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Chia seeds (*Salvia hispanica L.*): Botany, phytochemistry and health benefits

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Abstract

Chia seeds (*Salvia hispanica)* belongs to the family *Lamiaceae* have a variety of minerals, vitamins and shown to have beneficial effects in the treatment of hypertension, diabetes, and dyslipidaemia, as well as acting as an antioxidant, anti-anxiety, laxative, anti-depressant, analgesic, and strengthen the immune system. Chia (*Salvia hispanica* L.) is an annual herb of medium duration (103–136 days) belongs to the *Lamiaceae* family. It is a short-day plant with strong sensitivity to photoperiod and temperature. Various types of soil are suitable for cultivation of this crop, but plants do best in sandy and well-drained soil with optimal pH of 6.0–8.5 and are adapted to low nutrient concentrations. Due to presence of minerals, lipids (omega-3), fibers, proteins, and antioxidants, chia seed showed health benefits. Chia seeds were Introduced to India by the Central Food Technological Research Institute (CFTRI) in 2015 at Mysuru, Karnataka, it has swiftly spread across the country, including Karnataka's Kalyan-Karnataka region, owing to its rich nutritional profile and medicinal properties. Chia seed contains a high concentration of antioxidants such as kaempferol, caffeic-acid, myricetin, chlorogenic-acid, and quercetin that are known to have anti-hepatic, anti-cardiovascular, anti-aging, and anti-carcinogenic qualities. Chia seeds have also been linked to therapeutic benefits. Chia seeds have high dietary fibre content aids with diabetes management and digesting. The gluten free protein and vitamins in its PUFA have therapeutic effects in the control of hypertension, diabetes, and dyslipidaemia, as well as acting as an anti-oxidant, anti-blood clotting, anti-inflammatory, anti-anxiety, anti-depressant, laxative, analgesic, immune system, and vision improver. Chia seeds can be added to food to improve nutritional quality, and a diet rich in chia seeds can help to prevent disease owing to its phytochemical profile, high nutritional value and great therapeutic potential.

Keywords: Chia seeds; CFTRI Mysore; Fibers; India; Karnataka; *Salvia hispanica*; Omega-3 fatty acids

1. Introduction

Chia seeds (*Salvia hispanica L.*) belongs to the family *Lamiaceae* are a nutrient-dense functional food offering significant health benefits, including improved cardiovascular markers, blood sugar regulation, and antioxidant properties [1,2-35-89]. Chia (*Salvia hispanica* L.) belongs to the class Labiatae which is originated from Central America, Mexico, and Northern Guatemala [1-35-88-102]. Chia (*Salvia hispanica*) seeds have long been utilized as a staple meal for over 5,500 years in Aztec and Mayan diets [1-35-81]. Chia seeds (*Salvia hispanica* L.) in India highlights its potential as a high-value, drought-resistant "superfood" crop suitable for regions like Karnataka, offering significant economic returns for farmers [2-35-89-102]. Chia seed farming is a rapidly growing, high-profit super food venture in India, with Karnataka producing over 50% of the national output. Introduced commercially by Central Food Technological Research Institute (CFTRI) in 2015, the crop thrives in mild climates, requires minimal water, and offers significant export opportunities, making it an ideal, drought-resistant alternative to traditional [1-35-90]. Chia has been introduced to India in the year 2015 by Central Food Technological Research Institute (CFTRI) Mysore, Karnataka from Central America and were initially grown by farmers in few areas near Mysore. Presently the cultivation has spread to other areas of Karnataka

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and also to the neighboring states [1-35-90-102]. The white type is priced at a premium as it blends well with Indian food products [1-35-88-102]. CFTRI, Mysore, Karnataka state, India has developed chia- blended products such as ice creams, chocolates and jams, which are being commercialized by various companies. Chia (*Salvia hispanica* L.) was used as a super food from ancient times. In recent days with increase in the health awareness throughout the world, it demands for healthy food, using chia seeds in daily diet may prevent many diseases (diabetes, obesity and cardiovascular) [1-12-45-65-88-102]. Studies focus on its high dietary fiber, Omega-3 fatty acids, and antioxidant content, while establishing its medicinal efficacy in reducing blood glucose, hypertension, and assisting with body weight [1-83-89-102]. Chia seeds are a popular super food in India, prized for being a rich plant-based source of **Omega-3 fatty acids**, fiber, and protein [1-10-13-28-90-102]. They help with weight management by keeping full longer and aiding digestion [1-83-102]. These seeds are commonly used in smoothies, pizza, curd, yogurt, or soaked in water for summer drinks [1-2-5-9-89-102]. They are rich in omega-3 fatty acids (ALA), fiber, and protein, aiding in reduced blood pressure, and decreased inflammation [1-13-34-67-83-102].

Chia seeds (*Salvia hispanica* L.) belongs to the family *Lamiaceae*, are currently becoming more popular in the food industry as a "novel food", as ingredient of functional food (FOSHU) and dietary supplements [1-83]. Chia seeds have been approved by the European Food Safety Authority and National Nutrient Database [1-0-17-56-89-102]. Chia seed components are helpful in cardiovascular disease (CVD) by reducing blood pressure, platelet aggregation, cholesterol, and oxidation [1-21-35-48-89-102]. In GI-tract-related diseases like diabetes and constipation, chia fiber reduces the blood glucose level and provides bulk to stool [1-11-15-78-82-102]. However, antioxidants and polyphenols are protected beta cells of the pancreas from inflammation [1-89-102]. These components are protected from the cell damage of the different body parts, which can provide help in different types of cancer including breast, colorectal, liver, and pancreatic [1-89-102]. Chia seeds include several beneficial nutrients, including omega-3 fatty acids, polyunsaturated fatty acids, fiber, protein, vitamins, and minerals [1-19-32-42-88-102]. The seeds have abundant polyphenols and antioxidants such as caffeic acid, rosmarinic acid, myricetin, quercetin, and others. Chia has been studied recently in several academic disciplines [1-14-53-65-80-102]. Human-controlled studies and systematic scientific literature reviews have revealed that chia seeds positively affect cardiovascular risk factors, including body weight, blood pressure, lipid levels, blood sugar, and inflammation [1-80-102]. Because of the existence of bioactive chemicals with health advantages, chia seeds have rising potential as a source of nutrients and nutraceuticals important to technology, science, medicine, and engineering [1-83-102].

