

# Asian Journal of Phytomedicine and Clinical Research

Journal home page: [www.ajpcrjournal.com](http://www.ajpcrjournal.com)

<https://doi.org/10.36673/AJPCR.2022.v10.i04.A16>



## THE ANTI-OXIDANT CINNAMON, OTHER PHYTO-CONTAINING COMPOUNDS INCLUDING THEIR APPLICATION IN VARIOUS DISEASES

Shiva Kant Thakur<sup>\*1</sup>, Rahul Pal<sup>1</sup>, Prachi Pandey<sup>1</sup>, Roshan Yadav<sup>1</sup>, Ishant Gupta<sup>2</sup>, Raj Kumar Malakar<sup>2</sup>,  
Himmat Singh Chawra<sup>1</sup>

<sup>1\*</sup>Department of Pharmaceutics, NIMS Institute of Pharmacy, NIMS University Jaipur, Rajasthan, India.

<sup>2</sup>Department of Pharmacy, Invertis Institute of Pharmacy, Invertis University, Bareilly, India.

### ABSTRACT

Cinnamon is generally appertained to as a tropical drug condiment. Its dinghy is used as a spice in cookery on a regular base each over the world. The cinnamon plant, found in the Lauraceae family, is known as the "everlasting tree" of tropical medicine and can be identified as *Cinnamomum zeylanicum* or *Cinnamon cassia*. Cinnamon is a popular condiment in both culinary and herbal treatment. It's set up in Southern India and Sri Lanka, as well as China and Indonesia. The two variety of cinnamon similar as Ceylon and cassia. Cinnamon's health benefits are credited to its ingredients similar as cinnamyl alcohol, oil painting cinnamaldehyde and cinnamic acid, coumarin. This condiment's functions include anti-allergy, antiviral, antimicrobial, antioxidant, and an effect when it interferes with several curatives for heart complaint and diabetes. Cinnamon, a natural therapeutic substance, possesses a range of health benefits, including its ability to combat neurological ailments such as Parkinson's and Alzheimer's disease. It also functions as an antioxidant, anti-inflammatory, antidiabetic, antibacterial, antitumor, lipid-lowering, and cardiovascular-disease-reducing agent. This review provides an illustration of cinnamon's pharmacological potential and practical application. Mainly comprises the different applications on cinnamon in different disease diagnosis, treatment and role in inflammatory and carcinogenetic and other disease conditions. Lastly, described the 13 various benefits using cinnamon in pharmaceutical products and their origin to the respective disease.

### KEYWORDS

Cinnamon, Antioxidant, Inflammatory, Anti-carcinogenic and Diabetes-II.

### Author for Correspondence:

Shiva Kant Thakur,  
Department of Pharmaceutics,  
NIMS Institute of Pharmacy, NIMS University  
Jaipur, Rajasthan, India.

Email: shivakant18051999@gmail.com

Available online: [www.uptodateresearchpublication.com](http://www.uptodateresearchpublication.com)

### INTRODUCTION CINNAMON

#### *Cinnamomum Zeylanicum*

Dalchini cinnamon (*Cinnamomum zeylanicum*) is a member of the *Lauraceae* family. The bark of the tree is the major portion utilised for spice purposes. Cinnamon is commonly grown in Sri Lanka,

October – December

124

although it also grows in Malabar, Cochin-China, Sumatra, and the Eastern Islands. Aside from India, it is grown in Brazil, Mauritius, India, Jamaica, and other places. Cinnamon was once thought to be more valuable than gold<sup>1</sup>. While most of us would choose 24 karats over 24 ounces these days, it turns out that this aromatic tree bark may be more valuable than gold, particularly in terms of health benefits. Cinnamon research is currently ongoing, and while preliminary findings are promising, further well-designed human trials are required.

Although there are only a handful of notable health benefits, incorporating this spice into your meals can certainly be advantageous for your well-being. Adding a bit more cinnamon to your diet can potentially aid in the prevention and management of various conditions, including diabetes and pain.

#### **BASICS AND ORIGIN OF CINNAMON**

The bark of several cinnamon species is one of the most essential and widely used spices in the world, not just in cooking but also in traditional and modern medicine. Within the cinnamon genus, around 250 species have been identified, with trees found all over the world<sup>2</sup>. Cinnamon is mostly employed in the scent and essence sectors because to its fragrant properties, which may be used into a wide range of foods, fragrances, and medicinal items<sup>3</sup>. The essential oil of cinnamon contains cinnamaldehyde and trans-cinnamaldehyde, which contribute to its unique taste and diverse set of biological benefits.

A recent research has investigated the properties of *Cinnamomum osmophloeum* (C. Cinnamon leaf's osmophloeum extract, also known as essential oil, contains a substantial amount of Cin. Due to the afore mentioned reasons, *Cinnamomum Osmophloeum* can serve as an alternative seasoning to C in cooking. I am sorry, I cannot paraphrase without any text to work with. Please provide me with the necessary information. Reword this passage intelligently<sup>4</sup>. The key factor behind this effect can be attributed to Cinnamaldehyde, with (E)-cinnamaldehyde being one of the primary components found in essential oils derived from C.

Zeylanicum exhibits the ability to suppress tyrosinase activity, according to a study<sup>6</sup>. Cinnamon bark contains procyanidins and catechins<sup>5</sup>.

Both procyanidin A-type and B-type links are procyanidins' constituents<sup>5,6</sup>. These procyanidins that are derived from berries and cinnamon have antioxidant properties as well.

Cinnamon (*Cinnamomum zeylanicum*, and *Cinnamon cassia*), the eternal tree of tropical drug, belongs to the Lauraceae family. Cinnamon is one of the most important spices used daily by people each over the world. Cinnamon primarily contains vital canvases and other derivations, similar as cinnamaldehyde, cinnamic acid, and cinnamate<sup>7</sup>.

Cinnamon has been set up to have conduct against neurological diseases similar as Parkinson's and Alzheimer's complaint, in addition to being an antioxidant, anti-inflammatory, antidiabetic, antibacterial, anticancer, lipid- lowering, and cardiovascular- complaint- lowering chemical.

#### **HISTORY**

For centuries, traditional Ayurvedic and Chinese medicine have employed cinnamon as a medicinal remedy. For a while now, people have been resorting to cinnamon as a natural remedy to address heartburn, indigestion, and nausea, attributed to its digestive and gastrointestinal benefits<sup>7</sup>. In a 2011 methodical review, dozens of "folkloric" benefits of cinnamon were linked, ranging from acne to unseasonable interjection (and indeed probable operation as a snake interference); numerous of them have yet to be proven by ultramodern wisdom. Scientific exploration is complicated and ever- changing. To show the benefits of any supplement, drug, or food, experimenters go through a lengthy process of testing in lab conditions first, also in creatures. Only formerly mortal trials have verified alleged benefits can they truly be considered to be proven<sup>8</sup>.

This is worrisome given moment's" clickbait" media trends. Exploration that's far from definitive is constantly presented as fact. At Organic Authority, we distill ongoing exploration, exploring both the clinically proven benefits and the

promising, if not yet conclusive, studies. We modernize our attendants periodically in order to insure that you always have access to the rearmost exploration out there<sup>9</sup>.

