Research Article

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# Evaluation of the effect of a diet enriched with *Cinnamomum* Cassia (*Lauraceae*) on the glycemic balance of type 2 diabetic patients followed in two hospitals (Cameroon) in the city of Yaoundé

## Abstract

Traditional management of T2D involves lifestyle interventions, such as dietary modifications, increased physical activity, and weight management. The hygienic-dietary measures, particularly the diet, represent the first pillar of diabetes management. In the framework of our work, we conducted a study whose aim was to evaluate the effect of a diet enriched with *Cinnamomum cassia* on the equilibrium of diabetic patients followed at the Yaoundé General Hospital and at the Yaoundé National Centre for Diabetology and Hypertension. The study was a 12-week, parallel-design, randomized controlled trial (n = 34 Intervention Group (IG), n = 34 Control Group (CG); non-randomized open-label clinical trial with 2 arms lasting 4 months from May to August 2022. Patients were included if they had type 2 diabetes and the HbA1c value between 7%-8.5%. It was carried out in two groups: an experimental group and a control group whose patients were followed for a period of 12 weeks. At the beginning and at the end of the study, we recorded their HbA1c and then determined their level of adherence to the diet by a modified score. Patients in the experimental group were given a diet detailing the different types of food to be favoured in 07 categories: starchy foods, vegetables, fruits, fish, meats, dairy products and beverages, all associated with 100g of ground cinnamon and a 3g pod to be consumed ad libitum throughout the intervention period, as well as telephone calls as a reminder 1 times/week, while participants in the control group were given only the diet. In total we recruited 32 participants in both the experimental and control groups. The glycaemic control of both groups at baseline was 7.7 (7.12-8.37) and 7.85 (7.3-8.5) for the control and experimental groups respectively. At the end of the intervention we noted a decrease in HbA1c of 1.8% in the control group and a significant decrease of 3.6% in the experimental group (p=0.031) although there was an average adherence to the diet in both groups. This study shows that a diet enriched with *Cinnamomum cassia* improves glycaemic balance and significantly reduced HbA1c in intervention group compared to control group. This effect can be improve if the recommended dietary measures are strictly adhered to.if the recommended dietary measures are strictly adhered to.

**Keywords:** Type 2 diabetes, diet, cinnamomum cassia, glycaemic control, HbA1c, National center for diabetes and hypertension (NCDH) of the central hospital Yaoundé (CHY), endocrinology and metabolism unit of the CHY

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## Introduction

Diabetes is defined by the World Health Organization (WHO) as a metabolic disease characterized by chronic hyperglycaemia resulting from a defect in insulin secretion and/or action (insulin resistance).[1] In 2024, an estimated 589 million adults aged 20 to 79 were living with diabetes, giving a prevalence of 11.1%. Almost one-in-two (42.8%; 251.7million) adults with diabetes were undiagnosed, with considerable regional differences. By 2030, forecasts suggest a prevalence of 643 million people with the condition. In Cameroon, in 2021, the number of people with type 2 diabetes was estimated at 4.8%, with a mortality rate of 2% per year among people aged between 20 and 70.[2] Traditional management of T2D involves lifestyle interventions, such as dietary modifications, increased physical activity, and weight management, alongside pharmacological treatments, including metformin, sulfonylureas, and glucagon-like peptide-1 (GLP-1) receptor agonists.[3] Although these methods are established, there are ongoing challenges in maintaining long-term glycemic control and minimizing complications. Additionally, pharmacological options may pose side effects or remain out of reach for patients in resource-limited settings.[3–4] This makes action to prevent diabetes a matter of the utmost urgency. It is clear that measures linked to lifestyle, dietary intake, therapeutic education and health care are necessary to mitigate diabetes and the complications that expose the diabetic person.