Chia (*Salvia hispanica*) is an annual blossoming plant. Chia seeds are egg shaped and gray with black and white stains, bearing a width of about 2 millimeters (0.08 inches) [1-83-102]. These seeds were ingested as food [1-83-102]. Chia seeds are cultivated as a blend of both white and black seeds [19-76-83-102]. Now a days, black chia seeds are most of the seeds cultivated that are identified by spiral and striped coloring [1-83-102]. White chia seeds are present in a very low amount and a bit greater than black seeds. To enhance the yield of white seeds more as output, peasants segregated the white seeds prior to sowing to have more white seeds plants [1-83-102]. Gardeners employ a color segregation technique to grow homogenous seeds for seeding, and they may also use the same method after collecting the seeds [1-13-34-59-89-102]. It is exhibited by testing that in the past white and black chia seeds were cultured separately, but with time, the production of white chia seeds decreased and intermixed with high-yielding black seeds [1-5-7-42-89]. Recent outcomes of different investigations showed that chia seeds have a great nutritional profile and huge health-boosting characteristics [1-88-102]. Chia seed is attributed to have useful results on the betterment of the blood lipid profile, by their ability in lowering blood pressure, blood glucose, antimicrobial and immuno-boosting reactions [1-12-34-56-76-89-102].

2. Chia seed Production in India

According to the Anand et al., (2025) [2], India is one of the major producers and exporters of chia. Karnataka alone occupies more than 50 per cent of area of our country [2, 81-88-102]. Chia seeds are popularly known as 'Sabja' in Hindi 'Gale' in Kannada and 'Chia' in English [2, 81-89]. In recent years, Indian states also witnessing more area under chia production especially in Uttar Pradesh, Rajasthan, Andhra Pradesh and Karnataka [2, 81-88-102]. Research on chia is gaining momentum for increasing productivity, but crop improvement research is lacking because of limited germplasm in chia seed crop [2, 81-88-102]. Chia seeds are among the majorly exported commodities as the production of the commodity is limited to a few geographies [2, 81-88-102]. However, the COVID pandemic has increased the health consciousness among consumers, which has opened an opportunity for super foods, including chia seeds [2-81-88-102]. Chia (*Salvia hispanica* L.) a nutri-rich crop was originated from Mexico and Guatemala and belongs to the mint family *Lamiaceae* [1, 2-81-88-102]. It was a part of human food for about 5500 years [2, 81-83-102]. A plant of South American origin, chia a popular nutraceutical is a rich source of Omega-3 fatty acids and is gaining popularity across the world because of its nutritional value [2-81-89-102]. Chia is grown commercially for its seed, a food rich in omega-3 fatty acids since the seeds yield 25-30 per cent extractable oil, including -linolenic acid [2, 81-88]. Typical composition of the fat α-

oil is 55 per cent omega-3, 18 per cent omega-6, 6 per cent omega-9 and 10 per cent saturated fat [2-81-88-102]. Chia was domesticated almost 4,500 years ago in Mesoamerica and it was used as food and medicine [2, 81-89]. However, it became a forgotten crop and remained as unknown crop for many years. It is currently cultivated in, Australia, Bolivia, Colombia, Guatemala, Mexico, Peru, Paraguay and Argentina [2, 81-89]. The largest production centre is located in Mexico and currently exports seeds to Japan, USA, and Europe [2, 81-89]. The cultivation of chia is gaining popularity in Africa and Asia because it is considered as a good nutritional and healthy food [2- 81-89-102]. Chia seeds have been available in health and lifestyle stores in the country's metros, having been imported from Mexico [2, 81-89-102]. In India, the newly introduced crop is gaining importance in few states of the country viz., Rajasthan, Madya Pradesh, Uttar Pradesh, Andhra Pradesh and Karnataka [2, 81-89-102].

Chia seed has greater influence on Indian economy as it is having an economic value in national and international market [2-21, 81-89-102]. Successful cultivation of chia crop in India will improve economic condition, living standards and health benefits to the population [2-20, 81-83-102]. Chia is becoming very popular as super food all around the world with dramatic increase in cultivation and consumption [2-19, 81-88-102]. With high demand in international and Indian market, it can be cultivated as profitable, commercial and health crop [2-81-89-102]. Since, availability of germplasm lines in chia in India is very meagre, crop improvement programme needs to be taken up in collaboration with other international centers [2, 81-89-102]. In recent years, usage of chia seeds has tremendously grown due to their high nutritional and medicinal values [2, 81-89-102]. Researches around the world have been investigating the benefits of chia seeds in the medicinal, pharmaceutical, and food industry [2, 81-88-102]. Chia oil is today one of the most valuable oils on the market [2, 81-89-102]. Demand for chia seeds is increasingly fuelled by the plant-based nutrition movement and heightened awareness around digestive and cardiovascular health [2, 81-89]. This positions chia as both a preventive and performance-oriented ingredient [2, 81-89]. Organic chia seeds dominate the market landscape, accounting for 55% of global sales in 2025 [2, 81-89-102]. On the supply side, scalability remains a focus [2, 81-83]. While chia cultivation has traditionally been concentrated in Paraguay, Bolivia, and Mexico, newer production hubs are emerging in Kenya and India to support regional sourcing strategies and mitigate export bottlenecks [2-40, 81-88-102]. Simultaneously, manufacturers are upgrading processing technologies to enhance shelf life, improve milling outcomes, and ensure consistent nutritional profiles [2-30, 81-89-102].

India's chia seed market is projected to reach a volume of USD 22 million by 2025, growing at a CAGR of 5.3% during 2025 to 2035 [2, 81-89]. This surge in growth is primarily attributed to the rise of the middle-class icon and the rising health consciousness among consumers [2, 81-89-102]. Chia seeds are used as a protein and dietary fiber source and are becoming part of the traditional Indian diet - in beverages and bakery products [2-81-89-102]. India the native land of the vegetarian community is contributing further to the actual demand for plant-based super foods including chia seeds [2, 81-89-102]. Furthermore, the various government initiatives to promote healthy eating habits coupled with the rising organized retail sector have further increased the availability of chia seeds to customers in urban and semi-urban areas [2, 81-88-102].

According to the report [99, 100] of CAR-National Institute of Abiotic Stress Management, Malegaon, Baramati, Pune, Maharashtra, India, Chia is an emerging low-water-requiring crop with the potential to thrive under both rain fed and irrigated conditions [80-99-103]. It grows well even in marginal soils such as rocky basaltic, sandy, and medium black soils with low fertility [100]. The highly nutritious seeds of chia contain 30–32% dietary fibre and 50–55% Omega-3 fatty acids, with proven medicinal benefits in managing diabetes, obesity, and cardiovascular diseases [99, 100]. However, being a new crop in India, chia cultivation lacks standardized agronomic practices, leading to inconsistent yields and limiting its adoption by farmers. Recognizing this gap, ICAR- National Institute of Abiotic Stress Management, Baramati developed a comprehensive package of practices (POPs) for chia cultivation through agronomic experiments conducted from 2021to 2024 [100]. The ideal plant population recommendations include seed rates of 2.0 kg/ha for line sowing and 2.5-3.0 kg/ha for broadcasting [100]. Transplanting the fifteen-day-old seedlings raised in a cocopeat: vermicompost: red soil mix (1:1:1) proved effective for contingent planning and intercropping. The ideal sowing window for higher yield is from 1st August to 15th September. Spacing of 60 × 30 cm (July–September) and 50 × 30 cm (October-November) is optimal [99, 100]. The recommended dose of fertilizers were 90:60:75 kg N:P_2O_5:K_2O per hectare, with nitrogen applied in three splits, with the first one applied as a basal dose (50%) and the remaining 50% N in two splits at 30 and 45 days after sowing (DAS). For the *rabi* season, supplemental irrigation of approx. 350 mm (60% ETo) and foliar spraying of 0.5% KNO_3 at 30 and 45 DAS helps save 40% water [100]. Intercropping chia with leafy vegetables such as fenugreek, in a 1:2 row ratio, enhances productivity and profitability [99, 100]. The chia+fenugreek system yielded 628 kg/ha of chia seed and 4685 kg/ha of green fenugreek, with a chia equivalent yield of 1106 kg ha^{-1},significantly higher than the monocrop [100]. Economically, chia monocropping provided net returns of Rs. 75,213/ha (B:C ratio 2.58), while intercropping with fenugreek increased net income to Rs. 1,07,000/ha (B:C ratio 2.89) under full irrigation, and Rs. 75,000/ha (B:C ratio 2.45) under 50% irrigation [100]. The POPs developed by ICAR-NIASM serve as a critical foundation for scaling up chia cultivation in India [99, 100].