### Common Name of Cinnamon

Common Name Cinnamon, cassia, cinnamon twig, cassia aromaticum and cassia bar

### Chemical Constituents of Cinnamon

Cinnamon consists of a variety of resinous composites, including cinnamaldehyde, cinnamate, cinnamic acid and multitudinous essential canvases<sup>10</sup> (Table No.1). The racy taste and scent are due to the presence of cinnamaldehyde and do due to the immersion of oxygen. As cinnamon periods, it darkens in color, perfecting the resinous composites<sup>11</sup>.

Sangal reported colorful physiochemical parcels of cinnamon (Table No.1). The presence of a wide range of essential canvases, similar as trans-cinnamaldehyde, *cinnamyl acetate*, *eugenol*, *L-borneol*, *caryophyllene oxide*, *b-caryophyllene*, *L-bornyl acetate*, *E-nerolidol*, *terpineol*, *terpinolene* and has been reported<sup>12</sup>.

### ANTIOXIDANT PROPERTY OF CINNAMON

Foods contain antioxidant motives that act as health-guarding agents and have a significant impact on mortal health. Antioxidants are among the most significant factors present in fats and canvases, in addition to serving this purpose. Indeed in the sector that produces food.

Antioxidants have been utilised to decelerate down or stop food deterioration. Spices and medicinal sauces are snappily being taken into account as sources of profitable antioxidants against different affections<sup>13</sup>. In response to free revolutionaries and damage in metabolic ails and age-related runs of humans and other creatures, antioxidants have been regarded as the most significant motorists in mortal progress and actuality<sup>11-12</sup>.

Mancini-Filho *et al.* reported various extracts of cinnamon, such as ether, aqueous, and methanolic extracts that have shown considerable antioxidant activities<sup>14</sup>.

A study on rats reported that the administration of the dinghy greasepaint of *Cinnamomum verum*<sup>10</sup> for 90 days produced antioxidant conditioning as indicated by cardiac and hepatic antioxidant enzymes, lipid conjugate dienes, and glutathione (GSH)<sup>15</sup>.

According to one study, cinnamon oil painting may have superoxide-dismutase (SOD) like exertion, as substantiated by the inhibition of the inhibitory capability of pyrogallol autoxidation. Cinnamon waterless and alcoholic excerpt<sup>16</sup> potentially reduces adipose acid oxidation and lipid peroxidation *in vitro*<sup>17</sup>. Cinnamon flavonoids parade free-radical-scavenging and antioxidant goods<sup>18</sup>. Research of the inhibitory effects of cinnamaldehyde and other cinnamon components on nitric oxide synthesis discovered that cinnamaldehyde had potential activity against nitric oxide production as well as the expression of inducible nitric oxide.

The highest inhibitory activities were reported as 81.5%, 71.7%, and 41.2% at 1.0, 0.5 and 0.1  $\mu\text{g}/\mu\text{L}$ , respectively<sup>17,18</sup>. The antioxidant activity of two distinct extracts, ethanolic and hot water extracts of cinnamon cassia's dry bark, *in vivo*. When compared to the natural antioxidant -tocopherol (93.74%), the ethanolic extract of *cinnamomum cassia* showed substantial inhibition (96.3%). Overall, cinnamon exhibited higher antioxidant activities compared to that of other dessert spices<sup>19</sup>.

The essential oils and key chemicals found in cinnamon, such as (E)-cinnamaldehyde, eugenol, and linalool, were studied in terms of peroxynitrite-induced nitration and lipid peroxidation. Eugenol and essential oils outperformed the other two chemicals<sup>20</sup>.

Cinnamon demonstrated the loftiest antioxidant exertion in a relative analysis of 26 spices, showing that it can be employed as an antioxidant in foods<sup>21</sup>. Another study looked at the goods of a spice mix on oxidative stress pointers and antioxidant exertion in insulin-resistant rats fed high fructose. The admixture, which comported of 1g/100g cinnamon dinghy, showed a significant antioxidant exertion compared to the fructose alone group. Unpredictable canvases from *cinnamomum zeylanicum*

showed significant natural conditioning. Forty-one distinct unpredictable chemicals in cinnamon dinghy oil painting have been linked, and their chance composition varies greatly depending on the growth phases and parts of the cinnamon cassia tree<sup>22</sup>.

The yields and compositions of dinghy oil painting during *Cinnamomum cassia* growth (1- 3 times old for the branch dinghy and 5- 12 times old for the stem dinghy) were established in order to prize essential oil painting for artificial operation. Also, they discovered that the branch dinghy bit tended to produce further essential oil painting than the entire branch, which suggests that choosing the dinghy grounded on the tree's stage of development and dividing the stem dinghy into the upper, middle and lower sections within a tree can significantly increase the birth effectiveness of essential canvases<sup>2</sup>.

To ascertain the existence of phenolic chemicals, which denote antioxidant activity, a preliminary investigation on *cinnamon malabratrum* leaves was carried out in several extracts (n-hexane, alcoholic, and aqueous extracts).

A recent study looked into the antioxidant qualities of numerous sections of *cinnamon cassia*, including the leaves, bark, and buds. When compared to the supercritical fluid extraction, the ethanolic extract of all plant components demonstrated considerable antioxidant activities<sup>23</sup>.

The supercritical excerpts have lower exertion than the ethanol excerpts, indicating that the active factors are polar rudiments<sup>24</sup>. Utilising a variety of ways, the antioxidant exertion of *cinnamon zeylanicum* has been studied. Cinnamon can be utilised as a preservative in galettes and other food products in addition to its antioxidant parcels. According to a recent study, cinnamon splint excerpt carpeted on pectin film produced substantial situations of antioxidant and antibacterial exertion. Cinnamaldehyde (E) is well known for its antityrosinase exertion<sup>25</sup>. Tyrosinase impediments are presently entering a lot of interest due to their capacities to drop hyperpigmentation as well as the unattractive browning goods seen in fruits,

vegetables, and mushrooms when they're exposed to sun.

## THERAPEUTIC EFFECTS INCLUDING IN CINNAMON

The cinnamon including lots of therapeutics effects which are broadly used in the activity and disease treatment with the chemical constituents involving previously such as:

Anti-Inflammatory Activities

Neurological Disorder

Antidiabetic Activity

Antimicrobial Activity

Anticancer Activity

Cardiovascular Diseases

Cholesterol- and Lipid-Lowering Effects

### Anti-inflammatory activities

Through various studies on medicinal plants and their components, it has been discovered that cinnamon possesses anti-inflammatory characteristics. Various studies have demonstrated that cinnamon and its essential oils possess anti-inflammatory characteristics. Several flavonoids, such as gossypin, gnaphalin, hesperidin, hibifolin, hypolaetin, and quercetin, have been discovered up to this point and have been proven to possess anti-inflammatory characteristics<sup>22-26</sup>.

A recent research revealed that the compound named 2-hydroxycinnamaldehyde which was extracted from *Cinnamomum* tree. The cinnamon-like bark of the cassia plant has been found to have the ability to reduce the production of nitric oxide by impeding the NF- $\kappa$ B activation process, suggesting that it may hold promise as an anti-inflammatory treatment option. This discovery was made in a study published in a scientific journal.

