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Review

From spice to mind: How cinnamon supports women's mental health

[1]Saravanan Dhanapal, [2]Eashwatha Ramachandran, [3]Gopika U, [4*]Rajabhuvaneswari Ariyamuthu

ABSTRACT:

Background: Cinnamon, a frequently used spice with a rich history in traditional medicine, has now garnered scientific interest in its therapeutic potential. Beyond their culinary applications, bioactive compounds such as polyphenols, cinnamaldehyde, and flavonoids have been found to possess neuroprotective properties that can potentially benefit mental and cognitive health. **Objective:** This review explores the corresponding potential of cinnamon in supporting women's mental health and addresses the challenges, such as depression, cognitive decline, anxiety, and menopause related symptoms. It also evaluates its pharmacokinetics, mechanisms, and practical applications. **Methods:** Preclinical and clinical indications of the new reproductive effects of the synonyms, especially their anti-inflammatory and antioxidant properties, were analyzed. The review also explores the dosage delivery methods and accessibility. **Results:** The limited yet promising studies suggest that cinnamon may reduce the risk of neurodegeneration, aid in mood regulation, and enhance cognitive function. Nevertheless, the research on women's specific issues remains meager. The cultural significance, practical considerations, and their integration into their lifestyle are discussed. **Conclusion:** While cinnamon exhibits potential as a complementary therapy for women's mental and cognitive health, long-term, targeted research is essential to validate its efficacy and safe clinical application.

KEYWORDS: Cognitive Health, Anti-Inflammatory, Antioxidant, Bioactive Compounds, Dosage, Women's Lifestyle.

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Corresponding Author Email:

rajabhuvaneswariariyamuthu@gmail.com

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1. INTRODUCTION:

Mental and cognitive health challenges are significant in women's lives and the biological environment and hormonal factors play an essential role in influencing them. Often, the issues include stress, anxiety, depression, and postpartum disorders. It's surprising to know that women experience depression twice as much as men due to hormonal fluctuations and societal pressures. Alzheimer's disease post menopause is one of the cognitive health challenges due to estrogen decline, which affects neuroprotection. [1] Premenstrual dysphoric disorder and premenstrual syndrome also influence the mental health of women, as 20 - 40% experience moderate to severe symptoms. [2, 3] Cinnamon, derived from the inner bark of trees in the Cinnamomum genus, is a widely used spice with a rich history in both culinary and medicinal contexts. Cinnamon was valued for its antimicrobial, warming, and restorative properties, particularly in traditional systems such as Ayurveda and Traditional Chinese Medicine, which have historically been prized in India, China, and ancient Egypt. [4] There are two primary types of cinnamon: Ceylon and Cassia (Cinnamomum verum and Cinnamomum cassia, respectively). Ceylon is considered 'True Cinnamon' and because of its lower coumarin level, it is preferred for medicinal use. [3] In the current era, cinnamon remains famous not only as a flavoring agent in the food industry and beverages, but also for its therapeutic potential, which ranges from neuroprotection to mood regulation. [9] This mix of traditional reverence and emerging scientific interest positions the cinnamon as a valuable bioactive agent in preventive and integrative health strategies. This review aims to explore the therapeutic potential of cinnamon in supporting women's mental and cognitive health by analysing its bioactive compounds, existing scientific evidence, and its underlying mechanisms. Women, across various life stages, face distinct mental health challenges ranging from risk of anxiety, depression, to neurodegenerative diseases. [5] Spices like cinnamon, which are rich in bioactive compounds such as eugenol, Cinnamaldehyde, and polyphenols, have demonstrated anti-inflammatory, antioxidant, neuroprotective, and regulating effects in emerging clinical and preclinical studies. [4] The review focuses exceptionally on how these properties can influence the key biological components involved in neuroinflammation, neurodegeneration, and other related processes, with an emphasis on the specific vulnerabilities of women. By combining traditional knowledge with modern findings, this paper highlights the role of cinnamon as a promising adjunct in women's integrative mental and cognitive healthcare.

