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Ameliorative impact of cinnamon against high blood pressure; an updated review

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ABSTRACT

High blood pressure (BP) or hypertension is a vital people health challenge in both developed countries and economically developing ones. By commencing a few novel food habits, containing counting calories and observing portion sizes, individuals can lower their BPs and modulate administered drugs to regulator high BP better. Additionally, some herbal drugs may be able to lower BP. Over the past centuries, cinnamon has been consumed as a traditional remedy in China. Cinnamon, the everlasting tree of tropical medication, belongs to the *Lauraceae* clan. In fact, cinnamon is one of the most main spices consumed daily by people globally. The accessible in vitro and preclinical data suggest that cinnamon has anti-antioxidant, anti-inflammatory, antitumor, antimicrobial, cholesterol-lowering, cardiovascular protecting, and immuno-modulatory effects. Likewise, numerous researches have demonstrated its beneficial effects on BP. In this review, therapeutic effects of cinnamon particularly on BP and on patients having type II diabetes mellitus will be reviewed.

Review

Implication for health policy/practice/research/medical education:
Cinnamon and constituents of cinnamon have been presented to have helpful effects on essentially all of the agents related to metabolic syndrome, containing blood glucose regulation, insulin sensitivity, lipids, inflammation subsiding, antioxidant property, high blood pressure and body weight reduction efficacy.

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Introduction

Blood pressure (BP) is controlled, moment by moment, by the balance between heart outputs against total peripheral resistance and alters depending on position, activity, emotional state, and relative health/disease conditions. It is controlled by the brain through both the endocrine and nervous systems (1). On the other hand, BP is not stable and spontaneous variations in BP exist (2). Disorders of BP control include; low BP, high BP and BP that exhibits in excessive or in abnormal fluctuation (1). In 1987, Parati et al provided the first data of an association between 24 hours BP variability (BPV) and the intensity of organ injury (3). Lastly, it was discovered that, an optimum level of BP is associated with less organ injury than patients in with high BP (3).

Over the past 20 years dietary fiber has appeared as a leading dietary influence in the inhibition and treatment of chronic diseases. High fiber consumptions are related to, decreased risk of certain forms of cancer, lower risk of coronary heart disease, lower serum cholesterol concentrations, decreased BP, better glycemic control, increased weight control and recovered gastrointestinal function (4). As a matter of fact, herbal medicines with high quantities of phytochemicals have been emerged to have beneficial influences on BP, anthropometric measures and endothelial function (5).

Equally important, cinnamon has been consumed in several cultures for periods as a spice and also as a traditional herbal medicine (6). In other words, cinnamon, a plant of the laurel species *Lauraceae*, as a spice in numerous cultures for centuries (6), has been consumed in China for thousands of years against many diseases, for instance the "thirsty disease," which was an old expression for diabetes in China before the expression

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diabetes mellitus was created in modern medicine (7). In addition, some evidences recommend that cinnamon may be efficient in the supportive remedy of cancer, infectious diseases, and complaints related with modern life style owing to its antioxidant, antimicrobial, anti-inflammatory, and BP-lowering properties (6).

The bark is the only ingredient of this plant that is consumed in the function of a spice or for medical intentions (*Cinnamomi cortex*) (8). As a matter of fact, the bark of diverse cinnamon species is one of the most important and general spices used universal not only for cooking but also in traditional and present medicines. On the whole, approximately 250 species have been recognized among the cinnamon genus, with trees being distributed all over the Earth (9) . In addition, Cinnamon bark possesses catechins and procyanidins (10). The constituents of procyanidins contain both procyanidin A-type and B-type bonds (11). These procyanidins are taken out from cinnamon and berries. They also own antioxidant activities (11).

In the same way, the most important ingredients of cinnamon is *trans*-cinnamaldehyde or cinnamaldehyde (Figure 1), which exists in the essential oil, therefore donating to the fragrance and to the diverse biological activities perceived with cinnamon (12).

Equally important, in 2008, a study by Chang et al on *Cinnamomum osmophloeum* demonstrated that the essential oil from cinnamon leaves includes a high level of cinnamon. Subsequently, *C. osmophloeum* is also used as a replacement spice for *C. cassia* (13). One of the main constituents of essential oil obtained from *C. zeylanicum* termed (E)-cinnamaldehyde has an antityrosinase activity (14), whereas cinnamaldehyde is the main compound accountable for this activity (15).

