Plant Archives Vol. 20, Special Issue (AIAAS-2020), 2020 pp. 95-99 *ISSN 0972-5210*

CINNAMON: ALL ROUND MEDICINAL SPICE

Shivani Bhatia and Shubhra Saraswat*
Department of Nutrition and Dietetics, Manav Rachna International Institute of Research and Studies, Haryana-121001, India

Abstract

Nutraceuticals are products, which other than nutrition are also used as medicine. A nutraceutical product may be defined as a substance, which has physiological benefit or provides protection against chronic disease. Nutraceuticals may be used to improve health, delay the aging process, prevent chronic diseases, increase life expectancy, or support the structure or function of the body. Nowadays, nutraceuticals have received considerable interest due to potential nutritional, safety and therapeutic effects. Recent studies have shown promising results for these compounds in various complications. In the present review much effort has been devoted to present cinnamon as a nutraceutical based on its disease modifying indications. Cinnamon is one of the most important and widely used spices in the kitchen. Cinnamon contains vital oils and derivatives which makes it a medicinal spice. Emphasis has been made to present cinnamon nutraceutical effective on hard curative disorders related to oxidative stress including, cardiovascular, cancer, diabetes, eye, immune, inflammatory and Parkinson's diseases as well as obesity.

***Key words*:** Nutraceuticals, Cinnamon, Oxidative stress, Diabetes and Obesity.

Introduction

The cinnamon spices is one the most important and popular spices used worldwide. It is an indigenous spice and belongs to Lauracea family. A cinnamon spice is used in cooking, traditional and modern medicines. Overall, round 250 species have been identified among the cinnamon genus, with trees being scattered all over the world (Sangal, 2011; Vangalapati *et al*., 2012). The most important constituents of cinnamon are cinnamaldehyde and *trans*-cinnamaldehyde (Cin), which are present in the essential oil, contributing to the fragrance and to the various biological activities observed with cinnamon (Yeh *et al*., 2012). *Cinnamomum osmophloeum* (*C. osmophloeum*) contain essential oil from cinnamon leaves contains a high level of Cin. Consequently,*C. osmophloeum* is also used as an alternative spice for *C. Cassia* (Chang *et al*., 2008). One of the major constituents of essential oil extracted from *C. zeylanicum* named (E)-cinnamaldehyde has an antityrosinase activity (Marongiu *et al*., 2007), while cinnamaldehyde is the principal compound responsible for this activity (Chou *et al*., 2013). Cinnamon bark contains procyanidins, phenol polymers and catechins (Peng *et al*., 2008a). The components of procyanidins include both procyanidin A-type and B-type linkages (Anderson *et al*., 2004; Peng *et al*., 2008b; Tanaka *et al*., 2008a). These procyanidins extracted from cinnamon and berries also possess antioxidant activities Peng *et al*., 2008c; Tanaka *et al*., 2008b; Määttä-Riihinen *et al*., 2005)

Types of cinnamon: There are four types of cinnamon-

- Ceylon cinnamon or True cinnamon or Mexican cinnamon (*Cinnamomum zeylanicum*)
- Indonesian cinnamon (*Cinnamomum burmanni*)
- Vietnamese cinnamon (*Cinnamomum loureiroi*)
- Cassia cinnamon or Chinese cinnamon (*Cinnamomum aromaticum*).