2. BIOACTIVE COMPOSITION OF CINNAMON:

Types of Cinnamon:

Table 1: Types of Cinnamon and Their Definitions

Cassia Cinnamon	Ceylon Cinnamon
It is less expensive and more commonly available. It has a spicier and stronger taste, with a high coumadin level ranging from 0.1 to 5g/kg. Higher consumption increases the risk of liver damage. [6]	It is often referred to as 'true cinnamon,' which has a milder flavor and contains low levels of coumarin, a potentially carcinogenic compound. It ranges from 0.004 to 0.031 g/kg. [3]

Fig.1. Types of Cinnamon Cassia and Ceylon

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Both types contain Cinnamaldehyde, flavonoids, and even polyphenols, but Ceylon's lower coumarin content contributes to safer and regular therapeutic use, particularly for mental health benefits. [7] Cassie's character as a more affordable option contributes to its wide use, but high doses can exceed safe levels of coumarin. [8] However, Ceylon is preferred for long-term supplementation due to its safer profile.

Key Bioactive Components:

One of the main bioactive components is Cinnamaldehyde, which possesses significant neuroprotective properties by reducing amyloid beta accumulation and inhibiting tau aggregation, a key factor in Alzheimer's disease. This modulates neuroinflammation by exhibiting antioxidant activity, reducing oxygen stress in neural tissues, and down regulating the pro-inflammatory cytokine. [9] Flavonoids are a significant subgroup of polyphenols that protect neurons through antioxidant mechanisms and modulate cellular signaling pathways involved in apoptosis. Vitamin C and E are antioxidants that offer new reproduction by scavenging reactive oxygen species and supporting mitochondrial function. Polyphenols, found in foods such as berries and wine, support cognitive function by enhancing neurogenesis, synaptic plasticity, and partly through the regulation of brain-derived neurotropic factor. [10]

Pharmacokinetics:

Cinnamaldehyde and cinnamic acid are compounds found in cinnamon that exhibit neuroprotective effects; however, their pharmacological properties influence their efficacy. Cinnamaldehyde reduces its active systemic concentration by being rapidly absorbed and extensively metabolized in the liver to acid and further to benzoic acid derivative. [4] These metabolites undergo glucuronidation, a type of conjugation that increases solubility but decreases lipophilicity. This may limit the penetration of the blood-brain barrier. [11] Some metabolites, for example, cinnamic acid, are small and lipophilic enough to potentially cross the blood-brain barrier (BBB) and exert anti-inflammatory effects in neural tissues. [12]

3. MECHANISM OF ACTION IN MENTAL AND COGNITIVE HEALTH:

- **Antioxidant Property:**

Mental Health:

Antioxidant compounds, such as polyphenols in Cinnamon, may support women's mental health by reducing oxidative stress Associated With more regulation in brain regions. These include the amygdala and the prefrontal cortex. The neuroinflammation and neuronal damage are caused by oxidative stress that can even lead to anxiety and depression. Polyphenols in cinnamon enhance Endogenous Antioxidant Enzymatic Activity by scavenging free radicals. This helps preserve neuronal integrity and modulates the neurotransmitter system. [13] These reactions can reduce the symptoms

of mood disorders and improve the emotional resilience in women, especially for those who experience heightened oxidative stress due to the hormonal fluctuations.

Cognitive Health:

The antioxidants Present in cinnamon help support cognitive health by protecting the neurons from oxidative damage, which is a major contributor to neuronal degeneration and decline in mental health in women. [14] The polyphenols in cinnamon enhance enzymatic activity, preserving neuronal structure and function by reducing reactive oxygen species. [7] These compounds support the brain's ability to adapt and reorganize, that is, synaptic plasticity, which is essential for reading, learning, and memory. By regulating synaptic integrity and reducing neuroinflammation, cognitive performance can be sustained, and age-related cognitive impairment can be delayed in women. [8, 14]

- **Anti-inflammatory Property:**

Mental Health:

Cinnamon shows concern on neuroinflammation in women's mental health, which is a key factor for depression and anxiety. Chronic inflammation, often caused by hormonal fluctuations, stress, and sometimes autoimmune conditions, is associated with elevating the levels of proinflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-alpha), in the brain. [15] Studies suggest that cinnamon and its active compounds can down regulate these cytokines, which helps reduce new neuro-inflammatory signaling and increase emotional regulation. [16] Women who experience higher rates of depression and anxiety, especially during the postpartum and menopause, can benefit from the anti-inflammatory effects. [5] Through its anti-inflammatory effects, cinnamon provides a natural yet adjunctive approach to mental health care.

