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Effects of walnut consumption on brain health: A review

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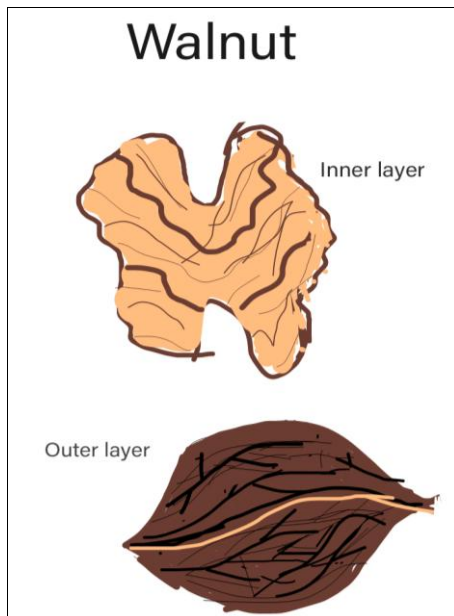
Abstract

Neurodegenerative disorders have become one of the most concerned issues of lately. Apart from clinical manifestations the initial prevalence of this disorder could be resisted by an appropriate dietary restoration. Walnuts have gained recognition for their potential benefits on brain health due to their unique nutritional composition rich in omega-3 fatty acids, antioxidants, vitamins, and minerals. Omega-3 fatty acids found in walnuts, particularly alpha-linolenic acid (ALA), may play a crucial role in supporting brain function and cognition. ALA is converted into long-chain polyunsaturated fatty acids (PUFAs) such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the body, which are essential for neuronal membrane integrity, synaptic function, and neuroplasticity. Thus, regular walnut consumption may contribute to the maintenance of cognitive function and may have potential implications for neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, depression, anxiety, confusion etc. Emerging evidence also suggests that walnuts may influence gut microbiota composition, leading to the production of metabolites that can positively impact brain health through the gut-brain axis. Additionally, walnut consumption has been associated with improvements in mood and psychological well-being, potentially due to the synergistic effects of its bioactive components on neurotransmitter pathways. Overall, the findings from this review suggest that incorporating walnuts into a balanced diet may confer beneficial effects on brain health and cognitive function. However, further research, including well-designed clinical trials, is needed to elucidate the specific mechanisms underlying these effects and to establish optimal intake recommendations for maximizing the potential benefits of walnut consumption on brain health. This review provides a comprehensive overview of the effects of walnut consumption on brain health based on current scientific evidence.

Keywords: Neurodegenerative disorders, walnuts, brain functions, Alpha linolenic acid (ALA)

Introduction

Nuts in general, especially walnut contain some beneficial nutrients with some additive effect that potentially work upon neuronal development and brain function. People of younger aged as well as older both equally be benefitted by consuming walnuts. Among the different tree nuts, walnuts contain n-3 PUFA, specifically α -linolenic acid (ALA). ALA has long been believed to improve brain health indirectly via modest conversion to docosahexaenoic acid (Domenichiello, 2015) [8] which has been found to modulate brain plasticity and counteract neuro inflammation in experimental studies (Dyall, 2015) [9]. However, studies in rodents uncovered brain benefits of ALA by itself, including increased brain plasticity (Blondeau *et al.*, 2009) [4] reduced cell death and calcium dysregulation (Carey, 2013) [5] and reduced amyloid-beta deposition (Gao, 2016) [11]. Other bioactive compounds in walnuts, such as arginine, tocopherols, folate, melatonin, and polyphenols also support neurological health and cognitive wellness by modulating blood pressure, HDL function, glucoregulation, endothelial vasodilator function, arterial compliance, oxidative status, and vascular inflammation. (Carey, 2013) [5] (O'Brien, 2014) [12]. As the lifespan increases the age related disease like Alzheimer disease, mild cognitive impairment, dementia, age related macular degeneration are very common and for younger adults there are depression at early age, memory intellectual decline, confusion are noticeable.



Neurodegenerative disorders in older ages and adolescents

Dementia: Dementia is the progressive impairment of brains in several domains like learning, judgement, orientation there by affecting daily life activities and social functions. Dementia can be seen in people of above 65 years of age, the reoccurrence of dementia is related to mild cognitive impairment and Alzheimer disease. (Chauhan, 2020) ^[1].

Mild cognitive impairment (MCI): Mild cognitive impairment occurs when the person is within his healthy aging and early dementia. People with MCI can perform all their daily activities but they have the higher risk of developing dementia within 3 -10 years. MCI can be of two types - amnesic (with impaired memory) and non - amnesic (without memory effects). The prevalence of MCI can happen within 65 years of age or older than that. People with amnesic MCI might develop dementia within 3 years. (Chauhan, 2020) ^[1].

Alzheimer disease (AD): The neuropathological hallmarks of AD include neuronal loss and progressive accumulation of fibrillar amyloid beta protein (A β) as amyloid plaques, and of paired helical filaments as neurofibrillary tangles in the brain (Huang and Jiang, 2009). Alzheimer's disease (AD) is a devastating neurodegenerative disorder that gradually leads to memory loss and decline of cognitive functions over a time period of 5-20 years. Although there are many types of dementia, AD ranks as the most common cause of dementia among elderly people, and it accounts for over 60% of dementia cases. (Chauhan, 2020) ^[1].

Parkinson's disease (PD): PD is characterized by the progressive loss of dopaminergic neurons and by clinical symptoms, including movement impairment, postural imbalance, tremor, and rigidity. In a mouse model of PD, walnut extract improved symptoms of PD (postural balance, motor coordination, and movement), reduced oxidative stress, and protected neurons.

