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NUTRITIONAL COMPOSITION AND THERAPEUTIC POTENTIAL OF CHIA SEEDS (*Salvia hispanica* L.):A REVIEW

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ABSTRACT

Chia seeds, scientifically referred to as *Salvia hispanica* L. seeds, are a type of oilseed recognized as pseudo-cereals. Given their abundance of macronutrients, micronutrients, and health aids, chia seeds can be classification as a nutraceutical food. These seed could present a significant concentration of phenolic compounds as rosmarinic acid, caffeine acids, protocatechic acid and myricetine. Research has shown that chia seeds are a good source of proteins (17–25%), fibers (30–35%), and lipids. In addition, chia seeds are a rich source of vitamins and miner- compared with flaxseed oil essential include having been shown to provide health benefits in the treat- als that may contribute its biological activity These differences ment of diabetes, hypertension, and cholesterol. Besides their antioxidants, anxiety-reducing and laxatives functions, anti-depressant and pain relief power comes from, chia seeds may help you boost your immune function. Their health-promoting effects have attracted the attention of many food companies and academic institutions in recent years. The paper also presents a review on nutritive value, phytochemical profile together with potential medicinal uses of the plant. Clinical benefits include cardioprotection, glycemic control and immune enhancement.

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1. INTRODUCTION

Chia represent an annual plant which may attain an extension of one meter (1m). The leaves are arranged oppositely and are embellished with little white or purple flowers. Chia seeds are oval-shaped and exhibit a coloration ranging from black and gray to white, often with speckles.[1]. The genus has more than 900 different types and takes the given name from Spanish term "chain," meaning oily [2]. It is taxonomy according to Anooj *et al*., 2019 [3].

Kingdom : Plantae (Plant)
Sub kingdom Tracheobionta (Vascular plant)
Supper division: Spermatophyta(Seed plant)
Division:Magnoliophyta (Flowering plant)
Class : Magnoliopsida(Dicotyledons)
Subclass : Asteridae

Order:Lamiales
Family: Lamiaceae(Labiatae – Mint family)
Sub Family: Nepetoideae
Genus : *Salvia*
Species: *hispanica* L.

Salvia genus has demonstrated widespread distribution in several global locations, including Southern Africa, North and South America, and South-East Asia. It is indigenous to central Mexico up to northern Guatemala and has been utilised as a food source. Pre-Columbian civilisations, such as the Mayas and Incas, cultivated chia as a primary crop for medicinal, culinary, artistic, and energising purposes[4]. In addition to fatty acids, total phenolic content, and antioxidant phenolic compounds, chia seeds are a rich source of macronutrients, B vitamins, calcium, phosphorus, potassium, magnesium, iron, zinc, and copper. Moreover, chia can be included into coeliac diets because it does not contain gluten. Chia has demonstrated certain health advantages such as antioxidant and antihypertensive properties [5]. In Figure 1, the seed of chia seen on the left before immersion and on the right after immersion in water.. This work aimed at examining both the nutritional and health benefits of the seeds of chia.

Figure 1. Chia seeds in their natural state (left) while Chia seeds post-soaking in water(right) [6]

2. Nutritional composition of chia seeds

Chia Seeds are highly nutritious because of the large number of biologically-active materials per unit weight, including 40% carbohydrates, 35.5% lipids, 25.0% protein on dry basis, ashes - 5%, nutrition fiber (15-35%) each within growing condition and environmental situation [7, 8]. Chia seed has high content of polyunsaturated fatty acids (PUFAs). However, it is regarded as one of the most efficient plant sources for the omega-3 (n-3) fatty acid α-linolenic acid (ALA). Chia seeds are naturally high in omega-3 fatty acids, which provide cardiovascular benefits. Seventy-five hundredths of the material within the fats in chia seeds is ALA, while solely twenty per cent is omega-6 fatty acids, two singular polyunsaturated fatty acids present to possess benefits Pharmacologic as anti-diabetic, anti-inflammatory and anticancer properties [9][10].