Cognitive Health:

Cinnamon has an essential role in preserving cognitive function by reducing neuroinflammation, which is the key driver of decline in neurodegenerative conditions like Alzheimer's disease. The primary mechanism is the inhibition of microglial activation, which, when overreacted, releases proinflammatory cytokines that damage neurons and synapses. [17] The bioactive compounds cinnamaldehyde and cinnamic acid, found in cinnamon, have been shown to suppress inflammatory signaling pathways, such as NF-kappaB, thereby protecting against neuronal degeneration induced by inflammation. [7] These kinds of effects are relevant particularly for women, who face a higher risk of Alzheimer's and related dementias that are encountered especially after menopause when estrogen's neuroprotective effects wane. The presence of cinnamon represents a promising and natural approach to preventing and slowing down age-related cognitive decline by targeting inflammation at the cellular level.

- **Neuroprotection:**

Mental Health:

Cinnamon helps in protecting the neurons that play a key role in mood-regulating regions of the brain, such as the hippocampus and cingulate cortex, from stress-induced damage. The chronic physiological stresses can

impair the synaptic plasticity and neurogenesis, which contributes to mental disorders like anxiety and depression. [18] Pre-clinical studies have suggested that the active components of the synonyms, including cinnamaldehyde, can exhibit anti-inflammatory and antioxidant effects that preserve neuronal integrity and function under stress. [16] These protective mechanisms may support emotional stability by enhancing the activity in brain circuits involved in emotional regulation and processing. [5] Vulnerable to stress-related affective disorders, especially during the hormonal transitions, cinnamon's neuroprotective effects could offer valuable support in regulating the emotional balance and mental health in women.

Cognitive Health:

Cinnamon has the potential to protect against key pathological processes underlying cognitive impairment, including amyloid-beta accumulation and hyper phosphorylation, which are the hallmarks of Alzheimer's disease. [4] Animal studies and in vitro studies demonstrate that extracts from cinnamon can potentially inhibit the aggregation of amyloid-beta and limit tau phosphorylation. This helps in preventing neuronal dysfunction and synaptic loss. In essence, synonyms of active compounds may also enhance neurogenesis in memory-related regions, such as the hippocampus, by promoting the expression of brain-derived neurotrophic factor (BDNF) and supporting neural plasticity. These mechanisms are particularly relevant for women who are particularly prone to Alzheimer's and may benefit from early and natural interventions that support long-term cognitive resilience. [19] Cinnamon's effects are a promising Avenue to prevent or delay neurodegeneration through both regenerative and molecular pathways.

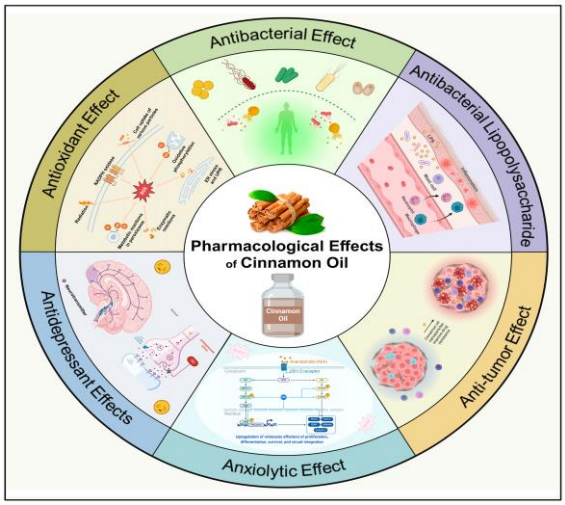

Fig.2. Properties and effects of Cinnamon in Women's Mental Health

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4. SPECIFIC BENEFITS FOR WOMEN'S MENTAL HEALTH:

Mood Disorders:

Cinnamon is promising to reduce the symptoms of anxiety and depression effectively for women twice as much as for men. Cinnamonaldehyde, an active compound of cinnamon, can exert neuroprotective and anti-inflammatory effects. Thus, modulating neurotransmitters like serotonin and dopamine. [16,20] Some animal models suggest that cinnamon's antidepressant effects are linked to reduced oxidative stress and enhanced Brain-Derived Neurotrophic Factor (BDNF) activity. In essence, it also contributes to stabilizing blood glucose, which can impact mood regulation, as glycemic variability is linked to mood swings and irritability. [21]