Nutritional value of cinnamon

Cinnamon contains more than 80 nutrients, beneficial for proper functioning of the body. Cinnamon is low in cholesterol, saturated fats, sugar, and sodium. The total calorie content in 6.8 g of cinnamon is 17 and only 1 calorie is contributed by fats (total fat content is 0.2 g per 1 tablespoon) and zero % from saturated fats. Overall, the amount of carbohydrates in 1 tablespoon serving size is approximately 5.5 g. Cinnamon shows a negligible amount of sugar (only 0.1g per 1 tablespoon). The high percentage content of dietary fiber (3.6 g in 1 tablespoon) also makes cinnamon a preferred spice among people having digestive problems. Cinnamon when consumed regularly will reduce indigestion, constipation, and intestinal disorders. The concentration of protein in cinnamon is relatively low, as compared to that of calcium, iron, and dietary fiber content as in 6.8 g of serving will provide you 0.3 g proteins. It's good source of calcium and iron; having 1 tablespoon of cinnamon is sufficient to yield 14 % calcium and 31 % iron of the daily requirements of an adult. The requirements may vary slightly as per calorie needs. It also contains high amounts of vitamin A and C along with other minerals like Zn, K, Mg, and Mn. A 6.8 g serving provides 20 % vitamin A and 12 % vitamin C of the daily requirements of an adult (Maheshwari *et al*., 2013).

Cinnamon is one of the most used spices in kitchen all over world as flavouring agent, cooking, and contains vital oils in it, but beside this, cinnamon also have other health beneficial properties like cholesterol and lipid lowering, anti microbial, weight losing, anti diabetic, anti oxidant and anti cancer agents. This review will highlight the medicinal effects of cinnamon and increases its uses in daily life.

Cinnamon have been known to help lowering cholesterol and lipid lowering effects and it has been proved by in a study reported that there was significant improvement when 3 g cinnamon consumed for 16 weeks in all components of

*Corresponding Author Email: shubhra.fas@mriu.edu.in

metabolic syndrome. The cinnamon intervention showed significantly greater improvements were: waist-hip ratio, blood pressure, serum total cholesterol, low-density lipoprotein cholesterol, serum triglycerides, and high-density lipoprotein cholesterol (Jain *et al*., 2017a). Another study on rats found a reduction in the total cholesterol, triglycerides, and low-density lipoproteins administered *Cinnamomum cassia* powder (15%) for 35 days (Rahman *et al*., 2013). A study reported that the administration of cinnamon at 1, 3, and 6 g doses per day resulted in reduction in serum glucose, triglyceride, total cholesterol and LDL cholesterol levels in humans by (Khan *et al*., 2003a). An *in vitro* study prove *C. zeylanicum* extract (0.75 g/kg bark powder) to be as effective as simvastatin (0.6 mg/kg body weight) were equieffective in treating hyperlipidaemia (Javed *et al*., 2012). A study showed that Cinnamon Extract (CE) had several beneficial effects on type 2 diabetes possibly through the activation of both Peroxisome proliferator-activated receptors PPARγ and PPARα resulting in lowered blood glucose, serum lipid level and improved insulin resistance without weight gain and the structure change of the white adipose tissue. CE improved the liver function of obese mice. CE may have potential use in management of obesity-related type 2 diabetes and hyperlipidemia (Sheng *et al*., 2008). A meta-analysis was done for 10 randomized controlled trials including 543 patients has established that cinnamon, for approximately 4 months when taken in a dose of 120 mg/day to 6 g/day and showed that consumption of cinnamon is associated with a statistically significant decrease in levels of fasting plasma glucose, total cholesterol, LDL-C and triglyceride levels and an increase in HDL-C levels (Allen *et al*., 2013a). Another study stated that total and LDL-cholesterol decreased with cinnamon extract and HDL-cholesterol decreased in both the cinnamon-extract and placebo groups. The study concluded that 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 by (Anderson *et al*., 2015a)

Cinnamon as antimicrobial

The component which is cinnamaldehyde present in cinnamon is responsible for antimicrobial activities. In a study showed that cinnamon essential oil when used in combination with nisin, monolaurin or ethylenediaminetetraacetic acid (EDTA) expressed stronger antimicrobial effect against food borne pathogens than when it was used alone (Raeisi *et al*., 2015). Another study stated that the major component of cinnamon, cinnamaldehyde, possesses antimicrobial effects on microorganisms, as it inhibited cell wall biosynthesis, membrane function and specific enzyme activities (Shreaz *et al*., 2016). A study reported the activity of the aqueous extract of cinnamon and other plants against oral microflora. Overall, the essential oil from cinnamon is more potent than other tested plant extracts, such as *Azadirachta indica* and *Syzygium aromaticum* (Parthasarathy and Thombare 2013). Cinnamon bark extract can inhibit the growth of Listeria and *Escherichia coli* in food products thereby potentiating their shelf life (Ziegenfuss *et al*., 2006). In a study it was found that in the presence of 0.05% of the essential oil from C. zeylanicum, mostly *E. coli* cells were killed after 30 min, suggesting that the antimicrobial activity of essential oil is bactericidal (Senhaji *et al*., 2007).