The purpose of this paper is to review recent researches in the therapeutic efficient of cinnamon particularly on high BP disease, and patients with prediabetes and type 2 diabetes mellitus (T2DM).

Materials and Methods

For this review, we used a variety of sources by searching through Web of Science, PubMed, EMBASE, Scopus and directory of open access journals (DOAJ). The search was performed using combinations of the following key words and or their equivalents such as; cinnamon, high blood pressure, hypertension and type II diabetes mellitus.

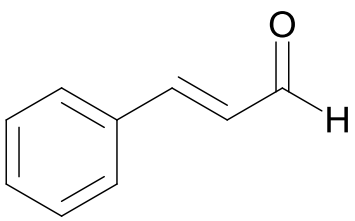

Figure 1. Structure of *trans*-cinnamaldehyde or cinnamaldehyde.

Results

The therapeutic effects of cinnamon

Cinnamon has a long history of consumption in traditional medicine, but there is few evidences on its interacted pathophysiological mechanisms (16).

As above noted, cinnamon is a spice generally used in cooking that derives from the bark of the cinnamon tree. When the bark is eliminated, it is termed cinnamon stick. It has also been consumed as medicine in traditional curing systems for ages. The fresh cinnamon sticks are crushed to prepare tea, to cook into sprinkle on toast, desserts or cereal. Since it may act together with certain medicines, it is notable to check other drugs before using cinnamon (17).

Actually, cinnamon is an aromatic spice that is a good source of iron, calcium and manganese. It can help relieve indigestion pain and toothaches. This creates it ideal for cooking and remedial use (18). In addition, cinnamon is highly disinfected, because it has a high phenolic content, which creates it effective against toothache and as a mouthwash remedy. Also, cinnamon stick is chewed to reduce toothache and refresh the breath. If it is ground and inserted to water and added fresh mint can be gurgled as a mouthwash. Likewise, cinnamon aids weak digestion, and aids ease muscle pain, arthritis and rheumatism, thus chewing a cinnamon stick, preparing tea with it or crushing the cinnamon stick and inserting it to food can be help the people who suffer from any of these disorders (18). In the same way, cinnamon is a coagulant and stops bleeding (19). It also enhances the blood circulation in the advances tissue renewal and uterus (20).

On the whole, this plant performs a key role as a spice, but its essential oils and other ingredients also have important activities, counting antifungal (21), antimicrobial (22), antidiabetic (23), antioxidant (24), anti-inflammatory (25), antitermitic (25), antimycotic (26), nematicidal (27), insecticidal (26), mosquito larvicidal (28), and anticancer activities (29).

The therapeutic effect of cinnamon on hypertension

More than 20 years have passed since the national high BP education program was started and its early report on the detection, assessment and remedy of patients with hypertension was published (30).

Hypertension is a critical public health challenge in both developed countries and economically developing ones owing to its high prevalence and concomitant rise in risk of disorder (31). It is the most significant modifiable risk agent for cerebrovascular, cardiovascular, and renal disease (32). The relative risk assessment collaborating group has recognized hypertension as the leading worldwide risk agent for mortality and as the third leading risk agent for disease burden (33). While hypertension is well-known as a main cause of morbidity and mortality in the economically developed globe, the significance of hypertension in economically developing countries is less

well created (32). Considerable numbers of persons with hypertension are unaware of their situation and, among those with identified hypertension, treatment is frequently inadequate. Measures are needed at a population level to inhibit the development of hypertension and to develop awareness, remedy and control of hypertension in the society (32).

The reported extensiveness of high BP is varied worldwide, with the highest level in Poland (68.9% in men and 72.5% in women subjects) and the lowest level in rural India (3.4% in men and 6.8% in women subjects). Awareness of high BP was about 46% of the examinations and was different in several countries (for example 25.2% in Korea and 75% in Barbados, also 10.7% in Mexico and 66% in Barbados). Furthermore, the subjects on antihypertensive medicines are also different from 5.4% in Korea to 58% in Barbados (32).

In the same way, the United States national high BP education program coordinating committee has advised six approaches with proven effectiveness for the initial prevention of hypertension (34). These interventions contain dietary sodium reduction, weight loss, physical activity, limitation in alcohol consumption, potassium supplementation and variation of whole diets (34).