2.1 Vitamins

Vitamin E refers to a group of lipid-soluble compounds that have antioxidant activities and is an important nutritional nutrient, which includes tocopherols and tocotrienols. Chia seed oil is known to be a good source of such compounds, especially γ-tocopherol as well as different quantities of α-, β- and δ-tocopherols [6]. The concentration and distribution of tocopherol isoforms may not be the same based on seed origin, processing conditions and extraction methods. In previous studies, exposure of chia seeds to high temperatures might compromise their structural integrity and favour the degradation of bioactive components affecting nutritional value. Therefore, adequate processing and storage conditions must be applied to maintain functional components of the seeds and their oil [6, 7].

2.2 Carbohydrates Content

The carbohydrate content of chia seeds is 39-41% and a high amount of polyphenols. Chia seed contains high levels of nutrition fibers that are 56.46 g/100gms which an significant advantages in farming as most of the fiber is insoluble (53.45g / 100g)Moreover, soluble fiber accounts for a very small amount (4.01 g/100 g), because chia seeds can generate hydro-philic mucilage with water. By having favorable physicochemical

properties, this mucilage can be an excellent option as industrial additives. Chia seeds have a dietary fibre composition that ranges from 35-45% per 100g, which satisfies the regular dietary fibre guidelines for adult [6]. Between (5 to 10) % of the chia seed is in soluble form, which functions as a component of mucilages. Chia seeds possess the potential to significantly contribute to the protection as well as alleviation of specific health issues, including heart disease and diabetics [11].

2.3 Protien Contents

Proteins represent the primary category of vital nutrients employed by our bodies for energy production, which it then uses to carry out a variety of operations throughout the body. Seeds of chia posses a significant protein content, reaching until twenty per cent, This can aid in mitigating the occurrence of issues linked to protein energy deficiency. A significant proportion of the protein present in chia seeds is globulin, that constitutes 53% from overall seed proteins and consists of both 11S and 7S proteins simultaneously [12]. When quality of plant derived proteins are being assessed, several considerations has to be taken that include bioavailability as well as amino acid composition. Actalikecereals Chia seed is higher in cysteine, lysine, and methioninethan all other cereals combined, with levels above higher that the one observed in primary cereals. Chia seed has an extraordinarily fine balance of amino acids. Chia seeds are interesting in many ways, One such being that it is gluten free (they make a great addition to gluten-free food). Chia is an excellent source of high-quality protein for those with obesity and its related health conditions such as weight loss, as well as other diseases like diabetes [13].

2.4 Lipids and Oil Content

Assessing Healthy oil through lipid content especially polyunsaturated fats (PUFAs). Omega-3/omega-6 ratio represent the most important variables with regard to the nutritional quality of lipid fractions rather than total fatty acid content. Many recent studies demonstrate a strong correlation between an increased relative ratio of omega-6/omega-3 fatty acids and high levels of polyunsaturated fatty acids, leading to inflammatory and hypercoagulable states. This imbalance is a significant factor in the development of health problems such as diabetes, obesity and cholesterol [14]. Accordingly, reduced incidence of such diseases is associated with regular consumption of PUFAs rich diets. Chia seed has been burgeoning in popularity and production recently as it possesses high PUFA contents. Chia seeds is one of the best sources of omega fatty acids, with 66% constituted by omega-3 and an overall content of 19% omega-6. The oil extracted from chia has a high content of PUFAs and contains as much as 69% omega-3 α-linolenic acid [15]. Hence, it may offer health advantages to individuals afflicted with cardiovascular problems. Considering the relative health benefits of omega-3 and omega-6 fatty acids, the seeds of chia are essential due to their superior omega-3 fatty acid contents, which provides more health advantages for nutritional populations [16].

2.5 Flavonoids Contents

Flavonoids are plant compounds found all around us on this planet. These made-up of a total of 15 carbon atoms in two-benzene rings (A & B) linked by heterocyclic bonds (C), these chemicals qualify as polyphenolics. The primary functions of these entities are to regulate the colour and flavour and inhibit fat oxidation in food. The phenolic chemicals included in dry Chia seeds amount to 8.8% including chlorogenic, diadzein, kaemoferol, quercetin, myricetin. Thomas said that Chia seeds had rosmarinic acid and daidzein as the primary constituents, along with caffeic acid, myricetin, quercetin, and other compounds. Furthermore, the study by Thomas M and Thomas [17] revealed the first detection of vitamins A, B1, B2, and B3 in seeds of Chia, Figure 2.