3. Chia seed Farming in Karnataka

Chia seeds farming (Figure-1, 2, 3) in Karnataka, particularly in Mysuru and Chamarajanagar districts, is a highly profitable, low-maintenance venture covering over 20,000 hectares [2, 81-89-102]. Introduced around 2015, this 90-120 day crop requires well-drained soil, moderate water, and plenty of sunlight, yielding an average of 7 quintals per hectare with a high benefit-cost. Introduced to India by CFTRI Mysore in 2015, chia has seen significant growth, particularly in Karnataka, where it is now a major crop [2, 81-89]. Mysore and Chamarajanagar districts are key contributors, collectively accounting for half of Karnataka's chia cultivation [2, 81-89-102]. The results of the study by KHANUM et al., (2025) [83] revealed that the most significant production constraints included lack of high-yielding varieties, inadequate post-harvest technology and inefficient threshing and storage methods [83]. Marketing issues highlighted, high transportation costs, fragmented production, inadequate pricing support [83-88]. Communication gaps with buyers and limited extension services [83-88]. Recommendations included investing in research for high-yielding varieties, improving post-harvest technologies, enhancing market access and strengthening extension services [83-88]. Additionally, promoting farmer cooperation and mechanization, along with better storage and transport infrastructure, are crucial steps for overcoming production and marketing challenges and fostering the growth of the chia industry in Karnataka [2, 83-88-102].

Figure 1 Chia seed plantation at Mysuru in Karnataka, India

According to the Anand et al., (2025) [2], in Karnataka, on experiment basis, adoptability trial of chia crop was first conducted in All India Co-ordinated Research Network on Potential Crops University of Agricultural Sciences, Bengaluru during 2012-2013 [2]. Later, it was the team of Ram Rajasekharan, former Director of Mysuru-based Central Food Technological Research Institute (CFTRI) and his colleagues, biochemist Malathi Srinivasan and plant breeder R. V. Sreedhar who introduced chia as a crop among Karnataka farmers [2]. Growing it in the 38 acres in Bengaluru campus of CFTRI, researchers began work on chia seeds in 2012 [2]. Crop improvement programme was initiated in CFTRI through pure line selection and developed a pure line with blue flower and white seeds and a high yielding line of white flower and white seeds and have tested them through five generations [2, 83-88]. According to the Anand et al., (2025) [2], in October 2014, CFTRI organized an all India farmers 'Empowerment program', where hundreds of farmers who had come from different parts of the country were gifted 100g pouches of chia seeds along with information on agronomical practices to be followed [2]. In September 2014 at a farmer training event in Central Food Technological Research Institute (CFTRI), Mysore, Karnataka State, India, former Agriculture Secretary Srivasta suggested Gopinath to start a Farmer's Producer Company to mitigate farmer distress by income generation [2, 88]. At the event, CFTRI shared 50 grams of premium white chia seeds with Gopinath, which he cultivated in his farm in Belikere village, Mysore, Karnataka state, India [2]. However, Gopinath Co-founded the Raitha Mithra Farmer Producer Company in 2015 with Kurubur Shantakumar, President of All India Sugarcane Growers Association [2]. Within the first year, the company gained a surplus of Rs.38,000 [2]. Today, the company has 526 farmers as shareholders from eight districts of Karnataka and over 1,500 farmers are connected with the organization through its six branch offices in Karnataka [2]. Raitha Mitra is providing a sustainable business model for farmers by connecting with marketing organisations who buy chia seeds in bulk [2, 83-88]. Since 2015, Chia seed farming is currently increasing opportunities for farmers in Mysore, Karnataka state, where the Raitha Mithra Farmer Producer Company has been assuring a buy-back agreement of chia seeds at Rs.15,000-20,000 per quintal which is more profitable than finger millet and other traditional millets [2, 88]. In recent years, the area under chia crop is increasing every year and it was estimated that chia cultivation in Karnataka state

alone is more than 5-6 thousand acres with a production of more than 2000 metric tonnes [2-102]. Many farmers are growing chia crop with buy back agreement with companies viz., Nutri-planet Foods Pvt. Ltd and Quessential India Pvt. Ltd. Situated in Bengaluru and Malur Industrial area respectively [2, 88-102].

Figure 2: Chia seed plantation with flowering stage.

Anand et al., (2025) [2], reviewed that very limited work has been done on crop improvement of chia as there are limited germplasm available in the country [2]. Though CFTRI, Scientists at Mysore have identified two varieties through pure line selection viz., Champion 1 (Black seed variety) and another one Champion 2 (White seed variety) during 2016 [2]. However, All India Co-ordinated Research Network (AICRN) on Potential Crops, Bengaluru centre, Karnataka have been initiated crop improvement programme by adopting mutation breeding programme to harness the new variability and to identify potential mutants with better productivity and nutritional qualities [2, 88].

Figure 3 Chia black matured seed

4. Chia seeds: Botany

Chia belong to the family *Lamiaceae*; Genera *Salvia*, Species *hispanica*, commonly known as chia, Spanish sage, Mexican chia and black chia [1-2-35-102]. Plant is an annual herb with a height of about one meter with reverse petiolate and

serrated leaves (4-8 cm long 3-5 cm wide) with hermaphrodite flowers, flowering during summer [1-2-35-43]. Plant can grow in a wide range of well drained clay and sandy soils with reasonable salt and acid tolerance [1-2-55-102]. It can produce 500-600 kg seed/acre but under appropriate agronomic conditions the yield of 2500 kg/acre has also been reported [1-2-25-102]. In tropical country like India, Chia is an annual herbaceous plant that can reach nearly one meter in height [1-2-35-102]. Its serrated lime-green leaves are oppositely arranged. The plant bears spikes of small blue, purple or white flowers that have a high rate of self-pollination [1-2-15-102]. The small oval seeds are about one mm in diameter and feature a shiny, mottled or speckled seed coat that ranges in colour from dark brown to gray-white [1-2-17]. The seeds produce a mucilaginous gel when soaked in water [1-2-35]. It is a desert plant requiring little irrigation and grows well in sandy loam soils, but it is sensitive to frost and day length [1-2-35]. The plant resists insect pests and disease and is a good candidate for organic production [1-2-35-102].

