Journal of Traditional and Complementary Medicine xxx (2015) 1–5

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Contents lists available at ScienceDirect

Journal of Traditional and Complementary Medicine

journal homepage: http://www.elsevier.com/locate/jtcme

Original article

Cinnamon extract lowers glucose, insulin and cholesterol in people with elevated serum glucose

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A R T I C L E I N F O

Article history:
Received 25 February 2015
Received in revised form
12 March 2015
Accepted 13 March 2015
Available online xxx

Keywords:
Cinnamon
Type A procyanidin polyphenols
Insulin sensitivity
Glucose
Lipids

A B S T R A C T

Cinnamon (肉桂 ròu guì) has *in vitro* insulin potentiating activity, and proanthocyanidins from cinnamon prevent *in vitro* formation of advanced glycation end products. Some human studies were equivocal, but several have shown beneficial effects of cinnamon supplementation on circulating glucose, lipids, and/or insulin. This placebo-controlled double-blind trial tested the effects of a dried water extract of cinnamon (*Cinnamomum cassia*) on circulating glucose, lipids, insulin, and insulin resistance. Men and women from Beijing and Dalian, China, were invited to participate if they had fasting serum glucose >6.1 mmol/L or 2-h glucose >7.8 mmol/L. Participants, (173 were enrolled and 137 completed the study) were randomly assigned to receive either a spray-dried, water extract of cinnamon (CinSulin®), 250 mg/capsule, or a placebo, twice a day for two months. Mean ± SEM age of participants was 61.3 ± 0.8 years, BMI was 25.3 ± 0.3 and M/F ratio was 65/72. After 2 mo, fasting glucose decreased ($p < 0.001$) in the cinnamon extract-supplemented group (8.85 ± 0.36 to 8.19 ± 0.29 mmol/L) compared with the placebo group (8.57 ± 0.32 to 8.44 ± 0.34 mmol/L, $p = 0.45$). Glucose 2 h after a 75 g carbohydrate load, fasting insulin, and HOMA-IR also decreased with cinnamon extract compared with placebo. Total and LDL-cholesterol decreased with cinnamon extract and HDL-cholesterol decreased in both the cinnamon-extract and placebo groups. In conclusion, supplementation with 500 mg of water-extract of cinnamon for two months reduced fasting insulin, glucose, total cholesterol, and LDL cholesterol and enhanced insulin sensitivity of subjects with elevated blood glucose.

1. Introduction

Cinnamon (*Cinnamomum verum, Cinnamomum zeylanicum*; 錫蘭肉桂 xī lán ròu guì) and cassia (*Cinnamomum aromaticum*; 中國肉桂 zhōng guó ròu guì) have a long history of uses as flavoring agents, preservatives, and pharmacological agents.[1] In addition, in 2004, Khan et al[2] reported that subjects with type 2 diabetes given 1, 3 or 6 g of ground cinnamon per day for 40 days showed significant reductions in fasting serum glucose (18–29%), triglycerides (23–30%), LDL cholesterol (7–27%), and total cholesterol (12–26%) with no significant changes in the placebo group. Several follow-up human studies have also reported beneficial effects of cinnamon on people with varying degrees of glucose intolerance ranging from normal to type 2 diabetes.[3–13] Not all studies have reported beneficial effects of cinnamon or cinnamon extracts in human supplementation trials. However, three of four recent meta-analyses conclude that there are positive effects of supplemental cinnamon or cinnamon extract and that further studies are needed.[10,14–16]

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Peer review under responsibility of The Center for Food and Biomolecules, National Taiwan University.

http://dx.doi.org/10.1016/j.jtcme.2015.03.005

One region where further studies are needed is China with only a single positive study.[13] The present study used a spray-dried water-extract of cinnamon for supplementing adults with hyperglycemia in a placebo controlled double-blind two-month trial conducted in China. In China, it is estimated that there are 90 million people with diabetes and over 150 million people with pre-diabetes who are likely to become diabetic due to the current rapidly changing lifestyle in China.[17] (替代醫療 tì dài yī liáo) are urgently needed to control the hyperglycemia which precedes the escalating incidence of type 2 diabetes and the resulting exploding health care costs.

2. Research design and methods

2.1. Study participants

Men and women with fasting serum glucose >6.1 mmol/L or 2-h glucose >7.8 mmol/L from the clinic of the General Hospital of the 2nd Artillery, Beijing Tang-An Clinic and Dalian Dakang Clinic, in Beijing and Dalian, China, were invited to join this study. Exclusion factors were fasting glucose >20 mmol/L or 2-hr glucose >25 mmol/L, serum insulin <5 IU, taking insulin therapy, or serious complications such as cardiac/cerebral vascular diseases, or renal dysfunction. The study was approved by the human use committee of both hospitals and all participants gave informed consent.[18] Initially 173 persons were enrolled in the study, 89 in the placebo group and 84 in the treatment group. A total of 137 completed the study with 73 in the placebo group and 64 in the treatment group. No complications were reported in either the placebo or the treatment groups; the 36 subjects who did not complete the study were dropped because of a change in medication or missing a blood draw. Participants were asked to return their capsule bottles to allow study personnel to confirm study compliance.