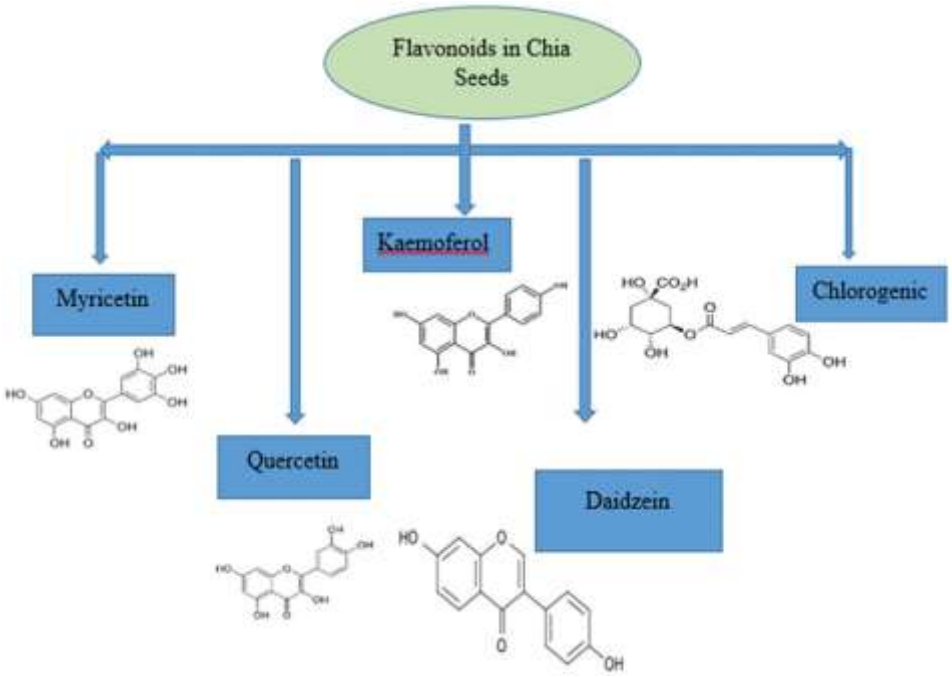
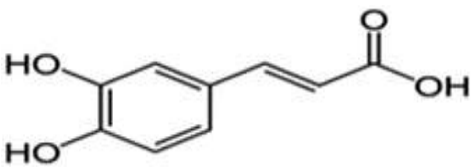
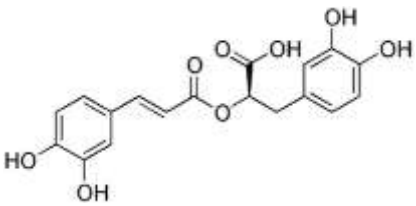
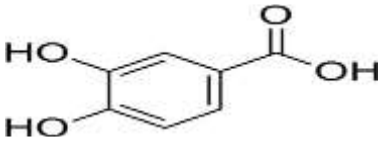


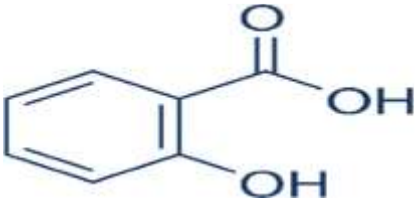
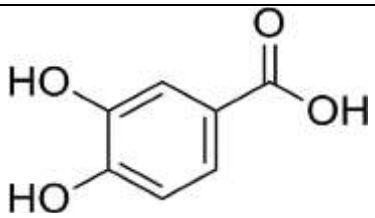
Figure 2. Flavonoids content in chia seeds [10]