Chia seeds are propagated from both the seeds and seedlings, growing chia plants from seeds can be the best job [1-2-35-99]. Soil should be well drained and bring it to fine tilth for better germination, sow the seeds over it and cover them with soil. Watering should be done at regular intervals [1-2-35]. Chia seeds start sprouting with in 3-5 days [1-2-35]. Thinning is to be done when the seedling grows up to 20-30 cm tall with 5-6 pairs of true leaves [1-2-35-102].

5. Chia seeds: Phytochemistrty and Health Benefits

Chia, seeds (*Salvia hispanica L.*) from the *Lamiaceae* family are tasty and come from Central America's lowlands, southern Mexico, and northern Guatemala [1-2-35-88-102]. The ancient Mayas and Aztecs used chia seeds for nourishment, folk medicine, and painting [1-21-45-88-102]. Chia seeds are becoming increasingly popular in Mexico, Chile, Japan, Argentina, the United States, Canada, and Australia [1-32-55-80]. Chia has been consumed as food since 4500 BC, central Mexico has long recognized as a viable food crop and utilized in a range of food products throughout the world [1-3-7-28-65-80]. The plant is tolerant of a wide spectrum of well-drained silt and saline soils, as well as salinity and acid. It can generate 500–600 kg of seed per acre, but under optimal agronomic conditions, a yield of 2,500 kg per acre has been reported [1-8-17-28-65-88-102]. Chia farming is gaining status in East Africa because of its low cost and nutritional benefits [1-13-73-80]. Chia is described as "the seed of the 21st century", "new gold", "superfood" or "super nutrient". Chia seeds are smooth, glossy, and oval, measuring 1 to 2 mm in size [1-3-7-28-65-88]. The seed coat can be grey, black-spotted, or white-spotted. In contrast, black chia seeds are more common, and white chia seeds are slightly larger than black chia seeds [1-3-7-28-65-80]. In latest years, there has been an increase in attention to the nutritional potential of chia seeds. This little seed has become a favorite of athletes due to its nutritious benefits [1-3-7-28-65-88-102]. It contains ω-3 fatty acids, a significant amount of dietary fibre, high-quality protein, minerals, vitamins, and a large number of antioxidant compounds including chlorogenic acid, quercetin, kaempferol, and myricetin [1-3-7-28-65-80-102]. When the oil content of the raw and roasted chia seeds was compared for various qualitative attributes, it was discovered to be 35.83% and 37.7%, respectively [1-3-7-28-65-80]. Chia seed is composed of high dietary fibre (18-30%), ash (4-5%), protein (15-25%), fats (30-33%), lipids (31-35%), carbohydrates (26-41%), minerals, vitamins and a high amount of antioxidants [1-3-7-28-65-80]. It is having higher concentration of PUFAs (Poly Unsaturated Fatty Acids) of omega-3 (58-64% of the total lipids) and omega-6 essential fatty acids [1-3-7-28-65-80-102]. Notably, chia seeds are free of gluten. It may be added to other foods as topping materials. Nutritional composition and health benefits of chia are presented here to create awareness [1-13-17-28-65-80-102].

Chia seeds' respective raw and roasted total phenol concentrations were found to be 3.07 and 3.43 mg GAE/g [1-3-7-28-65-80-102]. Chia seed oil's linoleic acid concentration varied between 19.21% (900W) and 21.17% (control) when cooked in a microwave (p0.05) [1-3-7-28-65-80-102]. Chia seed oils that had been heated ranged in linolenic acid concentration from 66.84% (900W) to 68.71% (control) [1-3-7-28-65-80]. The concentrations of the chia oil samples of -tocopherol and -tocopherol ranged from 47.71 mg/100 g (900W) and 51.17 mg/100 g (control) to 62.58 mg/100 g (900W) and 67.81 mg/100 g (control), respectively g [1-13-17-28-69-80]. While, the oils' caffeic acid concentrations range from 0.27 mg/g (900W) to 3.84 mg/g (control), the chia seed oils' rosmarinic acid contents were found to range from 1.32 mg/g (900W) to 3.17 mg/g (control) g [1-3-7-28-65-80-102].

According to current research, chia contains various beneficial effects on blood lipid profile, hypoglycemic, hypotension, antibacterial, and immunological response g [1-3-7-28-65-80-102]. For thousands of years, chia seeds have been largely consumed in many countries because of their huge nutritional and therapeutic potential. The nutritional and chemical composition of the seed makes it a potential crop for commercialization, and technological advancements have developed outstanding opportunities to establish an agricultural sector that can simultaneously contribute a new and an old crop to the world g [1-3-7-28-65-80-102]. Different studies have revealed the excellent nutritional and medicinal potential of these seeds, describing a diversity of possible applications for this remarkable food constituent [1-3-7-28-65-80-102].

Chia seeds are also high in phytochemicals (caffeic acid, quercetin, myricetin, kaempferol and chlorogenic acid, among others), fatty acids, dietary fibres, proteins (including important amino acids), vitamins, and minerals g [1-30-27-28-68-80-102]. An investigation conducted at St. Michael Hospital in Toronto, Canada, discovered that chia seeds had numerous health benefits, including higher iron, fiber, magnesium, and calcium content than milk, gluten-free and blood glucose levels in diabetic patients were stabilized by taking 37 g seeds daily, an excellent source of ω-3 fatty acids, reduced systolic blood pressure up to 6 mmHg and prevented myocardial infarction and strokes by suppressing aggregation of platelets [1-3-7-28-65-80-102]. Some excellent medicinal properties have also been encountered in chia seeds, including inhibiting blood clotting, preventing neurological disorders such as epilepsy and stress, decreasing blood cholesterol, and boosting the immune system [1-3-7-28-65-80-102]. It has been proved that consuming chia seeds during pregnancy can be beneficial since it improves the development of the fetus's retina and brain [1-3-7-28-65-80-102]. Another study also observed that feeding chia seed to male Wistar rats showed enhancement of the good high-density lipoprotein cholesterol and a significant reduction in triglycerides [1-3-7-28-65-80]. Another advantage of chia seed consumption was a decrease in ω-6 in plasma and a decrease in the ω-6: ω-3 ratio, which has a cardio-protective impact [1-3-7-28-65-80]. The impact of chia seed supplementation on blood pressure indicators in persons (21–65 years old) with type 2 diabetes has been reported [1-3-7-28-65-80-102]. According to research, long-term dietary supplementation with chia seeds decreases systolic blood pressure by 13 mmHg compared to baseline in persons with type 2 diabetes [1-3-7-28-65-80-102].

