glucose level was also statistically significantly lower than baseline blood glucose levels on both soaked branches and soaked powder of cinnamon ($p<0.05$). However, both boiled sticks and boiled powder did not show remarkable hypoglycemic effect (Fig. 2). These data suggest that preparation method might be very important in attenuating/altering the bioactivity of cinnamon against fasting hyperglycemia.

EFFECT OF CINNAMON ON RANDOM GLUCOSE LEVEL

Regarding random blood glucose, there was a significant difference relative to baseline only in the soaked branches of cinnamon ($p<0.05$). However, no significant effect was observed for the both soaked powder and boiled preparation (sticks or powder) (Fig. 2). This selective action implies that the bioactive components of postprandial glucose regulation might be relatively more maintained or extracted in infusions of the soaked branches rather than in other preparations.

EFFECT OF CINNAMON ON URINE GLUCOSE LEVEL

There was a significant effect of cinnamon treatment on urine glucose level. All four types of cinnamon preparation (boiled-branches, soaked-branches, boiled-powder, soaked-powder) lowered urinary glucose (glucosuria) versus the pretreatment (baseline) level ($p<0.05$) (Fig. 4). This uniform effects among the preparations stressed cinnamon's capacity to modify renal glucose handling or reduce glucosuria through alterations in systemic glucose regulation.

EFFECT OF CINNAMON ON URINE KETONE LEVEL

There were also significant decreases in urinary levels of ketones after treatment with all groups of cinnamon (boiled at branch part, soaked branch part, boiled powder or soaked powder) ($p<0.05$) (Fig. 5). This implies enhanced metabolic control, since the lower ketonuria indicates a lesser dependence upon fat oxidation and ketogenesis, possibly as a result of better glucose utilization post cinnamon in supplementation.

EFFECT OF CINNAMON ON URINE PH

With respect to the urine pH that was investigated in this work, no significant difference in all treated groups (boiled branch, soaked branch, boiled powder, and soaked powder) compared to the baseline value was found (Fig. 6). This suggests that cinnamon supplementation has no effect on systemic acid-base balance and renal hydrogen ion excretion.

EFFECT OF CINNAMON ON URINE SPECIFIC GRAVITY

Regarding the urine specific gravity measured in this study, the absence of negative urine specific gravity effects was demonstrated in any of the cinnamon groups

(Fig. 7). This indicates that supplement with cinnamon does not modify the renal concentration's capacity of the urine and general fluid-electrolyte homeostasis of these patients.

EFFECT OF CINNAMON ON URINE TOTAL PROTEIN

No significant difference in 24-h urinary total protein compared to the baseline was observed after the administration of either form of cinnamon supplement (Fig. 8). Perhaps, it is because – as the data indicate – that cinnamon does not affect renal glomerular permeability and/or the status of proteinuria in this cohort.

DISCUSSION

In order to compare the effect on blood glucose urine biochemical markers in diabetic person, different preparations of cinnamon were used. The glucose data on day zero (before treatment) represent the baseline data in diabetic subjects prior to initiation of supplementation. On the first day of experiment (day 0), mean fasting blood glucose in diabetic rats of all four groups, which were weighed to boiled and soaked branches/ powder from cinnamon was estimated. When diabetic subjects in these groups 3g/cinnamon/day received for a period of three days, the mean fasting blood glucose from patients at (day 3) was significantly lower compared to the mean fasting baseline value.

The result showed that soaked cinnamon dose could reduce mean fasting blood glucose in both sets of patients, while there seems to have been a decrease the drop in blood glucose level is not statistically significant in relation to the mean fasting blood sugar values of patients who received boiled cinnamon. This fact might be explained by the wide range of people's blood glucose levels at the outset, which means that boiled power was not effective. Also, boiling itself may alter both components [30-31]. Furthermore, the boiling time may influence the quality and/or quantity of compositions [32-34]. Hence, there may be a need for time-scale to ensure the effective period for boiling in order to give the highest yield of components. Even the mean fasting blood glucose levels further plummeted which might owe to cumulative action on the cinnamon powder. The same group members taking part in lengthy tests were rewarded with a further drop in fasting blood sugar, and they used a lot more cinnamon than the previous two doses put together. This means that, the longer the use of cinnamon – the better. However, such cumulative effect was not shown with cinnamon powder which may attributed to the reasons mentioned above. Furthermore,