Epilepsy: Epilepsy affects 50 million people worldwide and is defined by recurrent seizures. In experimentally induced

epilepsy in rats, a walnut-enriched diet showed neuroprotective and anticonvulsant effects, and it also reduced mortality.

Depression: Depression can be considered as the risk factor for dementia. It has been shown by the research that people consuming nuts are prone to show depressive symptoms rather people who do not consume nuts. Nutrients in walnut help people to do better concentrations, less hopelessness with higher energy levels. (Chauhan, 2020) ^[1] Hormonal imbalance plays a pivotal role in causing depression.

Nutrients rich in walnut

Walnuts are nutrient-dense nuts that provide a range of essential nutrients. Here is an approximate 1 ounce (28 grams) of walnuts provide Calories: 185 kcal, Protein: 4.3 gram, Fat: 18.5 grams (mainly polyunsaturated and monounsaturated fats), Carbohydrates: 3.9 grams, Dietary Fiber: 1.9 gram, Sugars: 0.7 grams, Vitamins: Vitamin E: 0.2 mg (1% of the daily recommended intake), Vitamin B6: 0.1 mg (5% of the daily recommended intake), Folate: 28.2 mcg (7% of the daily recommended intake), Minerals: Magnesium: 45.6 mg (11% of the daily recommended intake), Phosphorus: 98.7 mg (10% of the daily recommended intake), Potassium: 125 mg (3% of the daily recommended intake), Zinc: 0.9 mg (6% of the daily recommended intake), Omega-3 fatty acids: 2.6 grams, Omega-6 fatty acids: 10.7 grams. These values can vary slightly based on factors such as the specific type of walnut and growing conditions. Walnuts are known for their high content of heart-healthy omega-3 fatty acids, antioxidants, and other beneficial nutrients. Though walnuts are nutritious health benefits still it should be used in moderation as it is calorie-dense.

Mechanism of Walnut functions

Several studies suggest that neuroinflammation cascades mediated by activated microglia cells, which release proinflammatory cytokines, have a detrimental role in Alzheimer disease (Galasko and Montine, 2010) ^[10], (Agostinho *et al.*, 2010) ^[2]. Higher numbers of activated microglia and astrocytes, and elevated levels of inflammatory cytokines, namely, interleukin (IL)-6, IL-1 β , and tumor necrosis factor- α (TNF- α), have been reported in aging brains and Alzheimer disease (AD) brains. A β has also been reported to activate microglia cells, which leads to enhanced production of proinflammatory cytokines (IL-1 β , IL-6, and TNF- α) and stimulation of proinflammatory enzymes, e.g., inducible nitric oxide synthase (iNOS), resulting in enhanced NO (nitric oxide) production. In AD, the expression of cyclooxygenase (COX-2, induced by proinflammatory mediators) is also upregulated (Pasinetti and Aisen, 1998), which results in increased production of inflammatory prostaglandins (PGs), especially PGE2, in the brain. Increase in COX activity and PGE2 is also reported in aging brains. Because the PG synthesis pathway is a major source of reactive oxygen species (ROS) in the brain, inflammation may also be partly responsible for elevated oxidative stress in aging and AD. Several studies have suggested the association of chronic inflammation with other diseases, including CVD, diabetes, depression, Parkinson's disease (PD), and hypertension.

Walnut extracts prevent the amyloid beta induced cell damage. The formation of A β fibrils from soluble A β is

preceded by A β oligomerization/aggregation, and it involves change in A β conformation from α -helical to β -pleated sheet structure. In a study with synthetic A β , walnut extract inhibited A β fibrillization and solubilized preformed A β fibrils. Here, thioflavin T fluorescence spectroscopy was used to assess the degree of A β aggregation/fibrillization, and the morphology of A β structure was examined by electron microscopy (Chauhan *et al.*, 2004) [7].

Several studies with human and experimental models suggest increased oxidative stress (Chauhan and Chauhan, 2006) [6] (Bonda, *et al.*, 2010) [3] (Galasko and Montine, 2010) [10] and inflammation (Galasko and Montine, 2010) [10] (Agostinho *et al.*, 2010) [2] (Wang *et al.*, 2015) [16] to be important features in the aging process and in AD, which can cause neuronal dysfunction and death. Enhanced oxidative damage as evidenced by increased lipid peroxidation, Nutrients 2020, 12, 550 3 of 10 protein oxidation, and DNA oxidation has been demonstrated in the brain, cerebrospinal fluid (CSF), and blood samples of individuals with AD. Several reports suggest that A β induces neuronal death by increasing oxidative stress A β generation is also increased because of oxidative stress, which then causes more oxidative damage. It has been shown by the research that people consuming walnut extract are less prone to develop mental health disorders rather than people who don't consume walnut extract.

Conclusion

It has been proved by the studies that walnuts improve thinking ability, motor skills, memory, learning skills and amyloid beta generated oxidative stress. The dietary incorporation with walnut provide multiple benefits that all are under research. The main component of brain is alpha linolenic acid, walnut contains sufficient amount of n-3 acid along with polyphenolic compound, Vit E, carotenoids' may have a role in preventing cognitive impairment. Apart from this walnut helps to control heart disease, diabetes type 2, cholesterol etc. We wish its extensive use in daily diet and in new food product formulation to prevent alzheimer, parkinsons and epileptic disorders.

Author's Contribution

Dr. Rupali Dhara Mitra and Saheli Dutta both formulated the topic's concept. Saheli Dutta completed all the essential tasks to carry out the review paper. Dr. Rupali Dhara Mitra conducted thorough editing and provided a final revision for the entire document.

Conflict of Interest

Authors declare no conflict of interest

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