Malnutrition problem in the world is a big threat that is alarming our country too and there is a need to adopt nutritionally secured new diet practices for better health. This problem can be overcome by cultivation and consumption of new super food crop like chia which is nutritionally rich [1-3-7-28-65-80-102]. Chia seeds may be added to other foods as a topping into smoothies, breakfast cereals, energy bars, granola bars, yogurt, tortillas and bread [1-3-7-28-65-80]. In 2009, the European Union approved chia seeds as a novel food, allowing chia to be 5 per cent of a bread product's total matter [1-31-27-28-75-80=102]. The gel prepared out of chia seeds may be used to replace the egg content in cakes while providing other nutrients [1-3-7-28-65-80-102]. The chia oil has superior quality than other oils such as soybean oil, sunflower oil, rapeseed oil and olive oil [1-3-7-28-65-80-102]. Chia is the safest, cheapest and the most sustainable source of PUFA's omega-3, as the intake of 25 to 50 g per day is enough to meet the daily demand [1-35-17-28-72-84]. Hence, there is a need to introduce chia seeds into Indian diets because of its numerous positive nutritional characteristics to achieve nutritional security [1-3-7-28-65-84-102].

Chia seeds (*Salvia hispanica* L.) have re-emerged as a potent functional food, distinguished by an exceptional nutritional matrix rich in alpha-linolenic acid, high-quality complete protein, and unique soluble fiber in the form of mucilage [1-3-7-28-65-84-102]. Chia seed (*Salvia hispanica* L.), a small, oil-rich seed native to Central America, has experienced a monumental resurgence, transitioning from an ancient dietary staple of Aztec and Mayan civilizations to a celebrated modern-day super food [1-3-7-28-65-84]. This remarkable revival is fuelled by a growing consumer demand for nutrient-dense, plant-based foods that offer significant health benefits beyond basic nutrition [1-3-7-28-65-84]. Unlike many dietary trends, the rise of chia seed is firmly underpinned by a robust and expanding body of scientific evidence detailing its exceptional compositional matrix and diverse physiological effects [1-3-7-28-65-84-102].

Chia (*Salvia hispanica*) seeds are oilseeds, often known as pseudo-cereals, which contain a variety of nutrients, including macro and micronutrients, as well as health aids; consequently, they could be classified as a nutraceuticals food [1-3-7-28-65-84]. The seeds are a wonderful source of phenolic compounds like rosmarinic acid, caffeic acid, protocatechuic acids, quercetin, and myricetin [1-3-7-28-65-84-102]. According to studies, chia seeds have a high nutritious content of protein (18–24%), fiber (30–34%), and a variety of fatty acids [1-3-7-28-65-84]. Chia seeds also have a variety of minerals and vitamins and shown to have beneficial effects in the treatment of hypertension, diabetes, and dyslipidaemia, as well as acting as an antioxidant, anti-anxiety, laxative, anti-depressant, analgesic, and strengthen the immune system [1-3-7-28-65-84]. Due to its presence of minerals, lipids (omega-3), fibers, proteins, and antioxidants in chia seed are recognized for health benefits [1-3-7-28-65-84-102].

Chia seeds are composed of different functional components including fiber, polyphenols, antioxidants, omega-3 fatty acid vitamins, minerals, and peptides. Besides, these seeds are also a good source of vegetable protein, unsaturated fat, carbohydrates, and ash [1-3-7-28-65-84-102]. Chia seed is chemically composed of vegetable protein, lipids, carbohydrates, and dietary fiber. Chia seeds carry 40% fiber that brings them to the top of the list in providing more fibre [1-3-7-28-65-8-102]. Soaked seeds carry dietary fiber and present in the form of a gel that helps the stool in its movement. Fibre improves the motion of stool. Soluble fibre rises the volume and bulkiness of feces that regulates blood sugar level, body weight, and cholesterol level, and the health of the colon also acts as anti-aging [1-3-7-28-65-84]. Wet chia seeds are sticky in nature, due to mucilage and digestible fibre. These are useful in controlling blood sugar. Earlier studies claimed that soluble fibre can upgrade the consistency of digestive material so connected with health benefits to humans [1-3-7-28-65-84]. Artificial tools were designed to see the assimilation of mucilage in chia seeds. Mucilage

had a tremendous capacity to hold water. Three amounts of mucilage were used 3, 5, and 8 g/kg to assess the differences in the digestion process [1-3-7-28-65-84-102].

Apart from these direct health benefits, the impressive functional properties of chia seeds, particularly the water-holding and gelation capacities of its mucilage, have also spurred innovation in food product development [1-3-7-28-65-84-102]. For example, it serves as a natural structuring agent in gluten-free baking, a fat replacer in cookies and meats, and an egg substitute in vegan formulations, thereby successfully enhancing the nutritional profile and technological quality of a wide range of products [1-3-7-28-65-84]. However, the integration of chia into diets and products requires careful consideration of factors such as rare allergenic potential, optimized processing to enhance mineral bioavailability, and strategies to prevent lipid oxidation due to its high polyunsaturated fatty acid (PUFA) content [1-13-17-29-65-76-84-102].

One of the distinctive features of chia seeds is their high levels of omega-3 fatty acids good for cardiac health. Omega-3 alpha-linolenic acids (ALA) are about 75% and 20% omega-6 fatty acids present in chia seeds [1-3-7-28-65-84-102]. Omega-3 fatty acids contribute to heart health by improving heart rate fluctuations, parasympathetic tone, and abnormal heartbeats [1-3-7-28-65-84-102]. A higher intake of alpha-linolenic acid reduces the risk of heart failure considerably. It is an effortless way to boost mental health by just consuming chia seeds. Caffeic and rosmarinic acids are phenolic substances and previously recognized in chia seeds [1-3-7-28-65-84-102]. They have a key function in the inhibition and controlling many congenital diseases like epilepsy [1-3-7-28-65-84-102]. The phenolic components from samples of chia seeds, flour, dietary fiber, and oil were separated using different technologies. Omega-3 fatty acids, also known as omega-3 oils, ω-3 fatty acids, or n-3 fatty acids, are unsaturated fats and are key components in the digestion of animal fats and also play a vital function in human food and physical functioning [1-3-7-28-65-84-102].

Chia seed is a feasible source of phytochemicals having chlorogenic acid, caffeic acid, myricetin, quercetin, and kaempferol, which are assumed to have a defensive reaction for the heart and liver, and also have age-defying and anticancerous properties [1-3-7-28-65-84-102]. Antioxidants are substances that slow down oxidation. Oxidation, a process that creates free radicals in a series that can also harm cells. The phytochemicals including antioxidants, phenolic compound and ascorbic acid that function to stop oxidation process [1-3-7-28-65-84]. Foods including vegetables and fruits, are superior sources of photochemicals that is known to be good for health. Small-sized chia seeds have immune-boosting effects by having microchemicals and omega-3 fatty acids [1-3-7-28-65-84-102]. It lowers the sensitivity and swelling reactions through maintenance. The beneficial chia seed effects are linked to humans by having the antioxidant ability, antihypertensive, antihyperglycemic,and anticholesterolemic reactions may be linked with chia protein and peptide structures [1-3-7-28-65-84-102].