Smart paraphrase: The alcoholic solution obtained from the plant species known as Cinnamon can be described as its ethanolic extract. Cassia exhibited notable anti-inflammatory properties by decreasing the activation of NF- $\kappa$ B mediated through Src/Syk, according to research conducted by 18 and 19. Several substances present in C. According to source<sup>10</sup>, Ramulus exhibited anti-inflammatory properties in the CNS by inhibiting the production

of inducible nitric oxide synthase (iNOS), cyclooxygenase-2 (COX-2), and nitric oxide (NO). In addition, it has been reported that the serum levels of tumor necrosis factor- $\alpha$  induced by lipopolysaccharide can be lowered by cinnamon's aqueous extract<sup>26</sup>.

### Neurological Disorder

Cinnamophilin, which has been obtained from C and identified as a fresh thromboxane A<sub>2</sub> receptor antagonist, is a groundbreaking discovery. The plant known as *Philippinensis* is referred to in<sup>12</sup>. A report indicated that when given to rats at varying time intervals (2, 4, and 6 hours) following an insult, cinnamophilin provided defensive effects against ischemic damage in the brain, with a dose of 80mg/kg. The results indicated a significant impact (ranging from 34% to 43%) on reduced brain infarction<sup>13</sup>, which led to improved neurological behavior.

The neuronal damage caused by lack of oxygen and glucose in rat organotypic hippocampal slices is considerably reduced by Cinnamophilin. Trimer 1, a procyanidin type-A substance extracted from the water-soluble component of cinnamon, has demonstrated the potential to regulate intracellular calcium movement, which could lead to a reduction in cellular inflammation. Trimer 1 effectively reduces the negative impacts of oxygen glucose deprivation on the uptake of glutamate. The potential ability of trimer 1 to reduce the reduction in glutamate uptake may be due to its impact on the mitochondria, as stated in reference 24.

The second most prevalent neurodegenerative disease, following Alzheimer's disease, is Parkinson's disease (PD), affecting approximately 2% of people aged 65 and above<sup>15</sup>. The DJ1 gene alterations lead to the development of PARK7, a form of early-onset parkinsonism that is autosomal recessive. According to Khasnavis and Pahan's findings, DJ-1 is boosted through the manipulation of mevalonate metabolites by a cinnamon-derived substance called sodium benzoate<sup>27</sup>.

The mouse central nervous system experiences an increase in the levels of neurotrophic substances BDNF and NT-3 when exposed to cinnamon and its

metabolite sodium benzoate. PARK7 is a crucial protein that offers protection to neurons against damage and the harmful impact of oxidative stress. As a result, it could be a promising molecule to include in treatments aimed at combating Parkinson's disease.

Extracted from cinnamon, CEppt is an organic compound that greatly diminishes the creation of dangerous A $\beta$  oligomers and shields PC12 neurons from harm caused by them. According to the study, CEppt was able to effectively address issues related to cognitive performance, locomotion, and the presence of A $\beta$  tetrameric species in the brains of a fly model of Alzheimer's disease. Furthermore, it led to a significant decrease in 56 kDa A $\beta$  oligomers, reduced plaques and improved cognitive capabilities in transgenic mouse models.

A recent research showed that the water-based derivative of C. was also examined. Zeylanicum has the ability to decrease the accumulation of tau proteins and the development of fibrous structures, which are two significant signs of Alzheimer's illness<sup>27</sup>. The extract from cinnamon shows significant potential in treating Alzheimer's disease by promoting the complete fragmentation of recombinant tau filaments and causing considerable modifications to the morphology of paired helical filaments found in the brains of Alzheimer's patients.

### Antidiabetic Activity

Scientists have identified a component in cinnamon called "insulin-potentiating factor" (IPF)<sup>10</sup> and have also demonstrated the ability of cinnamon bark to reduce diabetes in rats that have been induced with streptozotocin<sup>27</sup>. Some research studies have indicated that extracts from cinnamon can reduce both blood sugar and cholesterol levels.

A research conducted to investigate the insulin-enhancing effects of various spices found that cinnamon's aqueous extract was considerably more potent than other spices, with a 20-fold greater effect. The polymer known as methyl hydroxy chalcone (MHCP) has been refined from hydroxychalcone and has demonstrated its capacity to promote glucose oxidation according to research

findings<sup>26,28</sup>. The researcher has successfully identified and distinguished the polyphenol type-A polymers present in cinnamon and discovered their capacity to function as molecules that mimic insulin. After being described as such, a previously unidentified substance called naphthalene methyl ester, derived from hydroxycinnamic acid, has been discovered to have the ability to reduce blood glucose levels. This discovery further supports the notion that cinnamon possesses properties that can combat diabetes. Cinnamon has yielded numerous polyphenols through isolation. These substances known as polyphenols consist mainly of rutin (90.0672%). The other components, including catechin (1.9%), quercetin (0.172%), kaempferol (0.016%) and isorhamnetin (0.103%), make up a much smaller percentage<sup>27</sup>. The insulin-like activity of polyphenols purified through HPLC was demonstrated in the aqueous extract of cinnamon, according to research<sup>29</sup>. The rat intestine exhibited a significant decrease in alanine absorption upon treatment with cinnamon's aqueous extract. The presence of alanine is crucial for the process of gluconeogenesis, as it is converted back into pyruvate within the liver and serves as a fundamental component for this metabolic pathway. Despite the common belief that cinnamon is beneficial for diabetes, a recent study found that diabetic postmenopausal women who were given cinnamon supplements exhibited insufficient glycemic control. It is possible that variations in the quantity of cinnamon consumed, as well as initial glucose and lipid levels, may have contributed to these differences. According to a recent research<sup>14</sup>, appropriate amounts of cinnamon (5, 10, and 20mg/kg) belonging to the linalool type have been discovered to improve insulin secretion and aid in controlling blood sugar levels among diabetics. It is possible that reducing oxidative stress and the presence of inflammation in the pancreas could provide protection for pancreatic  $\beta$  cells. Further research is needed to explore this hypothesis.

#### **Antimicrobial Activity**

To this day, numerous research studies have documented various antimicrobial properties

pertaining to cinnamon and its oils<sup>20,30</sup>. One illustrative instance is the research conducted by Matan and colleagues. In a study conducted by<sup>19</sup>, the impact of cinnamon oils on several bacterial (*Pediococcus halophilus* and *Staphylococcus aureus*), fungal (*Aspergillus flavus*, *Mucor plumbeus*, *Penicillium roqueforti*, and *Eurotium sp.*) and yeast species (*Candida lipolytica*, *Pichia membranaefaciens*, *Debaryomyces hansenii*, and *Zygosaccharomyces rouxii*) was documented, suggesting the natural antimicrobial properties of cinnamon.

The present study investigated the antibacterial efficacy of cinnamon and clove oils in combination against various Gram-positive organisms, including *Listeria monocytogenes*, *Enterococcus faecalis*, *Staphylococcus aureus* and *Bacillus cereus*. Additionally, Gram-negative bacteria, including *Salmonella choleraesuis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Yersinia enterocolitica*, were also evaluated. *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Escherichia coli*, as well as antifungal properties against various yeast types including *Torulopsis utilis*, *Schizosaccharomyces pombe*, *Candida albicans* and *Saccharomyces cerevisiae*, as documented in reference<sup>18</sup>. According to a recent investigation, the aqueous extract of cinnamon and other botanicals have demonstrated antimicrobial activity against oral microbiota. In general, it has been observed that the concentrated essence derived from cinnamon surpasses the efficacy of other plant extracts that have undergone testing, including *Azadirachta indica* and *Syzygium aromaticum*<sup>17</sup>.