2.6 Phenolic compounds

Phenolic compounds are the most important plant bioactive compounds in terms of biology and chemistry, and chia seeds contain many phenolic compounds. The corresponding compounds are: caffein, a dihydroxyphenyl moiety attached to acrylic and caffeoylquinic acids. This compound, when caffeine as hydroxycinnamic acid is bonded to quinic acid at different positions in the extract, was recognised as the major chlorogenic acid found in chia-polar and natives seeds. [10]. Study conducted by [18] has claimed the abundance of polyphenolic in chia seeds exhibits a protective effect against oxidative degradation. The study by [19] has confirmed the existence of caffeine acid, quercetin, phenolic glycoside K, and glycoside Q in chia seeds. Table 1 displays the principal phenolic substances identified in the seeds of chia, which have been demonstrated to exhibit antioxidant properties.

Table 1. Show phenolic chemicals present in chia seeds

Phenolic compounds	Chemical structure	Biological activity	Ref.
Caffeic Acid		Efficient in treating epilepsy	[20]
Rosmarinic acid		Antimicrobial, antioxidant and anti-inflammatory activities	[21]
Protocatechinic acids		Exhibit activity of antioxidants	[22]

Salicylic acid		Exfoliant agent	[23]
Protocatechuic acids		Exhibit anti mutagenic along with ant inflammation features.	[24]

3. Application of Chia seeds in Health Benefits

The consumption of chia seeds can contribute to several health benefits including reducing hyperlipidemia, diabetes, cancer and improve antioxidant in body [25]. Chia seeds also present a high nutritional profile, providing various healing medical benefits, attributed mainly to its high omega-3 polyunsaturated fatty acid (α-linolenic acid) content. Omega-3 fatty acids inhibit sodium with calcium channel disorders, hence averting hypertension and cardiac arrhythmia, a disorder marked by fast heartbeat that hinders oxygenated blood flow to the brain and body, therefore lowering the risk of cardiac arrest [26]. Furthermore, using chia seeds when pregnant forms the fetal brain and retina [27]. Moreover, chia seeds are a substantial dietary fiber reservoir, offering several therapeutic advantages. The dietary fiber in chia seeds is crucial in treating diabetes as it effectively reduces the rate of glucose release and digestion in the body [28]. Study by [29] examined the integration of chia seeds, quinoa flour, and wheat flour into the bread formulation. The sensory quality indexes and nutritional features pertaining to proteins, lipids, and carbohydrates were shown to be superior. See Figure 3.

