A Review on Neuroprotective Effects of Almonds

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ABSTRACT

Almonds are prunes belonging to the family Rosaceae. Almonds are the most popular and very commonly used nuts. These nuts are extremely beneficial included properties of alpha-tocopherol, vitamin E, sucrose, phenolics, folate, brain tryptophan mono and polyunsaturated fatty acids. It is well known that almonds are protective, and preventive nuts for various diseases. The mechanisms have proven its effects in various body systems and functions like immunostimulation, antioxidant action, hypoglycemic action, prebiotic potentials, cholesterol levels, hepatoprotective, and neuroprotective. Therefore, this study aims to review the neuroprotective functions of almonds, and a literature search was done in Pub Med, Google Scholar and Science Direct. From the selected database reviews about the neuroprotective effects of almonds were discussed. It is proven that the natural antioxidant property of almonds is said to be neuroprotective. The regular consumption of almonds in diet is said to increase the memory. The few review articles on neural effects of almonds have proven almond to be very effective and neuroprotective in nature compared to the other nuts. Therefore, it is recommended that dietary intake of almonds does not only have effects on cholesterol levels known previously it has major effects in developing and maintaining the neural mechanism.

INTRODUCTION

Almonds are prunes belonging to the family Rosaceae. (Rao and Lakshmi, 2012). Their binomial name is Prunus dulcis. They're nuts of high popularity belonging to a tree native to Iran. Almonds are one of the foremost commonly consumed nuts as these are extremely beneficial to health due to its rich nutrients include alpha-Tocopherol, vitamin E, sucrose, phenolics, folate, brain tryptophan (TRP), mono and poly unsaturated fatty acids (Rao and Lakshmi, 2012; Haider et al., 2012). Almonds are of 3 type’s sweet, semi bitter and bitter varies based on the proportion and concentration of amygdalin (Franklin and Mitchell, 2019). Almonds...
are basically grown in both types of climate dry summer and wet winters (Casas-Agustench et al., 2011). The Prunus dulcis plant flowers from March to April and its seeds ripen during October. Almonds are pollinated by insects. Nutrient combination of almonds are unique they are rich in proteins, vitamins and minerals and they also contain various bioactive substances like flavonoids and phytosterols (Haider et al., 2012).

Neuroprotection is a broadly used term, the term basically refers to the defense mechanism that protects against nervous degeneration, dysfunction, or injury (Ojha et al., 2013). Almonds are highly rich in its substances they are neuroprotective in nature as it contains polyphenolic compounds. These compounds are also rich in antioxidant properties they are fat soluble. The polyphenols are morin, quercetin, quercetin, kaempferol 3-O-rutinoside, isorhamnetin, and isorhamnetin-3-O-glucoside (Wijeratne et al., 2006). Almond contains protein equals to six grams and 3.5g of fiber; 14g of fat, thirty seven percent of Vitamin E, and minerals like calcium, Manganese, Magnesium, potassium. The antioxidants have the capacity to protect the cells of the body from oxidative damage. The higher vitamin E content is attributed to lower rates of diseases like Alzheimer’s disease, cancer, and heart diseases (Ames et al., 1993; Cutler, 1991). A study shows that memory loss in elderly could be the result of decline in the level of antioxidant enzyme like superoxide dismutase, glutathione peroxidase, and catalase (Haider et al., 2014).

Some studies have shown the effectiveness of almonds in weight loss. A study has proven to be effective in reducing weight up to 62 percent with 3 ounces (84g) of almonds a diet with low caloric when compared to a diet with complex carbohydrates (Albraham, 2020). And since overweight and obesity does have negative effects on the brain, almonds besides direct, have indirect effects on the brain that helps in the development of a better and healthier brain. Increase in weight leads to obesity is commonly occurs due to over eating but a research have proven that prefrontal cortex of the brain is less active in people who overeat (Joseph et al., 2011). And almonds help reduce hunger, and also reduce weight (Wien et al., 2003; Zaveri and Drummond, 2009). The prefrontal area is responsible for complex thinking, planning and self-control. The key nutrients of almonds have effects on the brain that includes riboflavin, L-carnitine and vitamin E. These nutrients have a major role in development of neural pathways, increase the activity of brain, enhances memory power, and that results in reduction of the occurrence of Alzheimer’s disease. Many researches have been concluded with a positive result towards almond’s potential to combat age-associated brain dysfunctions and also its ability to enhance memory functions. Also, the antioxidative property of the almonds is considered to decline the risk of occurrence of chronic diseases (Haider et al., 2011; Grosso and Estruch, 2016). Therefore, this study aimed to review the neuroprotective effects of almonds.

METHODS

A review study is done by collecting the related research articles. The search terms used included almonds, neuroprotection, cognition, Prunus dulcis, Prunus amygdalus, brain, neural effects, amnesia and memory. Another citation search was also performed for the retrieved articles of the reference list. We had no restrictions regarding the date of the year of publication.