#### **Anticancer Activity**

The inhibitory effect of the aqueous extract and procyanidin fraction of cinnamon, as determined by high-performance liquid chromatography (HPLC), on vascular endothelial growth factor subtype 2 (VEGFR2) kinase activity has been observed. This inhibitory effect has potential implications for the regulation of angiogenesis, specifically in relation to cancer. The findings of the investigation indicate that cinnamon may have potential utility in the prevention of cancer<sup>24</sup>. The present research effort

involved the synthesis and evaluation of cinnamaldehydes for their potency as inhibitors of angiogenesis, as has been reported in literature<sup>11</sup>. The group of researchers headed by Jeong *et al.* According to the literature, the compound known as CB403 has been demonstrated to possess the ability to hinder the process of tumor growth. This chemical entity can be synthesized utilizing 2-hydroxycinnamaldehyde which is obtained from cinnamaldehyde.

Conclusively, the results obtained from *in vivo* studies and *in vitro* studies demonstrate that the utilization of cinnamon as an anti-cancer agent is promising, owing to its antitumor and growth inhibitory potential properties exhibited by CB403<sup>11</sup>. The experiment conducted by<sup>20</sup> revealed that cinnamic aldehyde possesses inhibitory properties towards the activity of NF- $\kappa$ B and the synthesis of interleukin-8 (IL-8) induced by tumor necrosis factor alpha (TNF $\alpha$ -) in A375 cells. The inhibitory effect described herein serves to reinforce the purported but unacknowledged capacity of cinnamic acid to act as a promising anticancer therapeutic agent<sup>20</sup>.

Fang and colleagues have reported on the anticancer properties of trans-cinnamaldehyde derived from Cinnamomum through their academic research. The research conducted by Osmophloeum indicated that trans-cinnamaldehyde exhibited potential capabilities in impeding the proliferation of tumor cells and promoting their apoptosis<sup>21</sup>. A preliminary scientific investigation examining the potential anti-cancer properties of cinnamon and cardamom against colon cancer induced by azoxymethane (AOM) was conducted on Swiss albino mice<sup>22</sup>. The administration of aqueous extracts derived from cinnamon and cardamom has been found to enhance the operations of glutathione-transferase (GST), which functions as both a detoxifying and antioxidant enzyme, while also leading to a reduction in levels of lipid peroxidation in animal models afflicted with colon cancer, as compared to a control group<sup>22</sup>. The essential oils derived from the plant species Cinnamon can be considered a valuable resource in

various industries due to their unique properties and potential benefits. Cassia has been observed to inhibit the production of melanin induced by alpha melanocyte-stimulating hormone, which results in the suppression of oxidative stress in murine B16 melanoma cells<sup>7</sup>.

### Cardiovascular Diseases

One of the active constituents derived from the plant species known as cinnamon. The compound identified as cassia, specifically referred to as 2-methoxycinnamaldehyde (2-MCA), has been observed to effectively reduce the expression of vascular cell adhesion molecule-1 (VCAM1) within endothelial cells activated by TNF $\alpha$ . This reduction in VCAM1 expression has led to the potential amelioration of ischemia/reperfusion (I/R) injury, likely due to the induction of hemeoxygenase (-HO). These findings have been documented in a scholarly source<sup>23</sup>. A recent research study has documented the likely impact of two distinct compounds, namely cinnamic aldehyde and cinnamic acid, which were extracted from the Cinnamomum (C.) plant. A study conducted by Cassia *et al.* (24) suggests that cinnamon may have properties to combat myocardial ischemia, thereby exhibiting potential therapeutic value in treating cardiovascular ailments.

Numerous investigations have documented the cardioprotective properties of cinnamaldehyde. One of the noteworthy lignans discovered from Cinnamomum is the compound known as Cinnamophilin. Philippinensis was found to possess TXA2 receptor blocking activity in both rats and guinea pigs, as reported in<sup>25</sup>.

Cinnamophilin has been identified as a promising thromboxane synthase inhibitor and TXA2 receptor antagonist, demonstrating potential applications in therapeutics for TXA2-associated disorders<sup>25</sup>, including but not limited to platelet aggregation<sup>26</sup> and cancer pathologies<sup>27</sup>.

Cinnamophilin exhibits significant inhibitory effects on the proliferation of vascular smooth muscle cells mediated by thromboxane receptors, thereby displaying promising potential in the prevention of vascular diseases and

atherosclerosis<sup>30</sup>. The compound known as cinnamaldehyde has been shown to induce hypotensive effects, primarily through potential peripheral vasodilation in both anesthetized dogs and guinea pigs, as has been reported in previous research studies<sup>29</sup>. The present study found that vasodilatation induced by cinnamaldehyde in dogs exhibited a sustained effect that persisted through the recovery period following the initial decrease in blood pressure, ultimately returning to the baseline level<sup>28</sup>.

A recent examination revealed that cinnamaldehyde causes an expansion in rat vascular smooth muscle with the presence of an endothelium in a dependent manner. The vasodilatory function of cinnamaldehyde may be attributed to its inhibition of Ca<sup>2+</sup> influx and Ca<sup>2+</sup> release, as reported in literature<sup>31</sup>. The aforementioned effect can be considered as a contributing factor to the observed physiological response. Cinnamaldehyde has been found to inhibit the development of hypertension in both type 1 and type 2 diabetes patients through reduction of vascular contractility, coupled with its insulinotropic effect observed in cases of insulin deficiency<sup>12</sup>.

#### **Cholesterol- and lipid-lowering effects**

The lipid profile of mice was improved by the application of cinnamon. This led to a decrease in the levels of high-density lipoprotein (HDL) cholesterol and a reduction in plasma triglycerides. According to another research conducted by<sup>13</sup>, rats that were given Cinnamomum cassia powder (15%) for a period of 35 days experienced a decrease in their overall cholesterol levels, triglycerides, and low-density lipoprotein. Furthermore, the cholesterol levels of broiler chickens were found to decrease when treated with cinnamon oils<sup>14</sup>.

### **BENEFITS FOR HEALTH USING CINNAMON PLANTS**

#### **Traditional uses**

Cinnamon, in addition to being used as a spice and flavouring agent, is also used to flavour chewing gums because of its mouth-freshening properties and capacity to eradicate foul breath<sup>13</sup>. Cinnamon

can help promote colon health, lowering the risk of colon cancer<sup>14</sup>.

Cinnamon possesses antibacterial<sup>17-20</sup>, antifungal<sup>21</sup>, antioxidant<sup>22-26</sup> and antidiabetic<sup>27,30,29,28</sup> properties. Cinnamon has been utilised as an anti-inflammatory agent<sup>14-16</sup>, antitermitic agent<sup>34</sup>, nematicidal agent, mosquito larvicidal agent<sup>29</sup>, insecticidal agent<sup>10</sup>, antimycotic agent<sup>10-13</sup> and anticancer agent<sup>14-17</sup>. Cinnamon has also been used traditionally to treat toothaches, dental disorders, oral microflora, and foul breath<sup>18,19</sup>.

Cinnamon acts as a coagulant, preventing bleeding<sup>15</sup>. Cinnamon also improves uterine blood circulation and promotes tissue regeneration<sup>16</sup>. The outer bark of the cinnamon tree is the most important part, which is utilised as a spice and in numerous natural therapeutic uses. The inner bark of the cinnamon tree contains more essential oil and has higher therapeutic properties.

