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Review

To what extent does cinnamon administration improve the glycemic and lipid profiles?

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SUMMARY

Background & aims: Cinnamon is a condiment used in cooking and by some in large quantities as a supplement with purported hypoglycemic and lipid-lowering potential. The current literature review aims to discuss the evidence of cinnamon administration regarding its hypoglycemic and lipid-lowering effects, summarizing clinical recommendations.
Methods: Electronic databases including PubMed, Cochrane library, Science Direct and Web of Science were searched with the scientific name of the plant as well as the common name. The search for articles was based on following keywords: "cinnamon diabetes", "cinnamon diabetes type 2", "cinnamon and diabetes type 2", "*Cinnamomum aromaticum*", "*Cinnamomum cassia*", "*Cinnamomum verum*", "*Cinnamomum zeylanicum*". We carried out inclusion criteria between 2003 and 2018 focusing on human studies.
Results: Concerning glycemic profile, in individuals with type II diabetes mellitus the fasting blood glucose reduced from 12.9 to 52.2 mg/dL and HbA1c from 0.27 to 0.83%, whereas serum insulin decreased in few studies. Research papers ranged from 6 to 17 weeks in duration. The lipid lowering potential, in turn, is most controversial compared to anti-hyperglycemic potential. Also cinnamon administration has been claimed to reduce fat mass and raise serum antioxidants, but the studies used inaccurate methods. Two species are most investigated, *C. cassia/aromaticum, and C. zeylanicum/verum*.
Conclusions: About 1–6 g of these cinnamon species mainly in powder seems to be an adjunct drug treatment for type 2 diabetes mellitus and other conditions of glycemic impairment. However, more controlled clinical trials are needed.

1. Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disease whose prevalence is progressively increasing throughout the world. The number of people affected by the disease is expected to double in the next decade due to the population aging and the raised health costs [1]. It is estimated that 552 million people worldwide will have diabetes in 2030, which 439 million would be T2DM, about 90% of global diabetes cases [1].

In addition to confirming the increased diabetes prevalence as a function of growth population and aging, data between 1980 and 2014 from several countries, involving more than 4 million adults, showed that the number of adults with diabetes quadrupled during this period [2]. Based on estimates for the people number with diabetes in 2014, the annual cost of this disease in the world was $825 billion [2], which the countries that suffer most are the low and middle-income countries, resulting in 80% of people with T2DM [1].

T2DM can be delayed through lifestyle modification and diet control [1]. Public health prevention strategies are paramount to prevent or improve the T2DM control, leading people to adopt a healthier lifestyle, including nutritional and exercise strategies [3]. Within these changes, according to the US Department of Agriculture (USDA), 1,797,000 kg of cinnamon were imported into the US in 2005 for general consumption, exhibiting good accessibility and cost [4]. Cinnamon has appeared in the market as a promising supplement for T2DM, obesity and dyslipidemia treatments; is used in integrative and traditional medicine, both in capsule-based pharmaceutical form or as a seasoning.

Cinnamon is a condiment used in cooking since biblical times, and has been considered a nutraceutical for T2DM [5]. Various shell types represent the *Cinnamomum* genus, which 90% of the essential bark

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oil is composed of cinnamaldehyde, one of the active components that confers typical taste and odor [6]. Active cinnamon components may affect in vitro glucose intracellular metabolism [4].

Of the 59 types of spices and herbs, the antioxidant content of cinnamon was only lower than clove, peppermint and allspice, presenting 77 mmol/100 g of antioxidants [6]. Since cinnamon is rich in antioxidant compounds, such as cinnamaldehyde, its intake by humans may be useful in combating the hyperglycemia damage, like diabetic neuropathy and even hyperlipidemia.

Hence, this review aims to discuss the main impacts of the cinnamon administration in humans as a supportive therapy of glycemic and lipid profiles. Body weight loss and safety parameters were also explained.

2. Methods

Electronic databases including PubMed, Cochrane library, Science Direct and Web of Science were searched with the scientific name of the plant as well as the common name. The search for articles was based on following keywords: "cinnamon diabetes", "cinnamon diabetes type 2", "cinnamon and diabetes type 2", "*Cinnamomum aromaticum*", "*Cinnamomum cassia*", "*Cinnamomum verum*", "*Cinnamomum zeylanicum*".

As shown in the Fig. 1, the literature search resulted in the identification of 1465 titles, of whom 120 abstracts were retrieved. Of the 120 abstracts, 39 were considered potentially relevant and their full-length versions were retrieved. Finally, 23 full-length publications were included, which encompassed the use of cinnamon powder or water cinnamon extracts in human interventions. We carried out inclusion criteria between 2003 and 2018 focusing on human studies.