Therefore, the influence of dietary composition on BP is a subject of public health significance (35). Dietary approaches to stop hypertension (DASH) experimentally demonstrated that a regimen which emphasizes on vegetables, fruits, and low-fat dairy crops, and contains whole grains, fish, poultry, and nuts, that includes only small quantities of sweets, red meat, and sugar-containing beverages, and which includes decreased quantities of total and saturated fat and cholesterol lowers BP considerably both in persons with hypertension and those without hypertension, as contrasted with a usual diet in the United States (36).

In animal investigations, cinnamon has been appeared to reduce BP. In 1975, Mastoshi and Shingo showed that cinnamaldehyde creates hypotensive effects, which are perhaps due to outlying vasodilatation in guinea pigs and anesthetized dogs (37). The vasodilatation caused by cinnamaldehyde in dogs lasted and stayed over the recovery time of the fall in BP to the baseline (38). In 2011, Xue et al indicated that cinnamaldehyde increased rat vascular smooth muscle in an endothelium-independent method. The capability of cinnamaldehyde in vasodilatory performance might be due to inhibition of both Ca^{2+} invasion and Ca^{2+} discharge (39). Likewise, cinnamaldehyde prevents the development of hypertension in types I and II diabetes by reducing vascular contractility, as well as its insulinotropic effect in insulin fault (40).

In the other words, cinnamon (8% w/w) in the regimen decreased the systolic BP of spontaneously hypertensive rats (SHR) consuming sucrose-containing regimen to nearly the same levels as SHR consuming regimens including non-sucrose. Additionally, the presence of cinnamon in the diet reduced the systolic BP of SHR consuming a non-sucrose-containing regime, proposing that cinnamon degrades more than just sucrose-induced BP raises (6).

Besides, *C. cassia* bark influences on the cardiovascular and blood system (41). In 1995, Zhou et al published a paper in which they described that the actions of *C. cassia* bark was related to the amount of atrial natriuretic factor (ANF) in the plasma of mice (42). ANF performs to decrease the sodium, water, and adipose put in the circulatory system, thereby reducing BP (6). Likewise, ANF was considerably higher in the plasma of mice next giving *C. cassia* orally, compared with regulator ($P<0.001$) (6).

On the whole, accessible in vivo data powerfully support the hypothesis that cinnamon lowers systolic BP in experimental animals (6).

Cinnamon on BP regulation in patients with pre-diabetes and T2DM

Hypertension is very common in persons with T2DM, influencing up to 60% of the people (43). In 2006, Ziegenfuss et al (44) and, in 2010, Akilen et al (45) exhibited a significant decrease in systolic BP or diastolic BP followed by a considerable reduction in glycemic signs (fasting plasma glucose or HbA1c).

Insulin resistance and T2DM are rapidly rising throughout the world. In 1990, it was stated that compounds discovered in cinnamon (*Cinnamon cassia*) had insulin-potentiating attributes and might be involved in the improvement of the signs and indications of diabetes and cardiovascular disorder associated to insulin resistance (46). Cinnamon has been reported to positively affect the insulin system (45). Several combinations of essential oils counting cinnamon, fenugreek, cumin, and oregano have been exhibited to increase insulin sensitivity in vitro trials. In 2005, Talpur et al realized that the capability to alter systolic BP in rat models was the most sensitive primary index of insulin sensitivity (47). The merged essential oils reduced circulating glucose concentrations and systolic BP in both Zucker fatty rats (an example of insulin resistance and fatness) and SHR (an example of genetic hypertension), recommending that these natural products are able to increase insulin sensitivity (6).

Utilization of cinnamon (short term) is related with a notable decrease in systolic BP and diastolic BP. Even though cinnamon exhibits hopeful influences on BP-dropping potential, it would be premature to advise cinnamon for BP control owing to the limited number of investigations available. Therefore, a long-term, sufficiently powered randomized controlled trial (RCT) containing a larger number of patients is required to assess the clinical potential of cinnamon on BP regulator among patients with T2DM (48).

Discussion

Spices, consumed in Indian cooking, have a long record of use as drugs to prevent and treat diseases. Many investigates

have proved that spices can be useful drugs, but the main challenge is now to provide scientific data and reasonable mechanisms for their remedial responses (49).