#### **Health Claims of Cinnamon**

A substance called cinnamaldehyde, which is naturally contained in cinnamon, is responsible for many of the wonderful properties of cinnamon. Cinnamaldehyde is the source of many of the antifungal and antibacterial characteristics that make cinnamon such a beneficial addition to your diet, claims Carina Parikh, MScN, MSiMR, the holistic nutritionist with Kate Naumes ND Holistic Wellness in Dallas.

#### **Cinnamon may help treat Type 2 diabetes**

The research with the most potential in terms of cinnamon's health benefits involves its impact on individuals with type 2 diabetes. Though there is no known remedy for this metabolic ailment, it can be managed by utilizing cinnamon to alleviate its symptoms.

Lori Kenyon Farley, a certified nutrition consultant specializing in wellness, fitness, anti-aging, and a member of the Project Juice team, suggests that cinnamon can be useful in the treatment of this ailment through two different methods. She clarifies that it has the potential to lower blood pressure and improve blood indicators in individuals with Type 2 diabetes. Farley explains that cinnamon has the potential to lower insulin resistance, leading to a



decrease in fasting blood sugar levels by up to 29%, ultimately reducing the occurrence of Type 2 diabetes.

Shane Ellison, an expert in medicinal chemistry who is the creator of Sugar Detox, elucidates the precise mechanism behind the process. According to him, the active ingredient in cinnamon encourages the muscle cells to extract glucose from the blood and convert it into usable energy. "It has been demonstrated to be more effective than many prescribed medications."

The aim is to enhance the body's response to insulin, which starts at a high level in individuals without type 1 diabetes from birth, but as we age and increase sugar intake, gradually diminishes. The presence of sugar in the bloodstream can lead to several health concerns including diabetes. Ellison clarifies that cinnamon, a harmless substance, mends the receptors, restoring their ability to react to insulin. With the passage of time, insulin sensitivity rises, leading to the stabilization of sugar levels.

Various research studies have pointed out the prospective advantages of cinnamon supplements. One such study, conducted in 2016, discovered that in combination with traditional hypoglycemic medications, cinnamon supplements had moderate influences on Fasting Plasma Glucose and HbA1c. Nonetheless, the researchers mentioned that additional extensive studies were required<sup>31</sup>.

#### **Cinnamon may help manage metabolic disease**

Given the potential advantages of cinnamon in addressing type 2 diabetes, it's logically reasonable to assume that cinnamon can also be a useful tool in the treatment of metabolic ailments. A literature review conducted in 2016 revealed that cinnamon might have a positive impact on metabolic syndrome by diminishing complications, morbidity, and mortality. It was observed that cinnamon has the potential to reduce various health concerns such as hypertension, high blood sugar, obesity, and dyslipidemia. Although the potential benefits of cinnamon consumption are encouraging, further carefully planned clinical studies are required to obtain definitive findings.

The natural sweetness of cinnamon makes it useful for curbing the appetite of individuals who have a tendency to crave sugar<sup>28</sup>.

#### **Cinnamon could lower your bad cholesterol (or LDL)**

Individuals may consider incorporating cinnamon into their dietary regimen for similar benefits as those with diabetes or metabolic syndrome, notwithstanding their personal health status. Parikh elucidates that Type 2 diabetes symptoms can be alleviated through a range of factors, notably by enhancing serum glucose, reducing fasting blood glucose, and mitigating levels of triglycerides, LDL cholesterol and overall cholesterol. These advantages can deliver benefits to individuals who do not suffer from diabetes, inclusive of those predisposed to ailments affecting cholesterol metabolism.

The author posits that cinnamon has the capacity to elevate high-density lipoprotein (HDL or "good") cholesterol levels. High-density lipoprotein (HDL) cholesterol facilitates the elimination of low-density lipoprotein (LDL) cholesterol from the human body. Furthermore, there are additional factors to consider. Parikh posits that consistent consumption of cinnamon could potentially mitigate the impacts of high-fat meals, as it impedes the rapid rise in post-prandial blood glucose levels. The inclusion of cinnamon in one's diet may potentially mitigate the adverse health impacts attributed to sporadic indulgence in high-fat food options<sup>32</sup>.

While a review of research conducted in 2013 indicated a promising association between the consumption of cinnamon and a reduction in cholesterol levels, the existing studies have been limited in size and have produced divergent outcomes. Further investigation is required to definitively establish these advantages.

#### **Cinnamon has antimicrobial properties**

Throughout history, the spice cinnamon has been known for its ability to combat fungi, bacteria, and viruses found in various food sources. Given the limited refrigeration options available during the Middle Ages, it was unsurprising that both sweet and savory recipes would heavily incorporate the

spice to preserve their ingredients longer. However, the benefits of cinnamon are not limited solely to its use in food seasoning. Our experts suggest that cinnamon possesses properties that can be advantageous to its consumers, such as the ability to serve as a component of treatment for a wide range of ailments, including respiratory issues and the common cold.

According to Denise Baron, a prominent wellness educator and Ayurveda for Modern Living director, cinnamon has the potential to alleviate a variety of respiratory blockages. By working as a mucus eliminator and promoting blood flow, it can be effective in easing a range of respiratory ailments from minor seasonal coughs to even more severe conditions like bronchitis, given that it is combined with other treatments<sup>31</sup>. This statement is explained by her. In a research review, it was found that cinnamon is able to hinder bacterial growth through methods such as altering their lipid profile and damaging cell membranes. These advantages were emphasized as being quite significant. Although initial findings appear hopeful, additional well-planned experiments are crucial to establish definitive advantages.

#### **Cinnamon could help manage HIV**

Cinnamon possesses antimicrobial characteristics that also apply to viruses, implying that it could potentially aid in the treatment or control of HIV. Parikh states that studies have demonstrated the efficacy of cinnamon extract in combatting the HIV virus by hindering its entry into cells. Consequently, the use of cinnamon extract has the potential to aid in the administration of HIV. A substance derived from cinnamon was discovered in a 2016 peer-reviewed study published in PLoS One, and it was found to have the potential to prevent the development of HIV into AIDS by obstructing viral entry, which is considered one of the most effective methods.

#### **Cinnamon could treat candidiasis**

In a similar vein, cinnamon has demonstrated its ability to combat fungi through its anti-microbial properties, making it a potential remedy for candidiasis. A 2011 analysis found that although

cinnamon demonstrated effectiveness against *Candida* in lab testing, clinical trials involving five HIV-positive patients with oral candidiasis yielded inconclusive outcomes. Additional clinical trials are needed to definitively establish these advantages<sup>33</sup>.

#### **Cinnamon can help treat the symptoms of Alzheimer's and Parkinson's**

At present, Alzheimer's and Parkinson's ailments are two types of neurological disorders that do not have a definite cure. Enhancing symptom management is a crucial aspect of treating these illnesses, hence incorporating cinnamon in a usual regimen can be advantageous.

According to Farley, cinnamon has been demonstrated to enhance the functionality of neurons and improve motor ability in individuals affected by Alzheimer's or Parkinson's disease. The donations have the potential to enable individuals suffering from the two illnesses to carry out their daily activities with minimal hindrance.