Cinnamon as antidiabetic

Cinnamon as a natural product has been liked by any researcher due to its abundant pleiotropic effects. The study demonstrate that intake of 1, 3, or 6 g of cinnamon per day reduces serum glucose, triglyceride, LDL cholesterol, and total cholesterol in people with type 2 diabetes and suggest that the inclusion of cinnamon in the diet of people with type 2 diabetes will also reduce risk factors associated with diabetes and cardiovascular diseases (Khan *et al*., 2003b). Another study a meta-analysis was done for 10 randomized controlled trials including 543 patients has established that cinnamon, when taken in a dose of 120 mg/day to 6 g/day for approximately 4 months showed result that cinnamon significant decrease in levels of fasting plasma glucose (Allen *et al*., 2013b). *Cinnamon cassia* plays a significant role in phosphorylation of signaling proteins and enhancement of expression of insulin sensitive glucose transporters which results in mitigation of the insulin resistance (Jitomir and Willoughby, 2009). In a recent study showed suitable doses of cinnamon (5, 10 and 20 mg/kg) of the linalool chemotype were developed to help with glycemic control in diabetics due to enhanced insulin secretion (Lee *et al*., 2013). Another study was done to determine the effects of a dried aqueous extract of cinnamon on antioxidant status of people with impaired fasting glucose that are overweight or obese and was found that ferric reducing antioxidant power (FRAP) and plasma thiol (SH) groups increased, while plasma malondialdehyde (MDA) levels decreased in subjects receiving the cinnamon extract which supports the hypothesis that cinnamon compounds when includes with water soluble in the diet could reduce risk factors associated with diabetes and cardiovascular disease (Roussel *et al*., 2009a). Another study documents the beneficial effects of 500 mg of a cinnamon extract per day on Chinese adults with elevated blood glucose. The cinnamon extract used in this study was a commercially available spray-dried water extract of cinnamon (CinSulin®) containing more than 4% of type A procyanidin polyphenols which are associated with improvements in insulin potentiating, antioxidant and anti-inflammatory activities. As demonstrated by this and related studies, they concluded that cinnamon extract should be considered for the prevention and alleviation of elevated blood glucose thereby likely reducing progression to type 2 diabetes and its associated morbidity and mortality (Anderson *et al*., 2015b).

Cinnamon as antioxidant

Aintioxidant play an important role in health of human life as a protecting agent and cinnamon have shown considerable antioxidant activities. This study supports the hypothesis that the inclusion of water soluble cinnamon compounds in the diet could reduce risk factors associated with diabetes and cardiovascular disease by acting as antioxidant and increasing ferric reducing antioxidant power (FRAP) and plasma thiol (SH) groups, while plasma malondialdehyde (MDA) levels decreased in subjects receiving the cinnamon extract (Roussel *et al*., 2009b). A study evaluated the antioxidant activities of the methanolic extract of *Cinnamomum verum* barks (CBE) with reference to antioxidant compounds like butylated hydroxyl anisole, trolox and ascorbic acid. CBE were found to be potent in free radical scavenging activity especially against DPPH radicals and ABTS radical cations. The hydroxyl (and superoxide radicals (.OH) and superoxide radicals (O2-) were also scavenged by the tested compounds. CBE also exhibited metal chelating activity. The peroxidation inhibiting activity of CBE recorded using a linoleic acid emulsion system, showed very good antioxidant activity (Mathew and Abraham, 2004). The anti-oxidant effect has been extended to its application in liver disorders. The ethanolic extract has demonstrated to decrease the carbon tetrachloride induced lipid peroxidation resulting in a fall markers of oxidative