Chia seeds exceptionally have a high amount of numerous necessary minerals but are not a good source of vitamins [1-3-7-28-65-84-102]. These have high levels of magnesium, calcium, manganese, phosphorus, copper, selenium, and iron. Whole meals and grains are abundant in manganese, which is needed for ingestion, digestion, maturation, and progression [1-3-7-28-65-84-102]. Normally present in foods that are high in proteins (chia seed). Phosphorus provides health to bones and helps sustain tissues. As a mineral that is frequently deficient in recent food stuffs. Copper is crucial for cardiac health [1-3-7-28-65-84-102]. A major phytonutrient (selenium), is responsible for different systems in our body. Magnesium is mostly insufficient in Western food. it performs a vital role in various bodily mechanisms [1-3-7-28-65-84-102]. The chia seeds contain high amounts of B vitamins including niacin (883 mg/100 g), folic acid (49 mg/100 g), thiamine (0.62 mg/100 g), and riboflavin (0.17 mg/100 g) [1-3-7-28-65-84]. Chia seeds contain vitamin E as tocopherols: α-tocopherol (8 mg/kg of lipids), γ-tocopherol (422 mg/kg of lipids), and δ-tocopherol (15 mg/kg of lipids) [1-3-7-28-65-84-102]. Chia seeds are rich source of several important minerals. Chia seeds are good for boosting the metabolism. Apart from this, their high levels of omega-6 acids in absorbing fat-soluble vitamins A, D, E, and K [1-3-7-28-65-84]. Chia seeds are an extraordinary origin of numerous fundamental minerals but an imperfect source of vitamins. These are abundant in manganese, phosphorus, copper, selenium, iron, magnesium, and calcium [1-3-7-28-65-84]. Similar to vitamins, minerals keep healthy and also aid in the growth and development of the body [1-3-7-28-65-84-102].

Chia seed administration enhanced insulin and glucose tolerance, visceral obesity, hepatic steatosis, cardiac and hepatic fibrosis, and inflammation [1-3-7-28-65-84-102]. Stearoyl-CoA desaturase (SCD) activity, which converts elaidic acid to conjugated linolenic acid, is inhibited by chia seed. Soluble extracts derived from the seeds of plants high in dietary fiber, such as chia seeds, may improve gastrointestinal motility by enhancing vitamin and mineral salt absorption [1-3-7-28-65-84-102]. Chia seeds include insoluble dietary fiber, which prolongs digestion, expands defecations and prevents blockage. They also provide solid lipids, proteins, and cancer-prevention chemicals that protect cells [1-3-7-28-65-84]. Pereira da Silva et al. (2019) [22] investigated the effects of soluble chia seed extracts on Fe and Zn levels and intestinal brushtail functioning in vivo [22]. Chia seed extract was shown to enhance intestinal function by increasing the area,

thickness, and breadth of intestinal villi, as well as enterocyte proliferation and mucus production [1-3-7-28-65-84]. The scientists also discovered that chia seed extract improved the intestinal microbiota by boosting enterocyte proliferation and the number of mucus-producing cells, which may improve the digestive and absorptive ability of the intestinal brush-border membrane [1-3-7-28-65-84-102].

An eating routine wealthy in fiber can lessen the danger of hemorrhoids and colonic packs (diverticulosis). Studies have additionally tracked down that an eating regimen wealthy in fiber can reduced the risk of colorectal disease. It is concluded that functional components of agricultural food such as chia seeds have therapeutic importance [1-3-7-28-65-84-102]. Chia seeds contain more than one functional component. The importance of these components has the ability to suppress the risk of chronic diseases including GI-tract-related diseases, CVD, and various types of cancer [1-3-7-28-65-84]. Fiber, omega-3 fatty acid, protein, polyphenols, phytosterols, vitamins, and minerals reduce heart diseases by controlling bad cholesterol, hypertension, and platelet aggregation. In the GI tract, chia seed components reduce type 2 diabetes by improving the beta-cell performance and reducing the blood glucose level [1-3-7-28-65-84-102]. Moreover, chia seeds have rich fibre that provides bulk to stool, so these seeds can prevent constipation. However, antioxidants and phenolic part of these seeds improve oxidation and aid in reducing the risk of different types of cancer [1-3-7-28-65-84-102]. In the future, Chia seed components may be used as an additive ingredient in different food products such as meat products and baking products to improve the nutrition value and shelf stability [1-3-7-28-65-84-102].

Chia seeds confer significant health benefits, as demonstrated by a growing number of human clinical trials [1-3-7-28-65-84-102]. For instance, chia consumption has been shown to improve cardiovascular biomarkers; specifically, supplementation with 35 g/day of chia flour over 12 weeks reduced systolic blood pressure in hypertensive adults, while daily intake of 25 g of ground chia significantly increased plasma ALA by 138% in postmenopausal women [1-3-7-28-65-84]. In addition to cardiovascular effects, the chia seeds also exert pronounced effects on glycemic control. Mechanistically, the gel-forming soluble fiber delays gastric emptying and slows glucose absorption, leading to a dose-dependent reduction in postprandial blood glucose excursions by up to 30% in healthy individuals [1-3-7-28-65-84]. Beyond macronutrient metabolism, chia seeds are packed with antioxidants, including polyphenols like rosmarinic acid and flavonoids, which confer potent free radical-scavenging capacity and anti-inflammatory effects by modulating key pathways such as NF-κB [1-3-7-28-65-84-102]. Additionally, their high fiber content acts as a powerful prebiotic, selectively enriching beneficial gut bacteria like *Faecalibacterium prausnitzii* and increasing the production of health-promoting short-chain fatty acids such as butyrate [1-3-7-28-65-84-102].

Omega-3 is found in foods such as chia seed, flax seed, flax oil, olive oil, walnuts, sea fish, spinach, cauliflower, and broccoli [1-3-7-28-65-84-102]. Since 2000, India has been witnessing increased use of sunflower oil for consumption purpose, which has resulted in a drastic imbalance of the essential fatty acids with more intakes of omega-6 fatty acids. Recently, chia seed is gaining popularity across the globe because of its higher beneficial nutritional value for health [1-3-7-28-65-84]. The chia oil has superior quality than other oils such as soybean oil (*Glycine max*), sunflower oil (*Helianthus annuus* L.), rapeseed oil (*Brassica napus* L.) and olive oil (*Olea europaea* L.), it has a higher percentage of fatty acid, reaching 68 per cent [1-3-7-28-65-84]. Even if it is not cultivated on a large scale today, chia deserves to receive a great attention due to the universal applicability of its products and derivatives. [1-3-7-28-65-84-102].