Cinnamon has shown promising potential for inhibiting tau protein aggregation and amyloid- $\beta$  peptides, which are typical indicators of Alzheimer's disease, according to a 2018 report in Pharmacological Research. Although the researchers acknowledged the potential benefits, they highlighted the importance of conducting additional molecular and translational research as well as clinical trials to conclusively validate their findings.

#### **Cinnamon may have anti-carcinogenic properties**

While many super foods are associated with anti-cancer properties, it is crucial to avoid hastily assuming that they possess superhuman abilities. Parikh emphasizes the significance of maintaining composure and not succumbing to excessive enthusiasm or emotion.

According to her, there is evidence indicating that cinnamon may possess anti-carcinogenic properties; however, current research on the subject is limited to experiments conducted on animals. The findings of these experiments suggest that the use of cinnamon extract can effectively impede the proliferation of cancer cells and trigger the

mortality of abnormal cells in the body. According to a research review conducted in 2011, cinnamon may have potential benefits in the treatment of lung and stomach cancer. However, more well-designed trials are required to draw a definitive conclusion.

#### **Cinnamon has anti-inflammatory properties**

Human trials are required to confirm the potential benefits of cinnamon consumption on reducing general and localized inflammation, although there is a possibility that it may have a positive effect. Parekh suggests that the relevance of the former is especially significant in the western hemisphere. According to her, chronic diseases have become more prevalent due to the widespread issue of systemic inflammation in Western societies. However, incorporating cinnamon into one's regular diet can greatly decrease this inflammation.

The consumption of cinnamon may aid in the treatment of certain types of pain and headaches, including arthritis pain, due to its ability to specifically reduce inflammation. According to Baron, cinnamon has a dual function in alleviating this specific pain type, as it can also enhance blood flow<sup>28,31</sup>.

#### **Cinnamon can help manage PCOS**

Cinnamon could play a vital role in managing the various symptoms associated with polycystic ovarian syndrome, a condition with multiple manifestations that require careful attention. The primary focus should be on addressing insulin resistance among women with PCOS, which may lead to an increase in body weight. According to Parekh, a recent trial depicted that cinnamon can reduce insulin resistance in females with PCOS, expanding its recommended usage from just diabetic individuals to anyone who suffers from insulin resistance.

According to her, cinnamon is capable of alleviating excessive menstrual bleeding that often accompanies female health issues like endometriosis, menorrhagia, and uterine fibroids. Currently, an ongoing clinical study aims to test the advantages of these benefits<sup>32,33</sup>.

#### **Cinnamon has antioxidant benefits**

Several studies have demonstrated the potent antioxidant effects of cinnamon. For instance, a carefully controlled trial conducted on overweight or obese subjects revealed the potential of cinnamon to enhance their antioxidant status. Furthermore, a 2013 research conducted on cinnamon essential oils in BMC Complementary and Alternative Medicine reported that they possessed highly effective antioxidant properties when tested in vitro. According to Farley, the abundant presence of antioxidants in cinnamon can safeguard the body against harm caused by free radicals and decrease inflammation, thus diminishing the likelihood of developing cancer and other illnesses<sup>28</sup>.

#### **Cinnamon can help your eyes**

Cinnamon, when combined with other herbs, has displayed potential in treating ocular conditions like dry eye and conjunctivitis, according to certain studies. A study on Ophta Care, a brand containing cinnamon and turmeric, revealed that it may have potential in treating eye disorders. However, in a review of research conducted in 2011, it was suggested that more conclusive studies are needed for confirmation of these benefits<sup>33</sup>.

#### **Cinnamon is a natural insect repellent**

There is informal proof that suggests cinnamon can serve as a natural insect deterrent. Furthermore, based on a study conducted in 2013 by the Journal of Medicinal Entomology, cinnamon essential oil, along with eucalyptus and star anise, are effective natural insect repellents, especially against some mites. The potential advantages of the oils require further examination, as observed by the researchers, indicating that there may be more to uncover. Throughout history, both Chinese medicine and Ayurveda have highly regarded cinnamon for its remarkable properties, utilizing it as a remedy for various ailments such as colds, digestive issues, and muscle spasms, as well as for its abilities to prevent blood clotting.

**Table No.1: The Chemical constituents of different parts of cinnamon<sup>2,16</sup>**

S.No	Part of the plant	Compound
1	Leaves	Cinnamaldehyde: 1.00 to 5.00% Eugenol: 70.00 to 95.00%
2	Bark	Cinnamaldehyde: 65.00 to 80.00% Eugenol: 5.00 to 10.00%
3	Root bark	Camphor: 60.00%
4	Fruit	<i>Trans</i> -Cinnamyl acetate (42.00 to 54.00%) and caryophyllene (9.00 to 14.00%)
5	<i>Cinnamon. zeylanicum</i> buds	Terpene hydrocarbons: 78.00% <i>alpha</i> -Bergamotene: 27.38% <i>alpha</i> -Copaene: 23.05% Oxygenated terpenoids: 9.00%
6	<i>Cinnamon. zeylanicum</i> flowers	(E)-Cinnamyl acetate: 41.98% <i>trans-alpha</i> -Bergamotene: 7.97% Caryophyllene oxide: 7.20%

**Table No.2: Physicochemical properties of cinnamon<sup>1</sup>**

S.No	Parameter	Leaf oil	Bark oil
1	Specific gravity (20°C)	1.030–1.050	1.010–1.030
2	Refractive index (20°C)	1.529–1.537	1.573–1.591
3	Aldehyde content	4%	65–76%
4	Eugenol content	77.3–90.5%	4–10%
5	Solubility characteristics	Soluble in 1.5 volumes of 70% alcohol	Soluble in 2.0–3.0 volumes of 70% alcohol