2.1. Proposed pathways

Figure 2 show six possible that steps summarizes the expected mechanisms of action and repercussion on biochemical parameters after administration of cinnamon (Fig. 1).

2.2. Acute hypoglycemic cinnamon effect by carbohydrate overload

Given glucose uptake improvement, the cinnamon intake may be a food condiment to be used in various sweet preparations, however, does not justify the uncontrolled carbohydrates intake. Several studies have already proven the effectiveness of cinnamon intake along with carbohydrate-rich test meals, simulating the daily food adherence of the patients [13–18].

Solomon and Blannin (2007) submitted 7 healthy volunteers to 3 Oral Glucose Tolerance Test (OGTT), which 75 g of dextrose (diluted in 300 mL of water) was ingested with 5 g of placebo, 5 g of cinnamon or 5 g of cinnamon intake 12 h before. When cinnamon was ingested concomitantly with dextrose and 12 h before dextrose, the area under curve calculation (AUC) of total glycaemia 2 h after glucose overload was reduced by 13% and 10%, respectively, compared to the intake of dextrose only. However, total serum insulin did not change in this period [13].

Hlebowicz et al. (2007) showed efficacy of 6 g of cinnamon intake added to rice pudding portion by healthy patients; they reduced the postprandial blood glucose after 135 min when compared to pudding only intake [14]. Two years after the previous study [14], Hlebowicz et al. (2009) provided 300 g of rice pudding with 1 g of cinnamon or 3 g of cinnamon and pudding without cinnamon (control group) for healthy individuals. When cinnamon containing puddings were consumed, there was lower postprandial insulin secretion at 60 min compared to the control group. However, mean blood glucose did not differ between groups [15].

Since vinegar may exhibit a certain hypoglycemic effect in humans, whose acetic acid is the main active principle, Mettler et al. (2009) assigned young subjects to 4 test meals (minimum 2 days between them) based on rice milk drink enriched with glucose equivalent to 75 g of carbohydrates. The tests were the pure drink (control), added to 4 g of cinnamon, added to 1.8 g of acetic acid (equivalent ~2 tablespoon of vinegar) or added to these amounts of cinnamon and acetic acid. Through 2-h postprandial blood collections there was only glycaemia lower among individuals who used

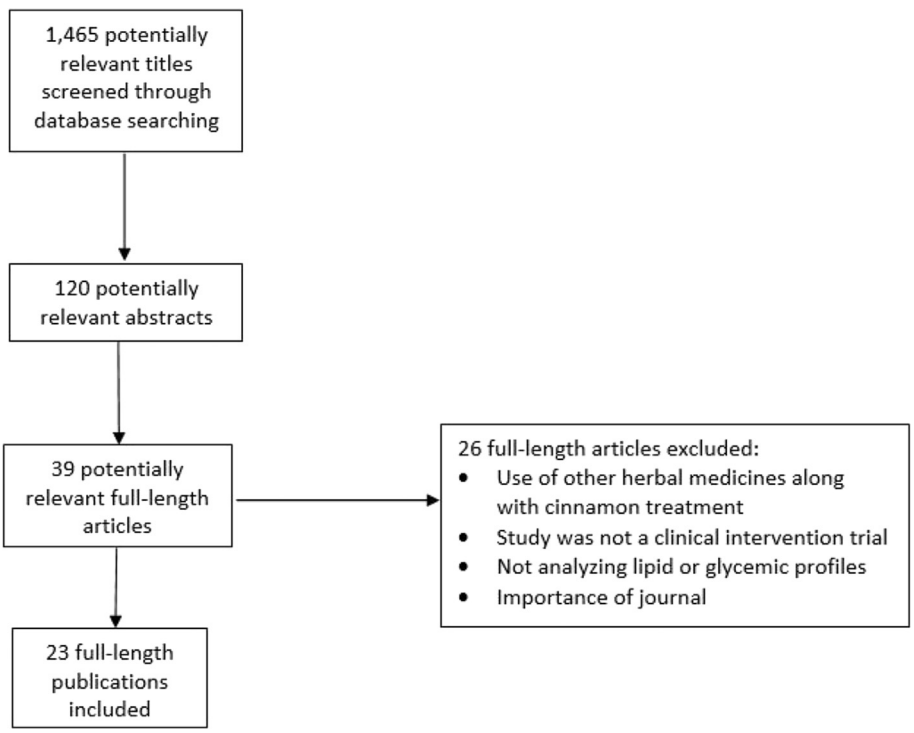

Fig. 1. Flow diagram of the literature process.

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