Chia seeds contain a high fat content, carbohydrates, dietary fiber, proteins, vitamins (A, B1, B2, and B3), minerals, and antioxidants. Furthermore, chia seeds contain the flavonoids quercetin, chlorogenic acid, and caffeic acid, which are proven to have anti-cancerogenic, anti-hypertensive, and neuron protective effects [1-3-7-28-65-84-102]. Furthermore, chia seeds are a rich source of nutrients such as polyunsaturated omega-3 fatty acids that protect from inflammation, improve cognitive performance, and lower the level of cholesterol [1-3-7-28-65-84]. Chia seeds contain antioxidant compounds that reduce the risk of chronic diseases (cancer and heart attack) and offer protection against some disorders such as diabetes, Alzheimer's, and Parkinson's disease [1-3-7-28-65-84-102]. Moreover, the high amount of fiber decreases the risk of coronary heart disease, the risk for diabetes type 2, and several types of cancer [1-3-7-28-65-85-102]. Chia seeds are already used in the food and pharmaceutical industry [1-3-7-28-65-84]. In the food industry, chia seeds can be used in different forms: as the whole seed, ground, in the form of flour, oil, and gel. Chia oil is one of the most valuable oils on the market today [1-3-7-28-65-84-102].

Chia seed oil nanoemulsion delivery systems represent a possibility for the further application of chia seed oil in beverages and the functional food industry which requires only a slightly turbid or even transparent appearance. Chia seed mucilage represents a promising alternative to synthetic polymers in nanoencapsulation [1-3-7-28-65-84-102].

6. Chia Seed Market

India is a rapidly growing market and leading exporter of chia seeds, with exports rising 50% year-on-year by mid-2025 [2, 81-89-102]. Driven by rising health consciousness and increased domestic production (nearly 50% from Karnataka), India has entered the big league of global chia exporters [2, 81-84-89]. The market is rapidly evolving beyond smoothies into skincare and mainstream dietary products [2, 81-898]. In 2024, India`s packaged chia seed import market continued to see strong growth, with top exporting countries including Brazil, Nigeria, Sudan, and Somalia [2, 81-88]. The India Packaged Chia Seed market is witnessing significant growth driven by increasing consumer awareness about the health benefits of chia seeds, such as being a rich source of omega-3 fatty acids, antioxidants, and fiber [2-81-83]. The market is also benefitting from the rising demand for natural and organic food products among health-conscious consumers [2, 81-83-102]. Various food and beverage manufacturers are incorporating chia seeds into their products to cater to this growing trend [2, 81-88]. Additionally, the online retail sector is playing a key role in expanding the reach of packaged chia seeds to a wider consumer base across India [2, 81-88]. Overall, the India Packaged Chia Seed market is expected to continue its growth trajectory in the coming years, fuelled by the shift towards healthier food choices and the increasing popularity [2, 81-89-102].

The India Packaged Chia Seed Market is experiencing a surge in demand due to the growing consumer focus on health and wellness [2, 81-89]. Chia seeds are becoming popular for their high nutritional value, including omega-3 fatty acids, fiber, and antioxidants [1-81-83-89]. The market is witnessing increasing product innovation with flavoured and ready-to-eat chia seed products entering the market [2, 81-89]. Additionally, the rise of e-commerce platforms in India provides a convenient avenue for chia seed brands to reach a wider audience [2, 81-89-102]. Chia seeds as a crucial food & beverage, dietary supplement, and personal care products ingredient is gaining immense recognition in the world market, due to its healthful properties [1-81-89]. Increasing demand for natural food ingredients, coupled with rising demand for health and dietary supplements is expected to fuel the demand for chia seeds, which in turn is expected to propel the chia seeds market growth during the upcoming years [2, 81-89].

The global chia seed market is projected to grow from USD 232.8 million in 2025 to USD 462.3 million by 2035, reflecting a compound annual growth rate (CAGR) of 7.1% [81-89]. South America is the major producer of chia seeds, especially countries, such as Bolivia and Argentina accounts for the major production share of chia seeds in South America [2, 81-88-102]. North America, followed by Europe is projected to witness significant growth in the global chia seeds market, owing to their increased recognition as a supe rfood and a crucial health supplement ingredient across North America and Europe [81-83]. Increasing chia-based food and beverage product launch across North America is another major reason for the anticipated growth of the region [81-89]. The demand for chia-based products is expected to witness a rise in the Asia Pacific during the forecast period, due to the rising popularity of the product as a nutrition-rich ingredient, coupled with a growing population of the region which in turn is fostering the demand for an affordable nutritional diet to feed the expanding population [81-89-102].

The Global Packaged Chia Seed Market based on Product Type can be further segmented into White Chia Seed, Black Chia Seed and Brown Chia Seed [2, 81-84]. The Black Chia Seed segment is the major segment generating revenue in 2025 [2, 81-88]. Black chia seed is small in size and contains more protein that rises the preference for black chia seed among health-conscious people [2, 81-89-102]. Moreover, black chia seed are mostly used in food and beverage industry owing to its benefits about health that raising the adoption of chia seeds among consumers [2, 81-89-102]. The White Chia Seed segment is estimated to register the fastest CAGR of 7.5 per cent for the period 2021-2026. This is mainly owing to its mild flavor and unique texture that attract consumers for consuming white chia seeds [2, 81-84]. Moreover, white chia seeds are rich in fiber and helps to improve metabolism rising the demand of white chia seeds among consumers which in turn boosts the growth of Global Packaged Chia Seed market [2, 81-84-102]. On the basis of application, the global chia seeds industry has been segmented into food & beverages, animal feed, nutraceuticals, personal care products, and others [2, 81-88-102]. Application of chia seeds in food & beverage segment is projected to be the highest during the forecast years, due to the high nutritional value of chia seeds [2, 81-89-102]. Chia seeds are rich in protein, fiber, omega-3 fatty acids, zinc, calcium, and other crucial nutrients that are required by the body [2- 81-85]. Increasing demand for super food and nutraceuticals is expected to contribute significantly to the growth of the market [2, 81-89-102].

The Global Packaged Chia Seed Market based on application can be further segmented into Food and Beverages, Pharmaceuticals, Personal Care and Cosmetics [2, 81-89-102]. The Food and Beverages segment registers for the higher Global Packaged Chia Seed market share in 2026 [81-89]. This is mainly owing to the rising consumption of chia seeds in bakery products, peanut butter, breakfast cereals and many more [2, 81-87-102]. Moreover, growing trends of consuming gluten free products in food and beverage industry rising the preference of chia seeds [2, 81-88]. The Pharmaceuticals segment is forecasted to register the fastest CAGR of 8.1 per cent over 2021-2026 [2, 81-88-102]. This

is mainly owing to the fact that chia seeds are used various health benefits such as cardiovascular diseases that increases the production of chia seeds in the form of capsules in pharmaceutical industry and are thus propelling the growth of Global Packaged Chia Seed Market [2, 81-83-102]. The growing popularity of chia seeds among consumers and increasing industrial application of chia seeds are the major drivers propelling the growth of chia seeds market globally [2, 81-83]. The use of Chia seeds in various food & beverages, pharmaceuticals, and personal care products is growing globally and has increased demand for chia seeds growers and helping the entry of new market players [2, 81-83]. The factors mentioned above are driving the growth of chia seeds market. In addition to that, the popularity of organic chia seeds among health-conscious consumers is expected to fuel the market growth of chia seeds over the forecast period [2, 81-84]. However, according to a new report by Market Research Future the global chia seeds market size is expected to reach USD 4.9 billion by 2027 growing at a CAGR of 22.5 per cent [2, 81-89].