Menopause Related Cognitive Decline:

Cinnamon can offer therapeutic benefits in handling the cognitive impairment and mood swings associated with Perimenopause and menopause. Memory, mood, and neuroplasticity are affected during this period due to the decline in estradiol. The anti-inflammatory and antioxidant properties of cinnamon play a key role in mitigating cognitive decline, as they help reduce neuroinflammation. Studies have shown that cinnamon promotes neurogenesis and improves insulin signaling in the brain, thereby enhancing brain function. The mood fluctuations during menopause are stabilized by cinnamon's ability to modulate glucose metabolism. [21]

Neurodegenerative Diseases:

Women have a higher risk of Alzheimer's disease, partly due to the longer life expectancy and hormonal changes. The neuro-protecting benefits of cinnamon help inhibit aggregation and amyloid Beta accumulation, which are the hallmarks of Alzheimer's pathology. [12,22] Cinnamaldehyde and epicatechin are active compounds in cinnamon that have been shown to enhance neuronal function and mitigate oxidative stress in brain tissue. Cinnamon enhancement is associated with improved insulin sensitivity, which can minimize cognitive decline linked to Brain insulin resistance, a condition prevalent in the postmenopausal period. [21]

5. SAFETY, DOSAGE, AND PRACTICAL CONSIDERATION:

Safety Profile:

Wild animals are generally considered safe, but long-term usage of cassia cinnamon raises agitation due to its high coumarin content, which poses hepatotoxic Risks. [23] Ceylon Cinnamon contains significantly lower coumarin levels than Cassia and is also considered safer for extended use. [11] Hence, Ceylon is preferred for long-term mental health support from cinnamon for women.

Delivery Methods:

Cinnamon is available in various forms, including capsules, powders, and extracts, each differing in its efficiency and therapeutic value. Cinnamon, in its encapsulated form and standardized extracts, provides a more consistent dosage and is often preferred for clinical purposes in mental and cognitive health applications. [24] Studies show that aqueous and ethanol-based extracts have higher concentrations of active compounds, such as proanthocyanidins and cinnamaldehyde. These are responsible for the mood-regulating and neuroprotective effects. [4] Surprisingly, the culinary use of cinnamon may offer benefits, but it lacks the potency required for the specific therapeutic results. [25] Standardised supplements help improve bioavailability and safety, enhancing women's mental and cognitive health.

Interactions and Contraindications:

Although cinnamon’s benefits for women's mental and cognitive health are appreciable, it is essential to exercise caution due to potential medical interactions. As the cinnamon can enhance insulin sensitivity, this can lead to hypoglycemia. [26] By influencing the liver enzymes like CYP450, it may alter drug efficiency and side effects, thus interfering with the metabolism of the antidepressants. [27] Women with hormone imbalance,

liver disorders, or even those who are pregnant should use cinnamon supplements with care, as high doses can pose corresponding risk. [4] When using cinnamon for pharmacotherapeutic and mood swing regulation, healthcare supervision is recommended.

6. CULTURAL AND PRACTICAL IMPLICATIONS:

Accessibility and Cost:

In comparison with the other pharmaceutical treatments for mood and cognitive disorders, cinnamon is more accessible and affordable, making it more valuable for women in low-income societies. Unlike prescribed medication, cinnamon is widely available as a culinary spice, without financial or logistical barriers to medical access. [21] Because it's low-cost and highly available, cinnamon became the practical option for women seeking mental and cognitive health support. [24] This encourages consistent usage, especially in a population where healthcare disparities limit traditional treatment. [4] Even then, ensuring the quality and proper dosages are essential.

Integration into Daily Life:

Cinnamon can be easily added to daily life to support women's mental well-being and cognitive health. Standard methods, such as adding ground cinnamon to teas, smoothies, or yogurt, are fine examples of how cinnamon is incorporated into daily routines to offer both functional benefits and flavor [3] Aromatherapy utilizes cinnamon as an essential oil, promoting relaxation and reducing symptoms of anxiety. [28]

7. FUTURE DIRECTIONS FOR RESEARCH:

Mechanistic Insights:

Despite extensive preclinical data, the precise mechanism by which cinnamon affects brain function remains unclear. Current research suggests that cinnamon can modulate neurotransmitters, thereby enhance neuroplasticity and reduce neuroinflammation. [27–30] However, tools like MRI or PET imaging for human trials are lacking. Setting up reliable biomarkers like changes in BDNF levels or inflammatory cytokines would support the growth of evidence-based interventions in women's mental health [18] To validate cinnamon's therapeutic potential, precise mechanistic studies are crucial, as such mechanistic insights are essential to move beyond anecdotal.