stress such as MDA (Moselhy and Ali 2009). Another study also investigated the antioxidant activity of *C. zeylanicum* using various methods. In addition to the antioxidant activity, cinnamon can be used as a preservative in cakes and other food products (Kordsardouei *et al*., 2013). A study reported that pectin film coated with cinnamon leaf extract yielded high antioxidant and antibacterial activities (Ayala-Zavala *et al*., 2013). The leaf and bark extracts of Ceylon cinnamon possess marked antioxidant properties, the leaf showing the highest activity. The bark of Ceylon cinnamon has more or less similar antioxidant properties reported with that of some economically important Cinnamomum species such as *C. cassia*, *C. tamala*, *C. verum* and *C. burmani*. The results of this study clearly indicate the potential use of leaves and bark of Ceylon cinnamon in the day-to-day life for prevention of oxidative stress-associated chronic diseases and for development of functional foods, nutraceuticals and drug discovery (Abeysekera *et al*., 2013). Another study done on rats showed that both Cinnamon and Garlic showed antioxidant activity and beneficial effects on liver tissue. Cinnamon showed oxidative stress in liver coupled with increased Glutathione (GSH), could be a compensatory mechanism. Thus constituents of Cinnamon and Garlic could provide better antioxidant activity in kidney, liver and heart tissues of rat against toxic assaults at a given doses under monitored conditions (Noori *et al*., 2012)

Cinnamon as anti cancer

A study stated that Cinnamon as a whole and/or its active components exhibited significant antineoplastic activity in different types of cancer. Some of cinnamon's active components exert chemosensitization of well-known anticancer drugs because of its outstanding properties, this spice necessitate its incorporation in both pharmaceuticals and nutraceuticals to explore possibilities of formulation of novel drug from this spice for treatment and prevention strategy of cancer (Dutta and Chakraborty, 2018).

Cinnamon and its constituents exhibit the anti-cancer and cancer prevention activities through various mechanisms: (1) anti-proliferation, (2) induction of cell death, (3) anti-angiogenesis, (4) antimetastasis, (5) suppression of tumor-promoted inflammation, (6) immunomodulation, and (7) modulation of redox homeostasis; both in vitro and in vivo. Moreover, cinnamon also shows the synergistic anti-cancer effect with well-known anti-cancer drugs, such as doxorubicin, which support its potency to be used as a combination chemotherapeutic (co-chemotherapeutic) agent and also suggested to further study to determine the exact target molecule(s) of cinnamon in the cancer cells (Larasati and Meiyanto, 2018). Research has been done to see the effect of cinnamon on melanoma cells. It has been found to impede the activity of pro angiogenic factors which is a major prerequisite for the tumor cells to proliferate and simultaneously increase the activity of CD8(+) T cells. In conclusion found out that cinnamon treatment increased the anti-tumor activities of CD8(+) T cells by increasing the levels of cytolytic molecules and their cytotoxic activity and cinnamon extract has the potential to be an alternative medicine for tumor treatment (Kwon *et al*., 2009). The anticancer effect of *trans*-cinnamaldehyde from *C. osmophloeum*, finding that*trans*-cinnamaldehyde showed potential effects in restraining tumor cell growth and in enhancing tumor cell apoptosis (Fang *et al*., 2004). The polyphenol component of cinnamon extract is a potent inhibitor of Vascular Endothelial growth factor, an eminent factor involved in the growth of endothelial cells, and migration during angiogenesis (Lu *et al*., 2010).

Cinnamon as a cognition enhancer

The review evaluated the current evidence available for herbs/spices and reviewed that herbs and spices potentially improve the metabolic syndrome, as well as their neuroprotective effects on the brain, and cognitive function in animal and human studies (Panickar, 2013). A study stated cinnamon contains phytochemicals which help in boosting the brains ability to utilize glucose. This has even been illustrated by the decrease in markers of oxidative stress like malondialdehyde (MDA) in rats pretreated with extract of CZ in Scopolamine treated rats (Jain *et al*., 2014).