Organic chia seeds are projected to maintain dominance with a 55% market share in 2025, supported by a strong CAGR of 7.4% through 2035 [81-83]. This leadership reflects their resonance with health-conscious consumers and sustainability-focused food brands [2, 81-89].

In the India Packaged Chia Seed Market, several challenges are encountered. One major challenge is the limited awareness and understanding of the health benefits of chia seeds among the Indian population [81-89-102].This lack of awareness hinders the adoption of chia seeds as a popular health food choice [81-88-102]. Additionally, the relatively high cost of packaged chia seeds compared to traditional staples may deter price-sensitive consumers from incorporating them into their diet [81-84]. Distribution and availability issues also pose a challenge, as chia seeds are not as widely available in all regions of India, limiting the market reach [81-88]. Furthermore, competition from other super foods and health foods in the market adds to the challenges faced by packaged chia seed brands in India [81-89]. Overcoming these obstacles through targeted marketing, education campaigns, and strategic pricing strategies will be crucial for the growth of the packaged chia seed market in India [81-83]. The rising prevalence of lifestyle diseases such as obesity and diabetes has also spurred the adoption of chia seeds due to their potential to aid in weight management and blood sugar control [1-81-83-102]. Additionally, the expanding vegan and vegetarian population in India has fuelled the demand for plant-based protein sources like chia seeds. [81-84]. The influence of social media, health and wellness trends, and the availability of a wide range of chia seed-based products in the market are further contributing to the market growth as consumers seek convenient and nutritious food options [81-84].

The Indian government does not have specific policies targeted at the packaged chia seed market [81-84]. However, the Food Safety and Standards Authority of India (FSSAI) regulates the safety and quality standards for packaged food products, including chia seeds, through the Food Safety and Standards Act, 2006 [81-88]. This legislation ensures that packaged chia seeds meet certain standards for labelling, packaging, and quality to protect consumer health [81-89]. Additionally, the government`s focus on promoting healthy eating habits and wellness through initiatives like the Eat Right India movement indirectly impacts the packaged chia seed market by increasing consumer awareness and demand for nutritious food products like chia seeds [81-88-102].

7. Conclusion

Chia belong to the mint family *Lamiaceae* are edible seeds of *Salvia hispanica*. Chia seeds with strong nutritional and therapeutic value has led to a dramatic increase in their popularity in recent years. Chia was domesticated almost 4,500 years ago in Mesoamerica and it was used as food and medicine. Chia, (*Salvia hispanica* L.), is a plant species used since ancient times for dietary and medical purposes. Its products are small dry white and dark seeds. Chia seed is composed of high dietary fiber (18-30%), ash (4-5%), protein (15-25%), fats (30-33%), lipids (31-35%), carbohydrates (26-41%), minerals, vitamins and also contains a high amount of antioxidants. The heavy metal content of seeds was within the safe limits with no potentially toxic mycotoxins and gluten. It is having higher concentration of PUFA's (Poly Unsaturated Fatty Acids) of omega-3 (58-64% of total lipids) and omega-6 essential fatty acids. This fatty acid is found to be very good for heart health. The ALA (Alpha Linolenic Fatty Acid) in Chia seed is the only known essential PUFA omega-3. They support heart health by lowering blood pressure and cholesterol, aid in weight management by promoting fullness, improve digestive health, and strengthen bones with calcium and magnesium.

Chia (*Salvia hispanica* L.) is grown mainly for its seeds. It belongs to the mint family- *Lamiaceae*. The species S. hispanica yields several dry indehiscent fruits referred to as seeds which are highly nutritious. In recent years, chia seeds have grown tremendously due to their high nutritive and medicinal values. Today it is one of the most important "superfood". Chia has been introduced to India in the year 2015 by Central Food Technological Research Institute (CFTRI) Mysore, Karnataka state, India from Central America and were initially grown by farmers in few areas near Mysore. Presently the cultivation has spread to other areas of Karnataka and also to the neighboring states. Chia is a new crop, but the

economic value of chia seed in the national and international market is very high. Successful cultivation of chia crops in India will increase economic enhancement, improve living standard and health. Chia is becoming very popular as a superfood all around the world with a dramatic increase in cultivation and consumption to fulfill high demand in the International and Indian market, therefore can be cultivated as a profitable commercial crop in India. Cultivating chia is only one of many experiments, to make agriculture, food and nutritional security drought-proof.

The medicinal properties of chia seeds are the subject of interest of cosmetic and pharmaceutical industries. The importance of these components has the ability to suppress the risk of chronic diseases including GI-tract-related diseases, CVD, and various types of cancer. Fiber, omega-3 fatty acid, protein, polyphenols, phytosterols, vitamins, and minerals reduce heart diseases by controlling bad cholesterol, hypertension, and platelet aggregation. In the GI tract, chia seed components reduce type 2 diabetes by improving the beta-cell performance and reducing the blood glucose level. Moreover, chia seeds have rich fibre that provides bulk to stool, so these seeds can prevent constipation. However, antioxidants and phenolic part of these seeds improve oxidation and aid in reducing the risk of different types of cancer. In the future, Chia seed components may be used as an additive ingredient in different food products such as meat products and baking products to improve the nutrition value and shelf stability. Chia crop being a super food due to its high nutrition profile, using chia seeds in daily diet may help to reduce malnutrition and also it may prevent many diseases (diabetes, obesity and cardiovascular). On the basis of product type, the global chia seeds market has been segmented into white chia seeds, black chia seeds, and brown chia seeds. Black chia seeds segment is projected to hold the major market share during the forecast years, due to higher consumer inclination towards the product, attributes by its health benefitting properties. Presence of abundance of anti-oxidants in black chia seeds is further projected to propel the growth of the segment. On the basis of application, the global chia seeds industry has been segmented into food & beverages, animal feed, nutraceuticals, personal care products, and others. Application of chia seeds in food and beverage segment is projected to be the highest during the forecast years, due to the high nutritional value of chia seeds. Chia seeds are rich in protein, fiber, omega-3 fatty acids, zinc, calcium, and other crucial nutrients. Increasing demand for super food and nutraceuticals is expected to contribute significantly to the growth of the market.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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