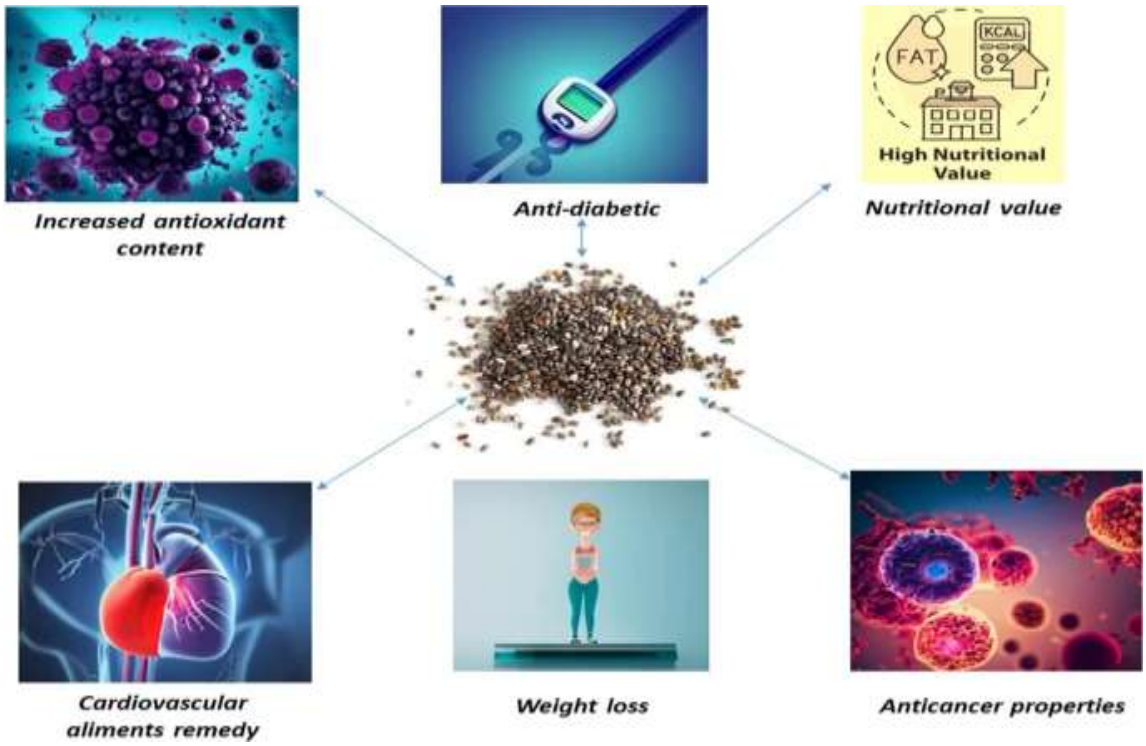


Figure 3. Application medicine of chia seeds [30]

3.1 Food Industry

Considerable research has been carried out concerning the application of the chia seed in the food business. The food business use chia seeds in multiple forms, including whole, crushed, flour, oil, and gel. The 2000 US Dietary Standards suggested chia may serve as a primary food source, albeit in moderation; a daily intake not exceeding 50 g is advised. Chia seeds can be incorporated into biscuit, pasta, snack, and sweets as supplementary ingredients. Chia seeds, by their hydrophilic characteristics, can serve as viable alternatives to eggs and fat. Their capacity to absorb water is 12 times their weight. One possible application of chia gel is replacing oil or eggs in baked goods. Experimental results demonstrated, chia oil has the potential to replace twenty-five percent of the eggs in the cake. A optimal nutritional composition for butter may be attained by combining it alongwith chia oil at a ratio between (6 _ 24) % [31], depicted in Figure 4.

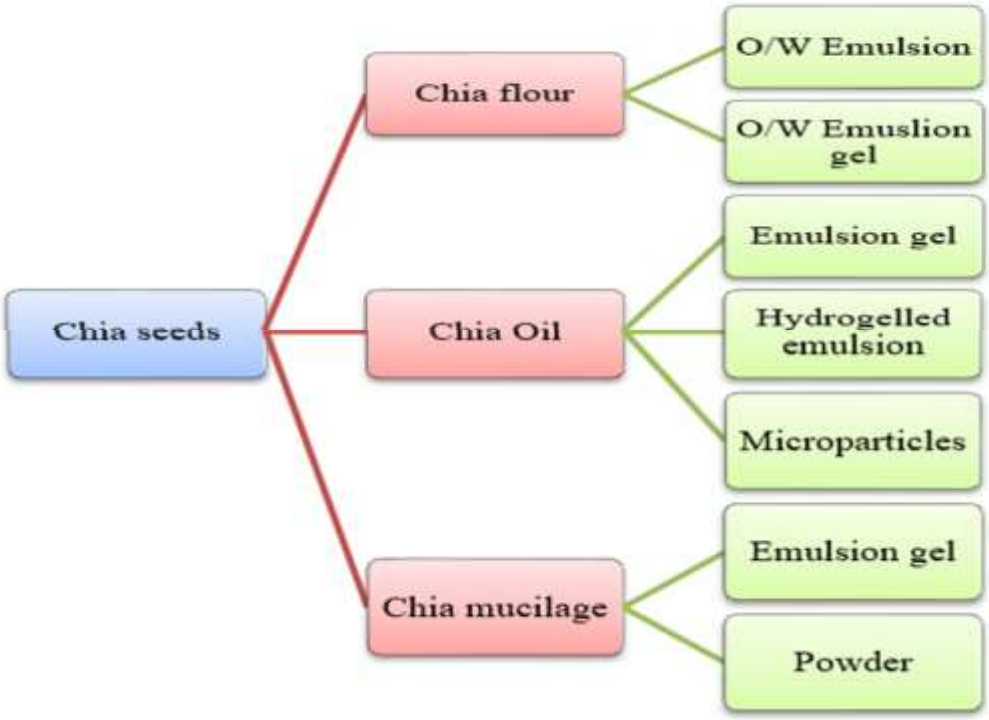


Figure 4. Several variations of chia seeds have utilization in product of food [32].