Cinnamomum is a middle sized evergreen tree, about 10-15 m tall, innate to Southern India and Sri Lanka (50), but also is found in central to Burma, southern mainland China, Cambodia, Malaysia, Taiwan and Indonesia (51). In brief, the tree is dispensed in regions between 500 and 1500 m in height. Its bark has been extensively used as a flavoring and spice agent for periods. Cinnamon has been suggested to have many pharmacological attributes, containing antimicrobial effects and antioxidant activity (52).

Numerous reports have distributed with the numerous attributes of cinnamon in the forms of, essential oils, bark, bark powder, flavonoids, phenolic compounds, and isolated constituents. Each of these attributes plays a vital role in the improvement of persons health (53). In fact, Akilen et al found that the regimen of cinnamon decreased both systolic and diastolic BP in T2DM from 132.6 to 129.2 mm Hg and 85.2 to 80.2 mm Hg, one-to-one (45). In spite of this, the exact BP-lowering procedure of cinnamon is still unknown and new studies are required to explain this issue (54).

As a matter of fact, cinnamon and constituents of cinnamon have been presented to have helpful effects on essentially all of the agents related with metabolic syndrome, containing glucose, insulin sensitivity, lipids, inflammation, antioxidants, high BP, and body weight. In addition, agents associated with related disorders, containing stroke, Alzheimer's disease, and cancer, have also been exhibited to be improved by cinnamon and its constituents in in vitro findings (55).

The influence of cinnamon on systolic BP and diastolic BP at baseline and post-interference is exhibited in Table 1. Two RCTs exhibited significant decrease in systolic BP (45), and another study showed marginally significant decrease in systolic BP (56). In contrast, two RCTs did not exhibit any significant decrease in diastolic BP (44), in spite of this, one study exhibited significant decrease in diastolic BP (45).

On the whole, up to now, there have been numerous suggested procedures of cinnamon's action, these contain postponed gastric emptying, risen glycogen synthesis by motivating glycogen synthase, and preventing glycogen synthase kinase 3b. But no one suggested a perfect understanding (54).

Conclusion

The present review provides additional evidence with respect to the cinnamon, as a spice in everyday life and devoid of any side effects, can be consumed as a remedy to lower BP levels particularly in patients with T2DM, although, so far, its mechanisms function is unclear.

Authors' contribution

LM and EA searched and gathered the related articles. LM prepared the draft. MRK edited the final manuscript. All authors read and signed the final paper.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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Table 1. Influence of cinnamon on systolic and diastolic BP

Research	Changing	Cinnamon		Placebo		*P* value	Calculations
		Baseline	Post-Intervention	Baseline	Post-Intervention		
[C=30, *P* = 28] (45)	Systolic BP	133 ± 8.6	129 ± 7.9	134 ± 10.9	135 ± 9.2	<0.001	Systolic BP and diastolic BP notably ($P < 0.05$) decreased after 12 weeks in the cinnamon group contrasted to placebo.
	Diastolic BP	8.5 ± 6.45	81 ± 5.80	87 ± 8.82	86 ± 8.08	<0.001	
[C=12, *P* = 10] (44)	Systolic BP	133 ± 14	128 ± 18	133 ± 22	142 ± 20	<0.001	Studies in the cinnamon group appeared a considerable decrease ($P < 0.05$) in systolic BP contrasted to placebo. No considerable changes were detected in diastolic BP.
	Diastolic BP	83 ± 6	84 ± 9	83 ± 14	86 ± 12	<0.32	
[C=29, *P* = 30] (56)	Systolic BP	140 ± 14	137.1 ± 14.7	130.7 ± 12	132.7 ± 10.3	0.06	Systolic BP values reduced in the cinnamon group and raised in the placebo group This difference of systolic BP was only slightly significant. No significant changes were detected in diastolic BP.
	Diastolic BP	78.6 ± 9.5	75.9 ± 10.4	75 ± 9.3	73.7 ± 7.0	0.68	

Abbreviations: C, cinnamon; P, placebo; BP, blood pressure.
All results are stated in mmHg. Data shown as mean + SD. *P* values present the changes (baseline vs. post-intervention) between cinnamon and placebo groups.

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