Cinnamon as a cardio protector

The review featured cardiovascular diseases and metabolic syndrome including insulin resistance, dyslipidemia, hyperglycemia, hypertension and obesity are under the influence by cinnamon and concluded that cinnamon has potential therapeutic use in metabolic syndrome and it also help in preventing morbidity and mortality due to cardiovascular diseases (Mollazadeh and Hosseinzadeh, 2016). A study concluded that consumption of cinnamon (short term) is associated with a notable reduction in SBP and DBP. They also stated that cinnamon shows hopeful effects on BP-lowering potential but it would be premature to recommend cinnamon for BP control because of the limited number of studies available and recommended to see result on larger number of patients (Akilen *et al*., 2013). An animal study on Sprague Dawley rats evaluated the effect of *C. cassia* on Ischemic Heart Disease. The active components cinnamaldehyde and cinnamic acid are said to be cardio protective due to their ability to produce nitric oxide as well as the associated anti-inflammatory property (Song *et al*., 2013)

Cinnamon in weight reduction

As it is difficult to reduce weight, cinnamon being naturally occurring spices help in reducing weight. A study by Mangala Gowri *et al*., 2017 stated in their study, proposed samples to have 5 g of cinnamon containing tea with honey for 2 weeks. The findings of this study tell that the prescribed cinnamon tea resulted in an improvement reduction of weight. The study support the efficacy of water-soluble cinnamon extract Cinnulin PF(R) supplementation helps in reducing Fasting Blood Glucose (FBG) and Systolic Blood Pressure (SBP), and improving body composition by increasing lean mass by 1.1% and decreasing body fat by 0.7% in men and women with the metabolic syndrome and brace that this naturally-occurring spice can reduce risk factors associated with diabetes and cardiovascular diseases (Ziegenfuss *et al*., 2006).

Another study was done between cinnamon capsules and placebo on metabolic profile and body composition and the finding relieved that there was no significant difference was found between the two groups in characteristics except for weight and BMI. The result showed that the mean weight and BMI were higher in the cinnamon group as compared to the placebo group and cinnamon capsules results in significant improvements will all metabolic syndrome in sample of Asian Indians in north India.

Conclusion

Cinnamon is used as a spice in daily life without any considerable side effects. Several studies show various beneficial properties of cinnamon in the form of bark, essential oils, bark powder, phenolic compounds, flavonoids, and isolated components. Each of these beneficial properties play an important key role in the betterment of human health.

The antioxidant and antimicrobial activities may occur through the direct action on oxidants or microbes, whereas the anti-inflammatory, anticancer and antidiabetic activities occur indirectly via receptor-mediated mechanisms. The review also highlights that cinnamon helps in reducing weight and improve metabolic syndrome. Many of the significant health benefits of various types of cinnamon are explored and documented. Despite all these pleiotropic effects, further investigations are necessary to provide additional clinical evidence for the traditional uses of this spice against cancer and inflammatory, cardioprotective and neurological disorders (Jain *et al*., 2017b).

References

Abeysekera WPKM, Premakumara GAS and Ratnasooriya WD (2013). *In Vitro* Antioxidant Properties of Leaf and Bark Extracts of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume). *Tropical Agricultural Research*, **24(2):** 128-138.

Akilen R, Pimlott Z, Tsiami A and Robinson N (2013). Effect of short-term administration of cinnamon on blood pressure in patients with prediabetes and type 2 diabetes. **Nutrition, 29(10):** 1192-6. doi: 10.1016/j.nut.2013.03.007.

Allen RW, Schwartzman E, Baker WL, Coleman CI, Phung OJ (2013). Cinnamon Use in Type 2 Diabetes: An Updated Systematic Review and Meta-Analysis. *Annals of family medicine*, **5:** 452-459. doi: 10.1370/afm.1517

Anderson RA, Broadhurst CL, Polansky MM, Schmidt WF , Khan A, Flanagan VP, Schoene NW and Graves DJ (2004). Isolation and characterization of polyphenol type-A polymers from cinnamon with insulin-like biological activity. *Journal of Agricultural and Food Chemistry*, **52(1):** 65-70.