Complementary and alternative medicine offers potential cost-effective and accessible approaches compared to traditional methods. With T2DM presenting a significant global health challenge, marked by insulin resistance and declining pancreatic beta cell function, current strategies relying heavily on expensive medications like metformin may fall short.[5] Traditional Complementary Medicine therapies, known for their efficacy and reduced side effects compared to pharmaceutical treatments, offer a promising avenue for managing T2DM, often with a lower economic burden.[6] Among the alternative therapies used in diabetes management, we found Curcumin, noted for its antioxidant and anti-inflammatory properties, stands out as a promising nutraceutical; *Trigonella foenum-graecum*, or fenugreek, a fiber-rich legume, exhibits blood glucose lowering effects attributed to its fiber content and bioactive compounds like biguanide-related compounds and 4-hydroxyisoleucine; Momordica charantia, or bitter melon, purported to have insulin-like actions, has shown conflicting results in glucose-lowering efficacy, with recent reviews suggesting a reduction in HbA1c but with limited evidence from randomized controlled trials; Cinnamon, derived from Cinnamomum cassia trees, demonstrates insulin-like action attributed to procyanidin polymers, with studies indicating reductions in fasting plasma glucose (FPG) levels.[7–11] It is therefore undeniable that the need to change lifestyle and eating habits is paramount. Integrative and complementary practices, with the aim of implementing alternative treatments to conventional medicine, would be an asset for the management of diabetics, given the high cost of prescribed drugs and national budgets for public health services that are too limited to allow the availability and accessibility of drugs for all. In Cameroon, 60% to 70% of the population uses phytotherapy, there is insufficient evidence of its safety. However, among the many herbal medicines examined to date, special mention goes to one spice for its usefulness in reducing glycemic, lipid and even anthropometric biomarkers in diabetic patients, namely cinnamon, whose scientific name is Cinnamomum cassia. *Cinnamomum cassia* Presl is an aromatic tree species belonging to the Lauraceae family.[11,12] From the bark of its young branches, cinnamon is obtained, which is widely used all around the world for its fragrance and spicy flavor (Figure 1). It can be used not only as a daily condiment, but also as a raw material for medical products, and has high economic value It has been indicated that cinnamon (*Cinnamomum* spp), as a dietary component, contains biologically active substances that can regulate blood glucose by insulin-like properties. Such properties increase glucose uptake by activating the insulin receptor's autophosphorylation, glycogen synthase activity, and insulin receptor kinase activity.[13] Cinnamon is a prophylactic supplement of insulin resistance, metabolic syndrome, T2DM, hyperlipidemia, and arthritis in the market.[14]

**Figure 1** Cinnamomum cassia Presl (*Lauraceae*).

**Figure 1A** The Cinnamomum cassia tree.[11]

**Figure 1B** Cinnamomum cassia Sticks and powder of Picture from Ondoua, 2022.

In view of the encouraging results on the use of *Cinnamomum cassia* and the convincing evidence on changes in lifestyle and dietary habits to improve the quality of life of diabetic subjects, which would reduce the cost of managing this pathology in our context where primary health policies are still conjunctural to the controversial national economy. We found it relevant to carry out this study, the aim of which is to evaluate the effect of a diet enriched with *Cinnamomum cassia* on the glycemic control of type 2 diabetic patients followed in 2 hospitals in the city of Yaoundé.

## Material and methods

### *Study design*

This was an investigator-initiated, two-arm, open-label, multi-center study conducted from randomized clinical trial controlled intervention.

### *Participant recruitment*

Over a period of three months from May to August 2022 a prospective cohort study on patients with T2D (n= 32) namely **Intervention Group (IG)** and **Control Group (CG)** (n=32) matched for age and gender were randomly recruited from the patient the Center for Diabetes and Hypertension (NCDH) of the Central Hospital Yaoundé (CHY) and at the Endocrinology and Metabolism Unit of the Central Hospital (CHY) and were invited to participate in this study.