3.2 Pharmaceutical use

3.2.1 The function of chia seeds in losing weight.

Chia provides a substantial proportion of dietary fibre. Its primary purpose is to facilitate loss of weight and enhance blood glucose and cholesterol levels. Chia seeds have been found to possess several antioxidants that contribute to its preventive properties. Chia seeds lack the ingredient of gluten, rendering them an appropriate protein option for individuals afflicted with coeliac disease. Chia seeds are abundant in vitamin B and niacin, functions as a superb calcium source, and are devoid of cholesterol. Chia seeds are believed to possess the capacity to decrease waist circumference when ingested for a moderate duration. Thus, further study is required to ascertain if prolonged periods of supplementation result in heightened weight reduction [30]. To conduct a randomised, double-blind, placebo-controlled study, Vuksan *et al*. (2017) recruited participants of both genders. Inclusion criteria were age between 30 and 65 and BMI between 25 and 35 kg/m2. Dietary consumption and blood samples were additionally examined for blood sugar and cholesterol levels, research findings indicated decreased waist circumference among participants who regularly ingested chia four. Furthermore, there was a significant decrease in body weight. Nevertheless, these findings are only observed within a particular group and clinical populations. Ingesting four chia seeds daily resulted in elevated levels

of total cholesterol, VLDL-c, and HDL-c in the bloodstream [33]. Therefore, chia seeds have some potential for weight management; yet, further extensive research is necessary to thoroughly investigate this matter.

3.2.1 Efect on diabetes

The Centre for Disease Control and Prevention (CDC) research indicates that over 100 million persons in the United States are either diagnosed with diabetes or are at risk of developing that condition. Diabetes is a pathological state marked by inadequate synthesis of insulin by the body or inefficient utilization of the synthesized insulin. The hormone insulin, which is produced by the pancreas, controls the concentration of glucose in the bloodstream. Diabetic diabetes is a persistent chronic condition that can be controlled but remains present throughout an individual's whole life. There exist two clearly defined categories of diabetes, namely type 1and type 2.

Physical activity and dietary modifications effectively treat type 1 and 2 diabetes. Chia seeds have a nutritious function in the diet and can be utilized as a dietary supplement. In study [34] examined the potential of chia to lower postprandial blood sugar levels in healthy individuals, Proposing a plausible rationale for the previously documented cardiovascular preventive benefits in individuals with diabetes. A randomized, acute, double-blind design was used in this investigation. A group of eleven individuals in good health were administered doses of 0, 7, 15, and 24 g of chia on white bread. Capillary samples were collected and hunger assessments were conducted around 2 hours after oral consumption. A reduction in postprandial blood glucose levels was observed with all three doses of chia. Each gram from the chia seed significantly lowered postoperative glucose levels in the blood approximately 2% relative to those in the control group. Moreover, the people who ingested chia demonstrated a reduction in eating [1,2].

3.2.2 Anticancer Property:

The cancer represents a malignant condition characterized by the uncontrolled development of aberrant cells that invade surrounding tissues. Cancer significantly contributes to global mortality and chronic illness. Over the past decade, this has been a significant increase in studies regarding the anticancer properties of phytochemical substances. A 2019 survey by Mutar and Alsadooni sought to examine the anticancer effects of chia seed extracts on the proliferation epithelium cells of breast in human (MCF-7 cells). The results indicated that extract from chia seeds has potentially as cancer treatment [35].

[36] posited that elevated levels of chia seed oil may improve the viability cancer cells of breast. Moreover, several authors have proclaimed the advantages of β-3 and c-6 fatty acids in terms of their anticancer properties [37].