Anderson RA, Zhan Z, Luo R, Guo X, Guo Q, Zhou J, Kong J, Davis PA and Stoecker BJ (2015). Cinnamon extract lowers glucose, insulin and cholesterol in people with elevated serum glucose. *Journal of traditional and complementary medicine*, **6(4):** 332-336. doi:10.1016/j.jtcme.2015.03.005

Anindita Dutta and Anindita Chakraborty (2018). Cinnamon in Anticancer Armamentarium: A Molecular Approach. Jorunal of Toxicology. doi: 10.1155/2018/8978731

Ayala-Zavala JF, Silva-Espinoza BA, Cruz-Valenzuela MR, Leyva LA, Ortega-Ramírez LA, Carrazco-Lugo DK, Pérez-Carlón JJ, Melgarejo-Flores BG, González-Aguilar GA and Miranda MRA (2013). Pectin-cinnamon leaf oil coatings add antioxidant and antibacterial properties to fresh-cut peach. *Flavour and Fragrance Journal*, **28(1):** 39-45.

Chang CW, Chang WL, Chang ST and Cheng SS (2008). Antibacterial activities of plant essential oils against *Legionella pneumophila* . *Water Research*, **42(1-2):** 278-286.

Chou ST, Chang WL, Chang CT, Hsu SL, Lin YC and Shih Y (2013). Cinnamomum cassia *Essential Oil* inhibits α-MSH-induced melanin production and oxidative stress in murine B16 melanoma cells. *International Journal of Molecular Sciences*, **14(9):** 19186-19201.

Fang SH, Rao YK and Tzeng YM (2004). Cytotoxic effect of trans-cinnamaldehyde from cinnamomum osmophloeum leaves on Human cancer cell lines. *International Journal of Applied Science and Engineering*, **2(2):** 136-147.

Gupta Jain S, Puri S, Misra A, Gulati S and Mani K (2017). Effect of oral cinnamon intervention on metabolic profile and body composition of Asian Indians with metabolic syndrome: a randomized double-blind control trial. *Lipids Health Dis*., **16(1):** 113. doi:10.1186/s12944-017-0504-8

Jain S, Sangma T, Shukla SK and Mediratta PK (2014). Effect of *Cinnamomum zeylanicum* extract on scopolamine-induced cognitive impairment and oxidative stress in rats. *Nutritional Neuroscience*, **18(5):** 210-216.

Javed I, Faisal I, Rahman Z, Khan MZ, Muhammad F, Aslam B, *et al*. (2012). Lipid lowering effect of *Cinnamomum zeylanicum* in hyperlipidaemic albino rabbits. *Pakistan Journal of Pharmaceutical Science*, **25:** 141-147.

Jitomir J and Willoughby DS (2009). Cassia cinnamon for the attenuation of glucose intolerance and insulin resistance resulting from sleep loss. *Journal of Medicinal Food*, **12:** 467-472.

Khan A, Safdar M, Khan MMA, Khattak KN, Anderson RA (2013). Cinnamon improves glucose and lipids of people with type 2 diabetes. *Diabetes Care*, **26(12):** 3215-3218.

Kordsardouei H, Barzegar M, Sahari MA (2013). Application of *Zataria multiflora* Boiss. and *Cinnamon zeylanicum* essential oils as two natural preservatives in cake. *Avicenna Journal of Phytomedicine*, **3(3):** 238-247.

Kwon HK, Jeon WK, Hwang JS, Lee CG, So JS, Park JA, Ko BS and Im SH (2009). Cinnamon extract suppresses tumor progression by modulating angiogenesis and the effector function of CD8+ T cells. *Cancer Letters*, **278:** 174-182.