### *Nutritional intervention*

Participants were divided into 02 groups:

An **Intervention Group or IG** (daily meal + 100g of *Cinnamomum cassia* powder and a measuring spoon which was to be consumed as much as you want in the form of tea) and subjected to different diets only. A diet consisted of 07 food categories: starchy foods, vegetables, fruits, meats, fish, dairy products. They were carefully educated on the foods they should eat and avoid such as oils made from palm nuts, oily fish, fruits with a high glycaemic index and oils. No specific meals or menus were given to the participants. They were free to consume the foods of their choice based on the recommendations according to the American Diabetes Association (ADA) recommendations for nutrition therapy for adults with diabetes and prediabetes consensus report.[15]

**Control Group or CG** participants were asked to follow a conventional diet with a follow-up sheet for diabetics according to the ADA recommendations, in particular, restricting their individualized daily energy intake according to weight and physical activity; no specific meals or menus were given to the participants. They were free to consume the foods of their choice based on the same ADA recommendations as experimental group.

### *Common to 02 groups*

We provided nutrition education and instructions at week 0, 3, 6, 9 which helped participants to develop appropriate menu plans using the instructional materials: Dietary guidelines, cooking methods, advice/answers to questions and encouragement were provided to encourage them to record their daily food intake on the food registration form provided, which consisted of the type and amount of food consumed during the intervention period. Diet compliance was measured on a weekly scale, one (1) point was deducted in groups when daily food consumption was not kept in accordance with prescribed dietary tracking sheets.

### *Ethical considerations*

Selected patients was informed of the objectives and conduct of our study. For each patient recruited, we ensured anonymity and confidentiality. The informed consent of any person recruited after information about the study, the various agreements were obtained before the conduct of our study. We carried out the study in strict compliance with fundamentals of medical research:

I. The principle of interest and benefit of research;

II. The principle of research safety;

III. Respect for the privacy of participants;

IV. Confidentiality;

As a result, this protocol were submitted to the Faculty committee of the *Université des Montagnes* for the verification of compliance and medical ethics. We then received a clearance from the UdM Ethics Committee. In the field, we obtained study authorizations requested from the administrative services of the Yaoundé General Hospital (HGY) at the CNDH. Verbal and written consent from patients prior to recruitment were also abstained. The information collected during our study was only used for scientific purposes.

## Biochemical analysis

### Glucose analysis

Fasting plasma glucose was estimated using in our samples. Glucose in the sample is oxidized to yield gluconic acid and hydrogen peroxide in the presence of Glucose oxidase. The glucose is determined after enzymatic oxidation in the presence of glucose oxidase. The formed hydrogen peroxide reacts under catalysis of peroxidase with phenol and 4-aminoantipyrine to a red-violet quinoneimine dye as indicator (GOD-PAP method). We used the Roche Cobas 6000 analyser (Roche Diagnostics, Indianapolis, IN) and a test kit of glucose-oxidase-peroxidase method produced by Human Gesellschaft für Biochemica und Diagnostica mbH.

### Glycated hemoglobin estimation

Glycated hemoglobin was estimated using kits Finecare HbA1c rapid quantitative kit obtained from Guangzhou Wondfo Biotech Co, Ltd., China. The Finecare™ HbA1c rapid quantitative test is based on fluorescence immunoassay technology. Test uses a sandwich immunodetection method to measure percentage of HbA1c in human blood. After mixing with sample and buffer, sample mixture is added to the sample well of the test cartridge, the fluorescence-labeled detector HbA1c antibody binds to HbA1c in blood sample. Normal range : <6%

### Inclusion criteria

Patients were included if they had type 2 diabetes and an HbA1c between 7%-8.5%.