it was found that even boiled water with powder can still packed quite a wallop in lowering blood glucose levels. In summary, 3 g/d cinnamon (3 g in powder form) can simply be conveniently incorporated into the regular diet as part of food and its use may be convenient, especially if we recall that 3 g/d cinnamon are within an effective and safe range [35-36]. Another advantage of cinnamon is its ability to reduce blood glucose, which is especially significant for those with type 2 diabetes. It is advised that diabetics regularly incorporate cinnamon into their dietary preparations in light of this findings. To prevent exceeding the suggested quantity, its consumption must be controlled. Otherwise, improper usage of cinnamon is still linked to health problems [37]. Numerous theories have been suggested to explain how cinnamon affects diabetes. Sangal suggests that cinnamon could mimic the effects of insulin [38]. Another process that is thought to be responsible for cinnamon's action is "inhibiting glycogen synthase" [39]. It may also have the effect of decreasing the absorption of glucose in the small intestine by inhibiting intestinal ATPase and boosting glycosidase enzymes [40-42]. Additional hypothesized mechanisms could include up-regulating insulin receptor gene expression [43], activating PPAR γ and AMP kinase [44], activating IGF1 signaling in fibroblasts [45], modifying mitochondrial physiology and elevating cellular metabolism [46], Cyclic-AMP signaling, and autophagy [47], in addition to inhibiting alpha-amylase, up-regulating GLUT4 translocation in muscle and adipose tissues [39], phosphorylating AMPK and acetyl-CoA carboxylase, and inhibiting AMPK to reduce glucose uptake by adipose tissues and anti-AGEs formation [48]. The participants who were not taking cinnamon dosages during the break days showed a steady rise in their mean fasting blood glucose levels, suggesting that cinnamon had a long-lasting hypoglycemic impact on diabetics. It's possible that the cinnamon dosage caused certain cellular metabolic changes, which is why the mean fasting blood glucose level did not increase to the level observed on day 0 of the experiment. Although we are unsure, it appears that cinnamon may have caused some biochemical or physiological alterations in insulin resistance sites, glucose transport across cell membranes, the enzyme system involved in the metabolism of carbohydrates, and receptor sites [49]. Using a rat model, Jayaweera and colleagues used a range of high doses of cinnamon (1500, 2250, 3000 mg/kg) to evaluate the diuretic effect of cinnamon [50]. Beside its diuretic effect, they found that cinnamon increase the renal excretion of several minerals. Consistent with our findings, Jayaweera and co-workers reported no significant difference in specific gravity. The urine pH, however, reported by the same team was slightly different when compare treatment to

control. This might be due to the high dose of cinnamon. In addition, it is more likely to be due to changes in the change in sodium bicarbonate nor hydrogen ion as they reported no changes in the concentration of hydrogen ion. It is noteworthy to mention that cinnamon supplementation may be associated with health problem. For example, it could increase the secretion of oxalate in the urine which may increase the incidence of renal oxalate stone [13, 51], however, the World Health Organization (WHO) suggested Acceptable Daily Intake level of cinnamon to be 0.7 mg / kg body weight [51], and a dose of 3 g per a day is very low compared to the Acceptable Daily Intake. This means it that can be considered safe if we consider that the average body weight is 70 kg.

CONCLUSIONS

Our study support previous ones regarding the beneficial effect of cinnamon in lowering blood glucose levels in diabetic patients. However, there are several points that our study highlighted them. Firstly, it more effective in lowering fasting more than random blood glucose. Secondly, soaked parts are more effective than boiled parts. In addition, the only urine biochemical parameters that were affected by cinnamon (reduced urine concentration) were urine glucose and urine ketones with no effect on urine pH, specific gravity or total proteins. Further studies are required to extend the duration of treatment to a longer period, scheduling concentration series of cinnamon and using double blind study including placebo.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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