3.2.3 Effect of Antioxidants

The seeds of Chia can act as a reservoir of anti-oxidants, such as chlorogenic acids, caffeine acid, phenolic compounds, carotenoids, and a substance called kaempferol . Chia seeds have been proven to possess a powerful antioxidant capacity, as evidenced by a number of previous studies and scientific research, Numerous studies has provided empirical evidence to support the significant antioxidants capacity of chia seeds as well, [38] demonstrated the efficiency of chia seeds to induce the deactivation of ABTS cation radicals. Significantly more activity was observed in the seeds of brown and golden flax.

Reduction of iron ions and scavenging of synthetic DPPH radicals. Analysis of both assays reveals that chia seeds have superior antioxidant activity to flaxseed. [39] duly verified chia seeds' antioxidant properties . Experimental evidence demonstrated that extracts derived from chia seeds can effectively suppress DPPH radicals, resulting in their neutralization by more than 70%. Furthermore, they demonstrated that these extracts prevent the enzymatic oxidation of guaiacol. [40] verified that protein hydrolysates derived from chia seeds can effectively minimize ABTS cation radicals. The experimental protein hydrolysates were proposed to function as electron donors. The oxygen radical absorbance capacity (ORAC) value is an essential measure of the antioxidant capacity in biological samples. The ORAC profile of chia seeds was similar to that of prunes and hazelnuts (Figure 5). Moreover, the fat emulsion method verified the antioxidant properties of compounds found in chia seeds. The effect including extract from chia seeds on the rate of beta-carotene degrading in a linoleic acid/beta-carotene model system undergoing heat at 50 C was studied in a study conducted by [41]. Observations showed extracts from chia seeds have antioxidants activities in the model emulsion, with concentrations of 74% and 79%. Their research confirmed the capacity of chia seeds to inhibit the peroxidation of lipids [41]. Nutrients 2018, 10, x FOR PEER REVIEW 8out of 16. The fat emulsion approach also confirmed the antioxidants effect of chemicals found in chia seeds. In their work [41] examined the effect of including chia seed extract on the degradation rate of beta-carotene in a linoleic acid/beta-carotene model system subjected to heating at 50 °C.

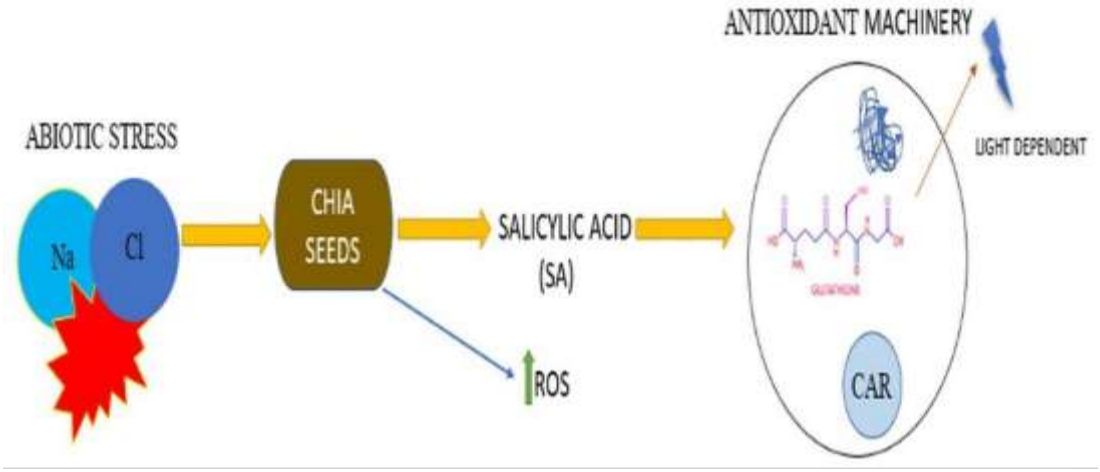


Figure 5. Antioxidant mechanism of chia seed [30]