Need for Women-specific Studies:

Despite the growing interest in cinnamon’s neuro-regulating and neuroprotective properties, research specific to women remains limited. Most existing studies either use male animal models or exclude sex-specific analyses, thereby overlooking the physiological and hormonal changes unique to women. [17] The clinical trials need to be tailored to evaluate the efficiency and safety of cinnamon in distinct phases, particularly focusing on metabolic variations, hormonal profiles, and co-existing conditions such as depression or polycystic ovary syndrome [31] Cognitive and mood disturbances during pregnancy, postpartum, menstruation, and menopause may respond variably to the interpretations like fluctuations due to the cinnamon in estragon and other neuroactive hormones [5] Developing sex specific protocols can ensure personalized, evidence-based use of cinnamon as a complementary strategy in women's mental health care.

Long-term Effects:

While short-term studies on cinnamon suggest that it enhances mental and cognitive health in women, there is poor understanding of how long-term effects affect these parameters on women's bodies and minds. The maximum number of trials that can be conducted is limited by duration, making it difficult to determine optimal dosing, sustained efficacy, or potential side effects [3] Longitudinal studies are crucial for assessing the impact of regular cinnamon intake on emotional resilience, hormonal fluctuations, and neurodegenerative risks across various life stages [5] Tracking long-term biomarkers, such as oxidative stress markers, cognitive performance metrics, and inflammatory cytokines, could potentially help establish a clearer, safer, and more beneficial profile. [21] These kinds of studies are critical for women, especially those who face unique vulnerabilities due to the longer life expectancy, hormonal shift, and higher rates of dementia and depression. A long-term perspective will lead to an effective and responsible integration of cinnamon's benefits into women's mental health.

8. CONCLUSION:

Cinnamon is often touted as a natural, accessible intervention for supporting women's mental and cognitive health. It's bioactive compounds, such as cinnamon aldehyde, polyphenols, and flavonoids, offer anti-inflammatory, neuroprotective, and antioxidant properties. These palliate the depression, cognitive decline, and anxiety in women by easing the oxidative stress, enhancing mood stability, and improving memory. Ceylon cinnamon has low coumarin levels, making it safer for long-term use. As a cost-effective supplement, cinnamon can complement existing mental health strategies. Women-specific research is needed to confirm its efficiency in this domain. German has the potential to enhance existing treatments, such as therapy and medications. Public health Initiatives may promote the inclusion of foods to support cognition and mood, especially for women who face mental health challenges. However, further research and standardized dosages are crucial to interpreting cinnamon's efficacy in clinical practices. Clinicians, researchers, and women are encouraged to explore the potential of cinnamon in supporting women's mental and cognitive health. Cinnamon's anti-inflammatory and antioxidant properties offer an accessible yet promising intervention, particularly for women facing mood disorders and cognitive decline. Clinicians should investigate its complementary role in mental health care, while women are encouraged to include Ceylon cinnamon in their diets to assess potential benefits. Despite that, robust, women-specific research is essential to establish optimal dosages, long-term safety, and efficacy. Advocacy for further study will help unlock cinnamon's full therapeutic potential and integrate it into a holistic health approach in supporting women's mental and cognitive health.

Authors Details:

[1]Professor, Department of Science and Humanities, Karpaga Vinayaga College of Engineering and Technology

[2]Karpaga Vinayaga College of Engineering and Technology

[3]Research Scholar, Center for Global Health Research, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-602105

[4*]Professor, Department of Chemistry, Karpaga Vinayaga College of Engineering and Technology

Authors Contribution

Conceptualization: Dr. RA, Dr. ER

Data collection & Literature search: Dr. RA, Dr. ER

Writing Original draft: Dr. RA, Dr. ER, Dr. SD

Reviewing & Editing: Dr. RA, Dr. ER, Dr. GU

Approval of final manuscripts: All Authors

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