Articles that dealt with the neural effects of almonds as the major criteria or at least one of the criteria were included. Neural effects in any aspect including memory, cognition and neural development were included. Studies involving administration of almonds in neuro related conditions like Alzheimer’s disease, Amnesia etc., were also included to critically analyse the effects of almonds administration over neural development. The studies with prime focus on nuts other than almonds and the studies dealing with non-neurological effects were excluded from the study. The articles which showed the effects of Prunus dulcis and amygdalus on other systems of the body such as cardiovascular system, gastrointestinal system, integumentary system, etc., were also excluded from the study. And from the articles that included components other than prunus dulcis and showed its effects on brain only the aspects focusing on the relevant information and analysis where included from the discussion and results section of the articles. The review was conducted by 3 independent reviewers, where each reviewer was studying the study description, quality and outcomes. The 8 articles obtained from Google Scholar overlapped with the articles that had already been found in Science Direct and PubMed. No relevant publications were found in the additional citation search.

RESULTS AND DISCUSSION

Initially, 11 articles collected from Google Scholar, PubMed, and Science direct were considered suitable for the review based on their title. From these only 8 articles were finalized for including in the review after scrutinizing their text through the inclusion, and exclusion criteria.
| Author          | Population /Year | Treatment component | Key Results                                                                 | Key findings                                                                 |
|-----------------|-------------------|---------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Batool et al. (2018) | Albino Wistar rats weighing 180-200gms aged between 5 to 6 months. | Rats were given intraperitoneal injection of scopolamine (0.5 mg/kg) and induced amnesia following which almond dosage of 400mg/kg was administered for a period of 28 days. | Almonds have reduced the lipid peroxidation, and catalase activity and normalized the Superoxide dismutase levels and improved memory retention. | Study has shown that amnesia induced by scopolamine is similar to the age related amnesia which increased oxidative stress and diminished memory. Consumption of almonds have a greater effects in decreasing the risk of oxidative stress and improved memory dysfunction. |
| Batool et al. (2017) | Albino wistar rats weighing 150 to 200gms | Cadmium was administered at the dose of 50 mg/kg/week. Almond and walnut supplementation at the dose of 400mg/kg/day given for 4 weeks. | Administration of cadmium have reduced the acetylcholine levels and elevated acetylcholinesterase activity in frontal cortex and hippocampus of rats. | This study shows that regular dietary intake of almond and walnut have a protective effects against pollution like metal induced toxicity as the nuts antioxidant capacity has the ability to augment the antioxidant levels of neuron and reduces the oxidative stress thereby improves the memory. |
| Anusha et al. (2017) | Male wistar rats weighing between 180-200g. | Prunus amygdalus was made into a fine paste with distilled water. Three doses of 150, 300 and 600mg/kg/day paste was administered daily for a period of one week. Ethanol was induced in the 6th day. Almonds were administered in 3 forms almonds as a whole, soaked, and blanched with a dosage of (3/6/12 g kg⁻¹), for scopolamine induced amnesia group. And the same three forms of almonds were administered with a dosage of (1/2/4 g kg⁻¹), for high fat diet induced group for period of one and half months. | Exposure to alcohol has influence on behavioural changes increased oxidative stress which damaged hippocampal neurons and apoptosis. Almond intake prevented the amnesia induced by scopolamine in mice. Improvement in dementia and memory was observed in high fat diet induced mice. Also effective in improving morris water maze and inhibited acetylcholinesterase in hippocampus and frontal cortex. | Prunus amygdalus was given to alcohol induced rats and observed the improvement in spatial and learning memory and altered the symptoms of anxiety and depression. Study proved the almonds soaked overnight and consumed in empty stomach in low doses had a greater effects significantly improved the memory in mice. |