3.2.4 Neuroprotective Effect

Given the worldwide prevalence of neurodegenerative disorders, the exploration of bioactive substances with neuroprotective properties is advantageous for the prevention and treatment of this category of disorders. The examination of peptides that can reduce proinflammatory and oxidative mediators may be utilized in the development of functional meals aimed at addressing chronic illnesses, when both inflammation and oxidative stress are important factors. Chia oils are distinguished by their abundant protein content, making them a potential reservoir of bioactive peptides that elicit a neuroprotective impact on controlling proinflammatory processes in HMC3 microglia cells [42]. Prior investigations have demonstrated the presence of anti-inflammation properties in chia seeds. Extracted peptide fragments from chia seeds (*Salvia hispanica L.*) exhibited an anti-inflammatory effect by reducing proinflammatory cytokines. Peritoneal macrophages from BALB/c mice were isolated [43]. Furthermore, peptides derived from simulated intestinal digestion of chia seeds exhibit anti-inflammatory properties by inhibiting COX-2, LOX-1, NFκβ, and antioxidants [42]. As shown in Figure 6.

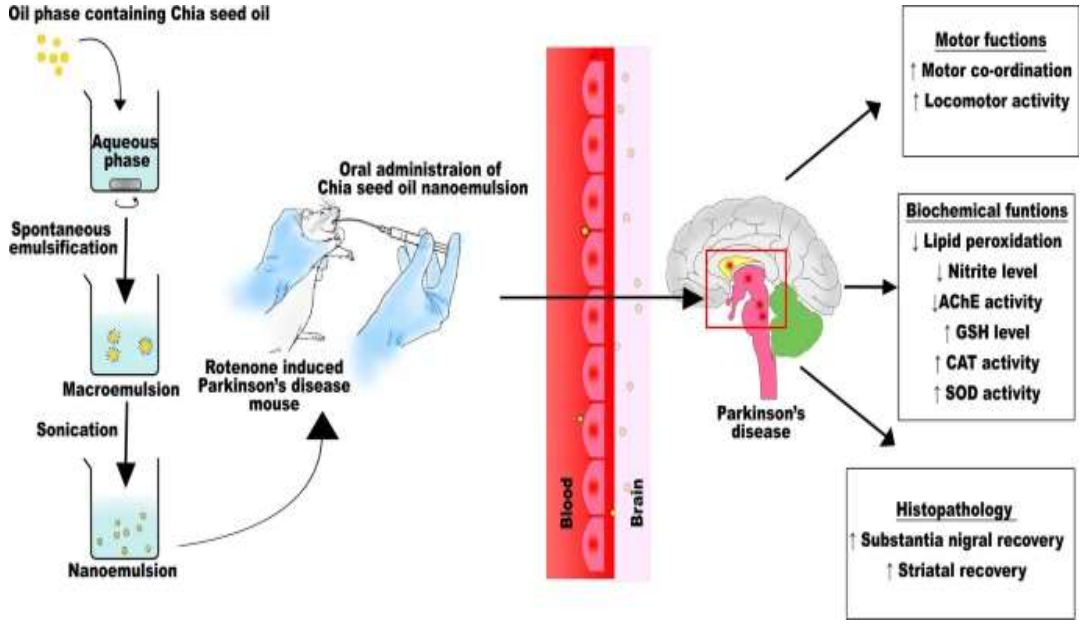


Figure 6. Neuroprotective Effect of chia seed [44]

4. CONCLUSION

Chia seeds has been a staple, Chia seed are ever more becoming useful as nutrient supply in technology, science and medicine. This is because they are high in bioactive substances with beneficial effects on health. They also contain more phytochemicals, including omega-3 and 6 fatty acids, soluble fiber in the form of mucilage as well as long-chain glucose polymer that is good for consumption by bacteria in the stomach and colon.Furthermore, Chia seeds have a higher content level than commonly used seeds such as: Vitamins Essential amino acids Proteins Minerals Fats. The phytochemical composition, high nutritional value and potential medicinal properties of chia seeds render it a candidate to improve the nutritional profile of meals. Further, a chia-seed rich diet can help prevent diseases from occurring.

Conflict of interest

No conflict of interest among the authors.

Source of funding

Non

Ethical clearance

This study is a review article and was not applied to human or animal tissue

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