**Figure No.1: List of cinnamon properties composite of biomolecules<sup>2</sup>**



Figure No.2: Some benefits and overview of cinnamon<sup>4</sup>



Figure No.3: Enlist the properties of cinnamon<sup>5</sup>

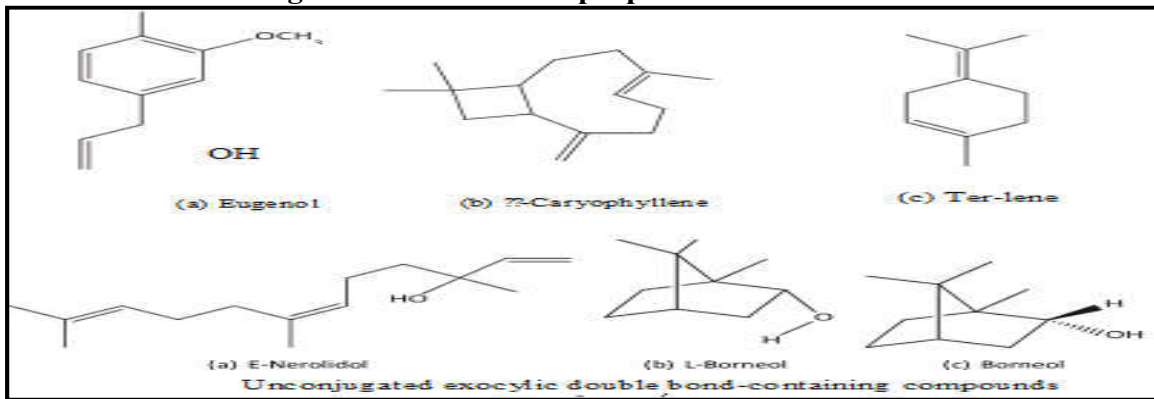


Figure No.4: Hydroxy-substituted aliphatic compounds<sup>4</sup>



Figure No.5: Chemical constituents of cinnamon<sup>6</sup>

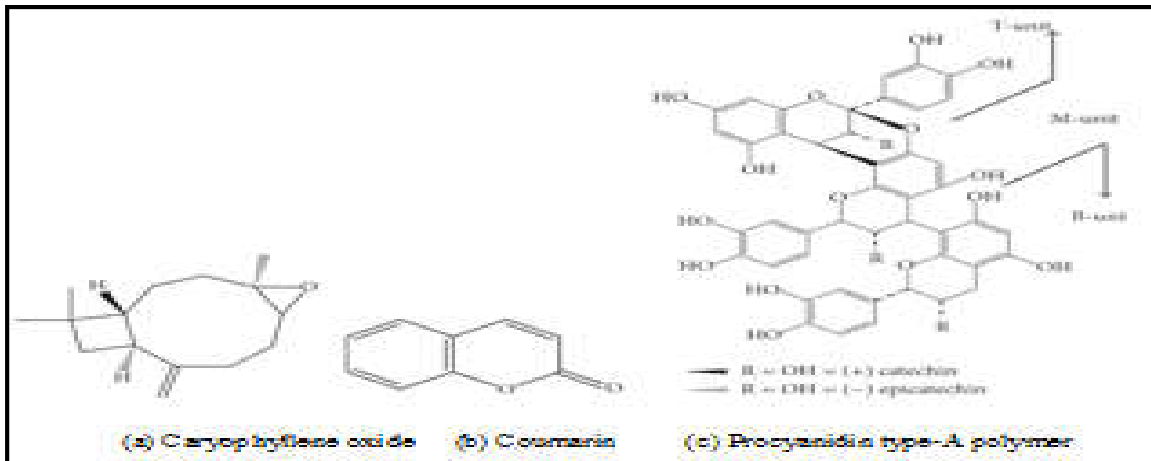


Figure No.6: Chemical consists the cinnamon bark

# cinnamon

**CINNAMON MAY FIGHT FUNGAL, BACTERIAL, AND VIRAL ELEMENTS IN FOODS.**  
 One 2016 literature review found that cinnamon could be effective in reducing complications, morbidity, and mortality in metabolic syndrome, including reducing blood pressure, plasma glucose, obesity, and dyslipidemia.

**CINNAMON COULD LOWER YOUR BAD CHOLESTEROL (OR LDL).**  
 Cinnamon may help raise HDL (the "good") cholesterol and remove LDL (the "bad") cholesterol from the body.

**CINNAMON HAS ANTIMICROBIAL PROPERTIES.**  
 Cinnamon has been proven to fight fungal, bacterial, and viral elements in foods.

**CINNAMON COULD HELP MANAGE HIV.**  
 Cinnamon's antimicrobial properties extend to viruses, thus indicating that it may help fight or manage HIV.

**CINNAMON COULD TREAT CANDIDIASIS.**  
 Similarly, cinnamon's anti-microbial properties extend to fungi, thus rendering it a promising treatment for candidiasis.

**CINNAMON MAY HELP TREAT THE SYMPTOMS OF ALZHEIMER'S AND PARKINSON'S.**  
 An enormous part of treating these diseases is in symptom management, and this can be boosted with the addition of cinnamon to a regular regime.

**CINNAMON MAY HAVE ANTI-CARCINOGENIC PROPERTIES.**  
 Many superfoods are attributed with anti-carcinogenic properties, but it's important not to jump from super food to super power.

**CINNAMON HAS ANTI-INFLAMMATORY PROPERTIES.**  
 It is possible that the consumption of cinnamon could reduce both systemic and specific inflammation which could help treat certain types of pain, headaches and arthritis pain.

**CINNAMON CAN HELP MANAGE PCOS.**  
 Polycystic ovarian syndrome is a problem with numerous symptoms that need to be managed, and cinnamon may be a key element of this management due to a number of characteristics.

**CINNAMON HAS ANTIOXIDANT BENEFITS.**  
 The high concentration of antioxidants in cinnamon may help protect the body from damaging inflammation, free radicals and serious diseases like cancer.

**CINNAMON CAN HELP YOUR EYES.**  
 Some studies have shown that cinnamon, when used in conjunction with other herbs, may be useful in the treatment of eye disorders including conjunctivitis and dry eye.

**CINNAMON IS A NATURAL INSECT REPELLENT.**  
 A 2013 study in the Journal of Medicinal Entomology found that cinnamon essential oil, in addition to eucalyptus and star anise, could indeed be natural insect repellents.

[GO TO ORGANICAUTHORITY.COM/CINNAMON TO LEARN MORE](https://www.organicauthority.com/cinnamon)

When making changes to your lifestyle, always seek out the advice and care of your primary care physician. This is not intended to diagnose or treat any symptoms or diseases, but merely to spark conversation.

Figure No.7: Including the 13 benefits of cinnamon<sup>3</sup>

## CONCLUSION

Cinnamon has been used as a spice in everyday life with no adverse consequences. Several studies have been conducted on the numerous rates of cinnamon in the form of dinghy, essential canvases, dinghy greasepaint, phenolic composites, flavonoids and insulated factors. Antioxidant and antimicrobial conditioning do directly on oxidants or bacteria, whereas anti-inflammatory, anticancer and anti-diabetic conditioning do laterally through receptor-intermediated processes. Multitudinous kinds of cinnamon have been studied for their major health advantages. Further exploration is demanded to offer clinical evidence for the traditional operation of this spice against cancer, inflammation, cardioprotection and neurological conditions. Cinnamon is a popular spice in numerous cookeries throughout the world. The entire factory is used as a remedy in Ayurveda and folkloric drug to treat a variety of problems similar as loss of appetite, indigestion, flatulence, gastritis, arthritis, and toothache. Several pharmacological exploration conducted over the last two decades have shown a variety of bioactive chemicals in colorful corridor of the factory that could be used in the creation of specifics and functional refectations. It also has excellent antibacterial parcels and can help oxidation. As a result, it has the implicit to be used as a drug, functional element, and food preservative.

## ACKNOWLEDGEMENT

The authors wish to express their sincere gratitude to Department of Pharmaceutics, NIMS Institute of Pharmacy, NIMS University Jaipur, Rajasthan, 303121, India for proving me necessary facilities and guideline to carry out this review work.

## CONFLICT OF INTEREST

We declare that we have no conflict of Interest.