Larasati YA and Meiyanto E (2018). Revealing the Potency of Cinnamon as an Anti-Cancer and Chemopreventive Agent. *Indonesian Journal of Cancer Chemoprevention*, **9(1):** 47-62.

Lee SC, Xu WX, Lin LY, Yang JJ and Liu CT (2013). Chemical composition and hypoglycemic and pancreas-protective effect of leaf essential oil from indigenous cinnamon (*Cinnamomum osmophloeum* Kanehira). *Journal of Agricultural and Food Chemistry*, **61(20):** 4905-4913. [PubMed]

Lu J, Zhang K, Nam S, Anderson RA, Jove R and Wen W (2010). Novel angiogenesis inhibitory activity in cinnamon extract blocks VEGFR2 kinase and downstream signaling. *Carcinogenesis*, **31:** 481-488.

Määttä-Riihinen KR, Kähkönen MP, Törrönen AR and Heinonen IM (2005). Catechins and procyanidins in berries of vaccinium species and their antioxidant activity. *Journal of Agricultural and Food Chemistry*, **53(22):** 8485-8491.

Mangala Gowri P, Mary Minolin T, Thenmozhi P, Meena P and Vimala (2017). Effectiveness Of Cinnamon Tea In Reducing Weight Among Late Obese Adolescence. Doi: 10.22159/Ajpcr.2017.V10

Marongiu B, Piras A, Porcedda S, Tuveri E, Sanjust E, Meli M, Sollai F, Zucca P and Rescigno A (2007). Supercritical CO_2 extract of *Cinnamomum zeylanicum*: chemical characterization and antityrosinase activity. *Journal of Agricultural and Food Chemistry*, **55(24):** 10022-10027.

Mollazadeh H and Hosseinzadeh H (2016). Cinnamon effects on metabolic syndrome: a review based on its mechanisms. Iranian Journal of Basic Medical Science, 19(12): 1258-1270. doi: 10.22038/ijbms.2016.7906

Moselhy SS and Ali HK. Hepatoprotective effect of cinnamon extracts against carbon tetrachloride induced oxidative stress and liver injury in rats. Biological Research, 42: 93-98.

Noori S, Azmat M and Mahboob T (2012). Study on antioxidant effects of cinnamon and garlic extract in liver, kidney and heart tissue of rat. Bioscience Research, 9(1): 17-22.

Panickar SK (2013). Beneficial Effects of Herbs, Spices and Medicinal Plants on the Metabolic Syndrome, Brain and Cognitive Function. Central Nervous System Agents in Medicinal Chemistry, 13(1): 13-29.

Parthasarathy H and Thombare S (2013). Evaluation of antimicrobial activity of Azadirachta indica, Syzygium aromaticum and Cinnamomum zeyalnicum against oral microflora. Asian Journal of Experimental Sciences, 27(2): 13-16.

Peng X, Cheng KW, Ma J, et al. Cinnamon bark proanthocyanidins as reactive carbonyl scavengers to prevent the formation of advanced glycation endproducts. Journal of Agricultural and Food Chemistry, 56(6): 1907-1911.

Maheshwari R, Chauhan AK, Gupta A and Sharma S (2013). Cinnamon: An imperative spice for human comfort. International Journal of Pharmaceutical Research and Bio- Science, 2(5): 131-145.

Raeisi M, Tajik H, Yarahmadi A and Sanginabadi S (2015). Antimicrobial Effect of Cinnamon Essential Oil Against Escherichia Coli and Staphylococcus aureus. Health Scope, 4(4): e21808. doi: 10.17795/jhealthscope-21808.

Rahman S, Begum H, Rahman Z, Ara F, Iqbal MJ and Yousuf AKM (2013). Effect of cinnamon (Cinnamomum cassia) as a lipid lowering agent on hypercholesterolemic rats. Journal of Enam Medical College, 3(2): 94-98.