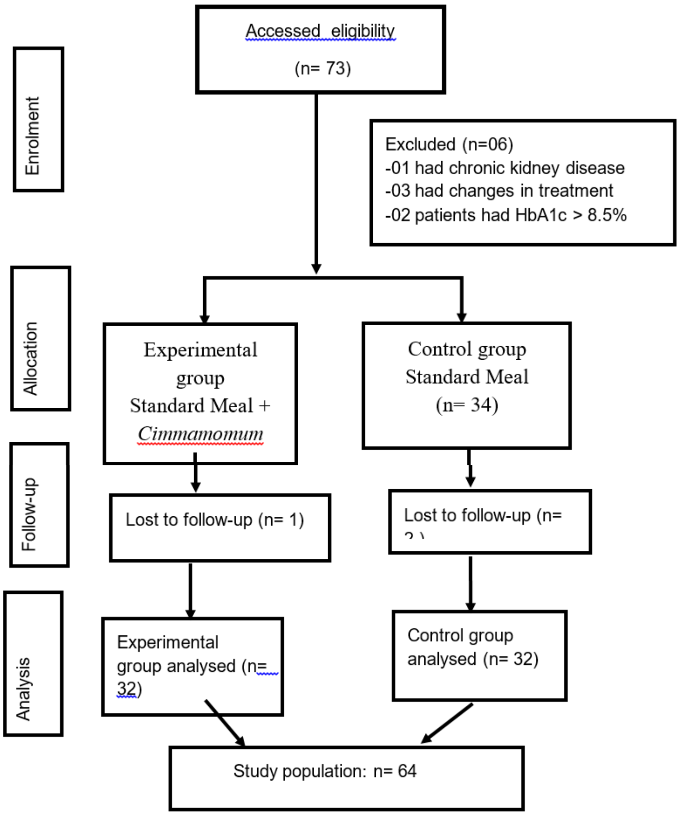
### Processing and statistical analysis

Study data were captured and analyzed using SPSS version 26.0 software. The tables were compiled using Microsoft Office Excel and Word 2010. Quantitative variables were expressed as standard deviation or median interquartile range means and qualitative variables were expressed as numbers and percentages. The comparison between the variables were made using Student's, Mann-Whitney's T-tests for the distribution of the data. The error threshold was set at 5% as statistically significant for each variable studied with its 95% confidence interval.

# Results

## Participant flow

Seventy three patients were assessed for eligibility during the recruitment (May to August 2022) six were excluded at the beginning intervention because of different reasons (chronic kidney disease, changes in treatment or patients who had HbA1c > 8.5%). During the follow up 3 patients were lost making at the analysis a study population of 64 participants equally, intervention (experimental) groups and control groups. (Figure 2).




Recruitment Flowchart

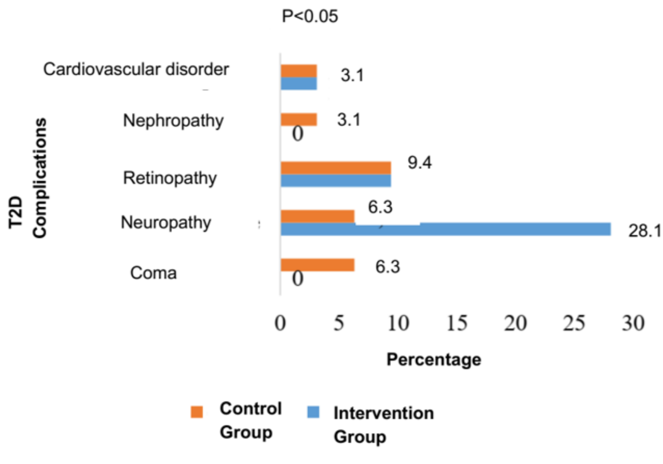



**Figure 2** Complications of diabetes mellitus.

## Changes in socio-demographic characteristic during intervention

Participants in this study were those who underwent screening for T2DM, with consideration given to various demographic factors. No significant differences in education, marital status, occupation, income, waist circumference were observed between non-diabetic controls and diabetic patients.

As the data in Table 1 indicate, mean age and mean body mass index (BMI) were similar between control groups and intervention groups (participants with diabetes and *Cinnamomum cassia* consumption).