2.2. Study design

Study participants were assigned to groups using a random number table in this double-blind placebo-controlled trial. The treatment group received a commercially available spray-dried water extract of cinnamon (肉桂 ròu guì) (CinSulin®) containing more than 4% type A procyanidin polyphenols,[19] in 250 mg capsules, twice a day. (This product does not contain added chromium or Vitamin D which is found in some commercial products using the same name). Type A procyanidin polyphenols are associated with insulin potentiating,[19–22] antioxidant[5,23] and anti-inflammatory activities.[24,25] The control group received placebo capsules which contained 250 mg of dark brown (baked) wheat flour and were very similar in appearance to the cinnamon extract.

2.3. Outcomes

In the present study, the by-group differences in fasting and in 2-hr serum glucose and in insulin resistance estimated as HOMA-IR were the primary outcome variables. Additional measurements included systolic and diastolic blood pressure, serum lipids, and fructosamine.

2.4. Anthropometry and clinical procedures

Height and weight were measured initially and weight was repeated at the end of the study. Subjects wore light clothing and removed their shoes for these measurements. Body mass index was calculated as weight (kg) divided by height (m^2). The Chinese Nutrition Society recommends BMI cutoffs of 28 for obesity and 24 for overweight.[26]

Blood pressure was measured after the participants had rested for 15 min and measurements were repeated two times. Post-prandial glucose was obtained by measuring plasma glucose two hours after each participant consumed 100 g of white steamed bread (equivalent to 75 g of carbohydrate).

2.5. Biochemical analyses

Serum glucose and lipids were analyzed on a Hitachi 7071A clinical analyzer. Insulin was analyzed by radioimmunoassay and fructosamine with a kit from RANDOX Laboratories.

2.6. Quantitative glycemic measures

The homeostasis model assessment for insulin resistance (HOMA-IR) was used as a proxy measurement of insulin sensitivity. HOMA-IR was calculated as (fasting serum glucose × fasting serum insulin) divided by 22.5.[27]

2.7. Statistical analyses

Descriptive statistics were summarized as means and standard error of the mean using the SAS version 9.1 (SAS Institute, Cary, NC). Parameters that were heavily right skewed (fasting insulin, HOMA-IR, and triacylglycerols) were log transformed prior to statistical analyses. Treatment effects were analyzed using analysis of variance with repeated measures (PROC MIXED) with an autoregressive period 1 error structure. The simple effect of treatment given time (SLICE option in an LSMEANS statement) was used to identify significant changes from baseline with supplementation with cinnamon extract.

3. Results

3.1. Baseline characteristics of subjects

Mean ± SEM age of participants was 61.3 ± 0.8 y; 47% were men. Mean body mass index (BMI) was 25.3 ± 0.3 but 56% of the subjects had BMI between 24–28, which based on Chinese standards,[26] is classified as overweight; nearly 14% were classified as obese with BMI >28. Participants were hyperglycemic with baseline fasting glucose values of 8.70 ± 0.24 mmol/L (Table 1). Baseline parameters for the entire group for fasting insulin, postprandial glucose and insulin, lipids and blood pressure are also shown in Table 1.

Fasting insulin and HOMA-IR were significantly higher in the overweight and obese groups than in the normal weight group (Table 1). The insulin at 2 h after a glucose load was markedly and significantly higher in the obese group than in the groups with lower BMIs. Glucose and fructosamine values were not different for the three BMI groups. Diastolic blood pressure was significantly higher in the obese group. Total cholesterol and LDL-cholesterol were not significantly different by BMI, but HDL-cholesterol was significantly lower in the overweight and obese groups and triacyglycerols were higher in those two groups.

At baseline, homeostasis model assessment-estimated that insulin resistance (HOMA-IR) was significantly correlated with diastolic blood pressure ($r = 0.23$) postprandial glucose ($r = 0.45$), insulin ($r = 0.42$), triacylglycerols ($r = 0.29$), fructosamine ($r = 0.23$), and BMI ($r = 0.29$) and negatively correlated with HDL-cholesterol ($r = 0.37$).

Participants were assigned to placebo or treatment groups using a random number table. There were no significant differences at baseline in any parameters between the two groups (Table 2). After