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| Study | Species | Age | Treatment | Outcomes |
|-------|---------|-----|-----------|----------|
| Batool et al. (2016) | Wistar albino rats weighing 180-200gms, aged 5 to 6 months. | Almonds were finely crushed and mixed with deionized water and orally administered (200, 400 or 800 mg/kg/day) for 28 days | Increase in acetylcholine levels were observed. Learning acquisition and retention of memory was observed in almond treated groups. | Study suggested that dietary intake of almonds from the early age could have effective outcomes in later age. As it is proven that intake of almonds have neuroprotective effects prevents neurodegenerative disorders. |
| Haider et al. (2012) | Male albino rats weighing around 200gms. | 80mg of almond was finely crushed and mixed with deionized water and orally administered for 28 days. | Rats were observed with decreased food intake and reduce in plasma cholesterol levels and increase in brain tryptophan levels and also increase in 5-hydroxytryptamine which improved learning and memory skills. | Regular dietary intake of almonds for a longer duration increased the serotonin metabolism which decreased the appetite and cholesterol levels but has enhanced the memory. |
| Mandalari et al. (2011) | Male adult CD1 mice weighing 25-30gms. | 30mg/kg of natural almond skin and blanched almond skin was administrated orally, one hour and six hour, after Spinal cord injury. | Natural almond skin was also compared with blanched almond skin group and determined the effect that natural almond skin was effective. It reduced edema and parameters of inflammation and apoptosis. | Natural almond skin is proven to be effective in reducing the tissue injury and inflammation in spinal cord injury. |
| Kulka-rni et al. (2010) | Male albino wistar rats weighing about 150 to 180gms. | The paste of prunus amygdalus nuts was administrated orally at three doses (150, 300 and 600 mg/kg) for 7 and 14 consecutive days to the respective groups of rats. | Prunus amygdalus doses significantly reversed scopolamine (1 mg/kg i.p.)-induced amnesia. Prunus amygdalus have reduced the serum cholesterol levels and reduced brain cholinesterase which increased the acetylcholine level. Decrease in transfer latency of elevated plus maze was observed. | Prunus amygdalushas been effective in improving memory in rats and also reduced the serum cholesterol levels among Alzheimer’s disease. |
According to some Persian medicine books, almonds protect the brain tissue that prevents atrophy of the brain and also improves memory (Kulkarni et al., 2010). The walnut, almonds and hazel nuts were traditionally used in Persian medicine for Alzheimer’s disease for their neuroprotective effects and they are considered as brain food that has a role in improving memory, concentration, and alertness (Gorji et al., 2018). In a study it was observed that consumption of almonds regularly for one to two weeks had a significant results in reversing scopolamine-induced amnesia. There was a slight increase in glucose besides reduced cholesterol and triglyceride and decreased cholinesterase activity in the brain (Kulkarni et al., 2010). Komathi Anusha et al., 2017 studied the behavioural parameters used Morris water maze test for spatial memory, elevated plus maze, forced swimming test for depression, open field test for loco motor activities among male wistar rats after administration of Prunus amygdalus paste for one week, where ethanol was administered on 6th day. They concluded that therapy of Prunus amygdalus significantly improved spatial learning and memory which was impaired by alcohol. It is generally said the Prunus amygdalus possess memory enhancing activity, reduced cholesterol, serves as a neuroprotective substance due to its nutritional values.

Yasmeen Shamsi et al., (2019) Almond possess the properties of anti-oxidant and anti-free radical activities and their phenolic extracts help in preventing oxidative stress-related diseases. Badam consists of properties of curing neurological disorders like autism. Sahem S El Hawary et al., 2014 briefed the benefits of Prunus amygdalus he stated that Prunus amygdalus is a good source of potassium (6656mg/kg), this potassium is stated to play an important role in muscle contraction and nerve transmission. Prunus amygdalus is also recommended in daily intake as they contain 2300mg/kg of calcium, and long-term calcium deficiency will lead to rickets and osteoporosis and poor blood clotting as well (Hawary et al., 2014).

In a study conducted by Batool, proved that the consumption of Almonds daily for a period of 28 days had a considerable effect on memory retention in rats. It has been observed that scopolamine being an antimuscarnic agent caused a decrease in the antioxidant enzyme activities and thereby induced oxidative stress in rats (Batool et al., 2016). The defense mechanism of the antioxidants serves as a protection against the cellular damages that occur in response to the induced species of the free radicals (Budzynska et al., 2015). Quercetin, a polyphenic compound of almond has the potential to adsorb on the membrane lipid bilayer, which intern serves as a guard for the membrane lipid bilayer and thus prevent the oxidative damage that could be caused by aqueous oxidant and also reduce lipid peroxidation (Pham-Huy et al., 2008). In a research rats were induced with diabetes mellitus and were treated with almond oil compared with vitamin E and L-carnitine for a period of 5 weeks and determined that there was a reduction in levels of cholesterol and glucose in diabetic group whereas the levels were increased in the non-diabetic group (Ridha et al., 2016).

Neuroprotective effects were assessed in composition of fatty acids in tree nuts and observed that they have a protective effect against oxidative stress. The nutrition value of food is affected by various processes like preparation, processing and storage. Of all nuts they exhibited that walnut has high potency in tree nuts. But reports that future investigation is required to determine the effects of composition of fatty acid in prevention of Alzheimer’s disease (Kim et al., 2013). Whereas various studies have researched the effects of almonds a tree nut in neurotoxicity especially its protective effects in Alzheimer’s disease have shown to increase the memory and reduced oxidative stress.

Zehra Batool, stated that, the reduced levels of malondialdehyde in the rats treated with the almonds was due to the lipid peroxidation inhibition and reduction of oxidative stress that occurred in response to the antioxidant nutrients of almond (Batool et al., 2016). Abdullah et al., 2017 stated the role of almond in central nervous system is extensive as the almonds are effective in improving insomnia and memory functions. Application of almond oil locally reduced headache. Therefore by considering the various benefits of almonds on neural functions, it is proven that the natural antioxidant property of almonds is said to be neuroprotective. The regular consumption of almonds in diet is said to increase the memory.

CONCLUSIONS

The few review articles on neural effects of almonds have proven almond to be very effective and neuroprotective in nature compared to the other nuts. Its natural antioxidant property is very effective in managing oxidative stress and various other parameters. Therefore, it is recommended that dietary intake of almonds does not only have effects on cholesterol levels known previously it has major effects in developing and maintaining the neural mechanism.
Conflict of Interest
Authors declare that this study has no conflict of interest.

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