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Hypertension was slightly prevalent in the participants with diabetes than in the intervention (51.85% vs. 48.14%). The FBG level was significantly different at the beginning of the study 1.09 g/L vs 1.27 g/L respectively for IG and CG. After 90 days follow up, mean fasting blood sugar was nearly the same in both groups. In both groups, the majority treatment was oral antidiabetic drugs at 59.4%, followed by the combination of oral antidiabetic insulin, the use of which predominates in the CG (40.6%) than in the IG (37.5%). There are no differences between the two proportions of groups under treatment.

**Table 1** Baseline demographic and clinical characteristics

| **Variable** | **Intervention Group, IG (%)(T2D + Cinnamomun c.)** | **Control Group, CG (%)(T2D)** | **P Value** |
|---|---|---|---|
| | **N= 32** | **N= 32** | |
| Demographic Characteristics | | | |
| **Age, years** | 61. 97 ± 12.96 | 62.66 ± 11.67 | |
| **Sex** | | | |
| Male gender | 10 (31,3) | 11(34,4) | 0,790 |
| Female gender | 22(68,8) | 21(65,6) | |
| Duration of disease (months) | 48 | 48 | |
| **BMI (kg/m2)** | | | |
| Day 0: Median (IQ) | 25.75(24.17-28.92) | 24.80(23.15-28.62) | 0.286 |
| Day 90 | 25.25(23.77-28.23) | 24.80(23.02-27.35) | 0.358 |
| **Waistline or W (m)** | | | |
| D0 | 91.18 ± 12.3 | 90.43 ± 13.61 | 0.818 |
| D90 | 89.75 ± 12,18 | 89.40 ± 12,71 | 0.261 |
| **Marital status** | | | |
| Married | 27 (84.4) | 25(78.1) | 0.494 |
| Single | 2 (6.3) | 1 (3.1) | |
| Widower | 3 (9.4) | 6 (18.8) | |
| **Educational status** | | | |
| Primary school | 3(9.4) | 6(18.8) | 0.49 |
| Secondary school | 17(53.1) | 17(53.1) | |
| University Level | 12(37.5) | 9(28.1) | |
| **Employment** | | | |
| Employed | 14 (43,8) | 15 (46.9) | 0.374 |
| Jobless | 4 (12.5) | 1 (3.1) | |
| Retired | 14 (43.8) | 16(50.0) | |
| **Clinical Characteristics** | | | |
| **Medical history** | | | |
| HTA | 13 (40.6) | 14 (43.8) | 0.8 |
| Tobacco | 0 | 1 (3.1) | 1 |
| Alcohol users | 6 (37.5) | 10 (62.5) | |
| **T2D treatment** | | | |
| LSM | 0 | 0 | 0,595 |
| OAD | 19 (59.4) | 19 (59.4) | |
| Insulin | 0 | 1 (3.1) | |
| OAD + Insulin | 12 (37.5) | 13 (40.6) | |
| **BP (mmHg)** | | | |
| SBP | 136.50 ± 18.284 | 139.09 ± 17.151 | 0.56 |
| DBP | 83.16 ± 14.90 | 80.84 ± 11.797 | 0.494 |
| **Glycaemic Status** | | | |
| FBG D0 (IQ) (g/l) | 1.09(0.99-1.40) | 1.27(0.97-1.61) | 0.368 |
| FBG D90 (IQ) (g/l) | 1.00(0.88 -1.11) | 1.08(1 – 1.03) | 0.009 |

**Legend:** IG, intervention group; CG, control group; D0, starting date of treatment, D90, end of follow-up; BMI, body mass index; HTA, hypertension; LSM, lifestyle modifications; OAD, oral antidiabetic agents; BP, blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBG, fasting blood glucose.

### *Adherence to dietary recommendation*

Taking into account glycaemia level, we noticed that patients with FBG level of 126 mg/dL or higher were time more likely to be non-adherent to the recommended diet. But with glycemia less than 126 mg/dL, about 71.9 % of patients in IG had mean adherent to the diet compared to 62.5% in CG.