Roussel AM, Hininger I, Benaraba R, Ziegenfuss TN and Anderson RA (2009). Antioxidant Effects of a Cinnamon Extract in People with Impaired Fasting Glucose That Are Overweight or Obese. Journal of the American College of Nutrition, 28(1): 16-21. DOI: 10.1080/07315724.2009.10719756

Sangal A (2011). Role of cinnamon as beneficial antidiabetic food adjunct: a review. Advances in Applied Science Research, 2(4): 440-450.

Table 1: Nutritional composition of cinnamon

Nutrients	As per serving 1 table spoon
Calories(in 6.8g)	17
Protein (in 6.8 g)	0.3 g
Total Fat	0.2 g
Saturated Fat	0
Carbohydrate	5.5 g
Sugar	0.1 g
Dietary Fiber	3.6 g
Vitamin A	20%
Vitamin C	12%
It also contain high amount of other vitamins like zinc, potassium, magnesium, iron and calcium.	

Source: (Maheshwari *et al*., 2013)

Senhaji O, Faid M and Kalalou I (2007). Inactivation of Escherichia coli O157:H7 by essential oil from Cinnamomum zeylanicum. Braz. J. Infect. Dis., 11: 234-236.

Sheng X, Zhang Y, Gong Z, Huang C and Zang YQ (2008). Improved Insulin Resistance and Lipid Metabolism by Cinnamon Extract through Activation of Peroxisome Proliferator-Activated Receptors. PPAR Research, 9. https://doi.org/10.1155/2008/581348.

Shreaz S, Wani WA, Behbehani JM, Raja V, Irshad M, Karched M, Ali I, Siddiqi WA and Hun LT (2016). Cinnamaldehyde and its derivatives, a novel class of antifungal agents. Fitoterapia, 112: 116-131.

Sindhu Mathew and T Emilia Abraham (2004). Studies on the antioxidant activities of cinnamon (Cinnamomum verum) bark extracts, through various in vitro models. doi.org/10.1016 J.foodchem.2004.11.043

Song F, Li H, Sun J and Wang S (2013). Protective effects of cinnamic acid and cinnamic aldehyde on isoproterenol-induced acute myocardial ischemia in rats. Journal of Ethnopharmacology, 150: 125-130.

Tanaka T, Matsuo Y, Yamada Y and Kouno I (2008). Structure of polymeric polyphenols of cinnamon bark deduced from condensation products of cinnamaldehyde with catechin and procyanidins. Journal of Agricultural and Food Chemistry, 56(14): 5864-5870.

Vangalapati M, Sree Satya N, Surya Prakash D, Avanigadda S (2012). A review on pharmacological activities and clinical effects of cinnamon species. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 3(1): 653-663.

Yeh HF, Luo CY, Lin CY, Cheng SS, Hsu YR, Chang ST (2013). Methods for thermal stability enhancement of leaf essential oils and their main Constituents from Indigenous Cinnamon (Cinnamomum osmophloeum). Journal of Agricultural and Food Chemistry, 61(26): 6293-6298.

Ziegenfuss TN, Hofheins JE, Mendel RW, Landis J and Anderson RA (2006). Effects of a water-soluble cinnamon extract on body composition and features of the metabolic syndrome in pre-diabetic men and women. Journal of the International Society of Sports Nutrition, 3: 45-53. doi: 10.1186/1550-2783-3-2-45.

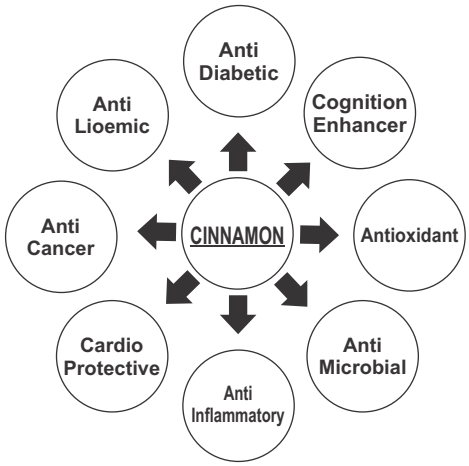

Fig 1: Figure illustrates the many pleiotropic effects of this wonderful spice Cinnamon helps in cholesterol and lipid lowering