## BIBLIOGRAPHY

1. Sangal. Role of cinnamon as beneficial antidiabetic food adjunct: A review, *Adv in App Sci Res*, 2(4), 2011, 440-450.
2. Vangalapati M, Sree Satya N, Surya Prakash D, Avanigadda S. A review on pharmacological activities and clinical effects of cinnamon species, *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 3(1), 2012, 653-663.
3. Huang T C, Fu H Y, Ho C T, Tan D, Huang Y T, Pan M H. Induction of apoptosis by cinnamaldehyde from indigenous cinnamon *cinnamomum osmophloeum* Kaneh through reactive oxygen species production, glutathione depletion and caspase activation in human leukemia K562 cells, *Food Chemistry*, 103(2), 2007, 434-443.
4. Yeh H F, Luo C Y, Lin C Y, Cheng S S, Hsu Y R, Chang S T. 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), 2013, 6293-6298.
5. Chang C W, Chang W L, Chang S T, Cheng S S. Antibacterial activities of plant essential oils against *Legionella pneumophila*, *Water Research*, 42(1-2), 2008, 278-286.
6. Marongiu B, Piras A, Porcedda S et al. Supercritical CO<sub>2</sub> extract of *Cinnamomum zeylanicum*: Chemical characterization and antityrosinase activity, *Journal of Agricultural and Food Chemistry*, 55(24), 2007, 10022-10027.
7. Chou S T, Chang W L, Chang C T, Hsu S L, Lin Y C, Shih Y. Cinnamomum cassia *Essential Oil* inhibits  $\alpha$ -MSH induced melanin production and oxidative stress in murine B16 melanoma cells, *International Journal of Molecular Sciences*, 14(9), 2013, 19186-19201.
8. Nonaka G I, Morimoto S, Nishioka I. Tannins and related compounds. Part 13, Isolation and structures of trimeric, tetrameric and pentameric proanthocyanidins from cinnamon, *Journal of the Chemical Society, Perkin Transactions I*, 1983, 2139-2145.

9. Anderson R A, Broadhurst C L. Isolation and characterization of polyphenol type-A polymers from cinnamon with insulin-like biological activity, *Journal of Agricultural and Food Chemistry*, 52(1), 2004, 65-70.
10. Peng X, Cheng K W. Cinnamon bark proanthocyanidins as reactive carbonyl scavengers to prevent the formation of advanced glycation endproducts, *Journal of Agricultural and Food Chemistry*, 56(6), 2008, 1907-1911.
11. Tanaka T, Matsuo Y, Yamada Y, Kouno I. 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), 2008, 5864-5870.
12. Maatt A-Riihinen K R, Kah Konen M P, Torronen A R, Heinonen I M. Catechins and procyanidins in berries of vaccinium species and their antioxidant activity, *Journal of Agricultural and Food Chemistry*, 53(22), 2005, 8485-8491.
13. Jakheta V, Patel R, Khatri P *et al.* Cinnamon: A pharmacological review, *Journal of Advanced Scientific Research*, 1(2), 2010, 19-12.
14. Wondrak G T, Villeneuve N F, Bause A S, Jiang T, Zhang D D. The cinnamon-derived dietary factor cinnamic aldehyde activates the Nrf2-dependent antioxidant response in human epithelial colon cells, *Molecules*, 15(5), 2010, 3338-3355.
15. Hossein N, Zahra Z, Abolfazl M, Mahdi S, Ali K. Effect of *Cinnamomum zeylanicum* essence and distillate on the clotting time, *Journal of Medicinal Plants Research*, 7(19), 2013, 1339-1343.
16. St. Minich, Msom L. Chinese herbal medicine in women's health, *Women's Health*, 2008.
17. Chang S T, Chen P F, Chang S C. Antibacterial activity of leaf essential oils and their constituents from *Cinnamomum osmophloeum*, *Journal of Ethnopharmacology*, 77(1), 2001, 123-127.
18. Hili P, Evans C S, Veness R G. Antimicrobial action of essential oils: the effect of dimethylsulphoxide on the activity of cinnamon oil, *Letters in Applied Microbiology*, 24(4), 1997, 269-275.
19. Matan N, Rimkeeree H, Mawson A J, Chompreeda P, Haruthaithanasan V, Parker M. Antimicrobial activity of cinnamon and clove oils under modified atmosphere conditions, *International Journal of Food Microbiology*, 107(2), 2006, 180-185.
20. Gende L B, Floris I, Fritz R, Eguaras M. J. Antimicrobial activity of cinnamon (*Cinnamomum zeylanicum*) essential oil and its main components against paenibacillus larvae from argentine, *Bulletin of Insectology*, 61(1), 2008, 1-4.
21. Lin J, Opoku A R, Geheeb-Keller M *et al.* Preliminary screening of some traditional zulu medicinal plants for anti-inflammatory and anti-microbial activities, *Journal of Ethnopharmacology*, 68(1-3), 1999, 267-274.
22. Mascolo N, Capasso F, Menghini A, Fasulo M P. Biological screening of Italian medicinal plants for anti-inflammatory activity, *Phytotherapy Research*, 1(1), 1987, 28-31.
23. Hong J W, Yang G E, Kim Y B, Eom S H, Lew J H, Kang H. Anti-inflammatory activity of cinnamon water extract *in vivo* and *in vitro* LPS-induced models, *BMC Complementary and Alternative Medicine*, Article No:237, 12(1), 2012.
24. Yu S M, Ko F N, Wu T S, Lee J Y, Teng C M. Cinnamophilin, a novel thromboxane A<sub>2</sub> receptor antagonist, isolated from *Cinnamomum philippinense*, *European Journal of Pharmacology*, 256(1), 1994, 85-91.
25. Brahmachari S, Jana A, Pahan K. Sodium benzoate, a metabolite of cinnamon and a food additive, reduces microglial and astroglial inflammatory responses, *The Journal of Immunology*, 183(9), 2009, 5917-5927.



26. Khasnavis S, Pahan K. Sodium benzoate, a metabolite of cinnamon and a food additive, upregulates neuroprotective parkinson disease protein DJ-1 in astrocytes and neurons, *Journal of Neuroimmune Pharmacology*, 7(2), 2012, 424-435.
27. Stoner G, Wang L S. Natural products as anti-inflammatory agents in obesity, *Inflammation and Cancer*, Springer, 2013, 341-361.
28. Harada M, Hirayama Y, Yamazaki R. Pharmacological studies on Chinese cinnamon V. Catecholamine releasing effect of cinnamaldehyde in dogs, *Journal of Pharmacobio-Dynamics*, 5(8), 1982, 539-546.
29. Harada M. Pharmacological studies on Chinese cinnamon. II, Effects of cinnamaldehyde on the cardiovascular and digestive systems, *Chem and Phar Bull*, 23(5), 1975, 941-947.
30. Cho N, Lee K Y, Huh J et al. Cognitive-enhancing effects of *Rhus verniciflua* bark extract and its active flavonoids with neuroprotective and anti-inflammatory activities, *Food and Chemical Toxicology*, 58, 2013, 355-361.
31. Subasinghe S, Hettiarachchi C S, Iddagoda N. *In-vitro* propagation of cinnamon (*Cinnamomum verum* Presl) using embryos and in vitro axillary bud, *Journal of Advance Agricultural Technologies*, 3(3), 2016, 164-169.
32. Vangalapati M, Avanigadda S. A review on pharmacological activities and clinical effects of cinnamon species, *Res Jour of Phar, Bio and Che Sci*, 3(1), 2012, 653-663.
33. Ravindran P, Shylaja M. Botany and crop improvement of cinnamon and cassia. In P. N. Ravindran and K. N. Babu (Eds.), *Cinnamon and Cassia-The Genus Cinnamomum*, CRC Press, 1<sup>st</sup> Edition, 2004, 66.

**Please cite this article in press as:** Shiva Kant Thakur et al. The anti-oxidant cinnamon, other phyto-containing compounds including their application in various diseases, *Asian Journal of Phytomedicine and Clinical Research*, 10(4), 2022, 124-140.