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### T2D complications

Regarding the T2D Mellitus complications described in this study, 28.1% of the patients had neuropathy, followed by nephropathy subjects with 9.4%, coma subjects with 6.3% and cardiopathy with 3% (Figure 2).

### Markers of diabetes evolution

The results of statistical analysis revealed a significant difference between intervention groups and control groups in terms of mean values of glycosylated hemoglobin (p<o.001) such that the mean was lower in IG compared to CG (Figure 3 & 4).

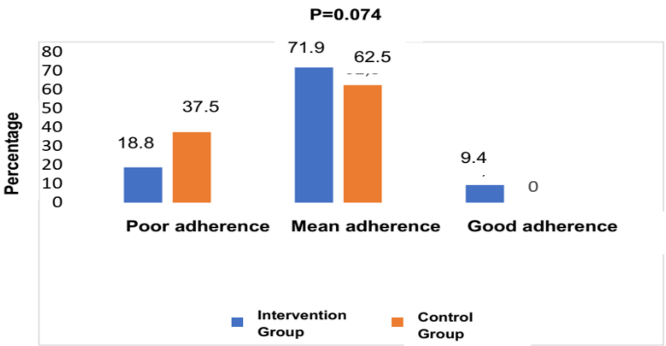


**Figure 3** Dietary adherence status of type 2 diabetic patients attending follow up at 02 Central Hospital of Yaoundé's Centers of Cameroon.

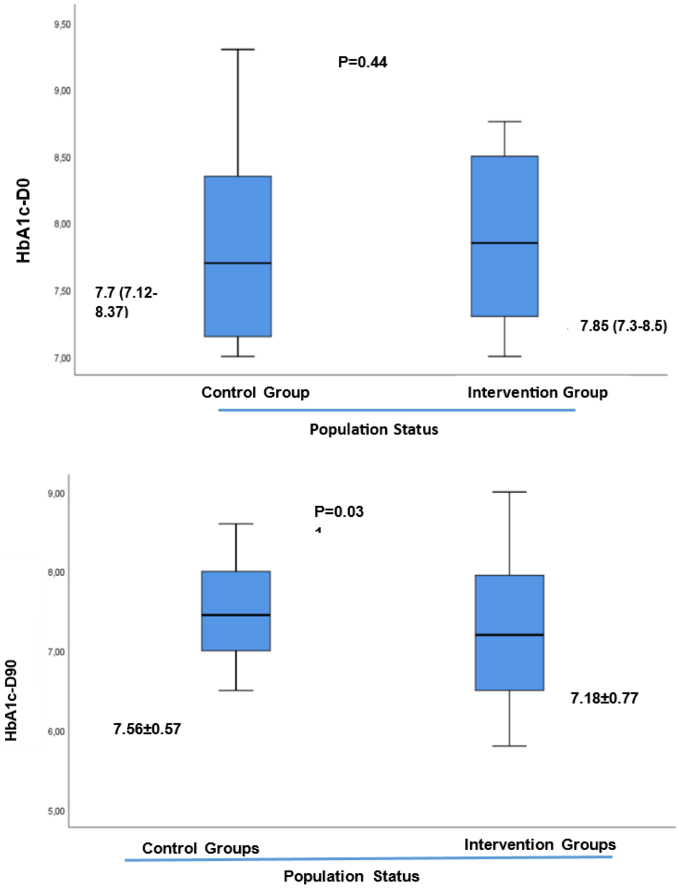


**Figure 4** Comparison mean of HBA1Cin the control group and intervention group after recommended diet enriched with Cinnamomum Cassia (Lauraceae). /Figure 4A: D0; Figure 4B: After the follow-up.

## Discussion

In the present study, the effects of adjunctive *Cinnamon Cassia* (Lauraceae) powder (in the form of Tea) combined with standard treatment in T2D patients at the 2 Centres of the Central Hospital of Yaoundé were evaluated. To the best of our knowledge, it was the first hospital based study conducted to identify the dietary habits of T2D patients associated with *Cinnamomum cassia* in the General Hospital of Yaoundé. If left untreated or when poorly controlled, Diabetes Mellius (DM) increases the risk of vascular complications such as hypertension, nephropathy, neuropathy, and retinopathy, which can be severely debilitating or life-threatening. This research showed that Diabetic Neuropathy (DN) was highly prevalent in T2D'study subjects, around 28% compared to other diabetic complications. DN preferentially targets sensory and autonomic axons; Different action mechanisms of DN included: the polyol pathways due to hyperglycaemia; hexosamine; The Advanced Glycation end Products (AGEs) formation; the protein kinase C pathway and the dyslipidaemia.[16] Our study is in line with the one published by Amelia et al. in 2019 showing that the majority of the research Type 2 DM patients had mild neuropathy as many as 24 people (45.3%) also they noticed that there was a significant relationship between age and the prevalence of diabetic neuropathy In theory, the important percentage of DN can be explained that increasing age stimulates the degeneration process and causes nerve cell damage.[17]

We observed that with less than 126 mg/dL, about 71.9 % of patients in IG had mean adherent to the diet compared to 62.5% in CG. Adherence to medication is a crucial part of patient care and indispensable for reaching clinical goals. Factors such as poverty or financial stress (social and economic), patient-related factors (eg. beliefs about medication), therapy-related factors like complex therapy regime, primary care follow-up and education in healthy lifestyle habits seem to positively influence adherence.[18] A study in Catalonia showed that more than 30% of patients on treatments like SGLT-2 »inhibitors had insufficient adherence at 24 months and another study with GLP-1 receptor agonists found that while initial adherence was 74%, it dropped down to 50% after 2 years.[19,20]

The glycated hemoglobin (HbA1c) test is a useful, economic, and practical clinical tool for long-term glycaemic control in patients with diabetes mellitus (DM); it is also is a good indicator for evaluating the efficiency of therapeutic interventions and selfcare in diabetic patients since it provides the mean blood glucose level in the past three months and can, therefore, calculate the complications caused by diabetes.[21] Consumption of *Cinnamon Cassia* (Lauraceae) powder (in the form of Tea twice daily for 12 weeks) with their recommended diet and treatment, results in significant reduction of glycosylated hemoglobin (HbA1c) in diabetic patients after day 90 in intervention group compared to control group; Instead, our study is to be differentiate with that of Mangs and al. (2006), who showed that in Western type 2 diabetics treated, the intake of an aqueous cinnamon extract leads to a moderate effect on fasting plasma glucose, but not on HbA 1c. This can be justified by the phytochemical difference during the preparation process of the medication. Anyway, HbA1c is considered as a marker of microvascular diabetic complications.[21,22] It was confirmed that in patients with T2DM/DM1, HbA1c is an excellent risk marker that predicts the development and aggravation not only of microvascular diabetic lesions but also of macrovascular ones, well. According to the DCCT,[23] lowering HbA1c in young patients with DM1 less than 7% was associated with a 50-76% reduction of microvascular diabetic lesions,54 while the UKPDS trial showed that a value of HbA1c of 7% diminished the risk of all diabetes related endpoints by 12-32%.[24]

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## Concluding remarks

The data supported the hypothesis that a diet enriched with *Cinnamomum cassia* the mean fasting blood sugar was nearly the same in both groups and also revealed a significant lowering A1C levels compared to control group after 90 days follow up. This effect can be improve if the recommended dietary measures are strictly adhered to. Its multifaceted biochemical actions targeting fasting blood glucose levels and glycated hemoglobin, position cinnamon cassia as promising complementary in diabetes management.

## Acknowledgements

None.

## Conflicts of interest

The authors declare that there are no conflicts of interest.

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