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A Review on Potential Properties and Therapeutic Application of Chia Seeds Extraction

Kale Saroja, Dr. Gajanan Sanap

Late Bhagirathi College of pharmacy Pathri Chh. Sambhaji nagar, Maharashtra, India

ABSTRACT: The extracted oil from the seeds of the *Salvia hispanica* has been studied by different extraction methods to obtain the highest percentage of extracted oil from white and black chia seeds. In recent years, usage of Chia seeds has tremendously grown due to their high nutritional and medicinal values. Chia was cultivated by Mesopotamian cultures, but then disappeared for centuries until the middle of the 20th century, when it was rediscovered. Chia seeds contain healthy ω-3 fatty acids, polyunsaturated fatty acids, dietary fiber, proteins, vitamins, and some minerals. Besides this, the seeds are an excellent source of polyphenols and antioxidants, such as caffeic acid, rosmarinic acid, myricetin, quercetin, and others. Today, chia has been analyzed in different areas of research. Researches around the world have been investigating the benefits of chia seeds in the medicinal, pharmaceutical, and food industry. Chia oil is today one of the most valuable oils on the market. Different extraction methods have been used to produce the oil. In the present study, an extensive overview of the chemical composition, nutritional properties, and antioxidant and antimicrobial activities, along with extraction methods used to produce chia oil, will be discussed. Three extraction methods were used solvent extraction (cold extraction), extraction using Soxhlet device (hot extraction), and extraction by using the screw pressing etc. the study concluded that solvent extraction is the best method for extraction in terms of quantity and quality of extracted oil. Fatty acids were also diagnosed in each type of oil extracted using Gas Chromatography (GC) to determine the type of fatty acids that make up the highest percentage of extracted oil, Where it found that the saturated fatty acid Arachidic and unsaturated fatty acid linoleic (omega-6) have formed the highest percentage of the extract from the seed oil where their percentages (6.61%) and (3.54%), respectively, while the fatty acid linoleic (omiga-6) of oil extracted from black seeds was (4%). The vitamins dissolved in extracted oil from the Chia seeds were diagnosed using high performance liquid chromatography (HPLC).

KEYWORDS *:* *Salvia hispanica,* Dietary supliment, Antioxidant, Chia seed Oil

I. INTRODUCTION

Salvia hispanica, also known as chia, belongs to order Lamiales, mint family Labiate, subfamily Nepetoideae, family Salvia[1] and Chia seeds have been used as food since the early years (3500 BC) and cultivated as a crop. In the 9th century. BC and 1500 BC in Central Mexico [2]

Taxonomic nomenclature

Synonym: Salvia hispanica

Kingdom: Plantae

Subdivision: Spermatophyta

Order: Lamiales

Family: Lamiaceae

Genus: Salvia

Species: Hispanica

The genus Salvia includes approximately 900 species that have spread over thousands of years to various parts of the world, including South Africa, Central America, North and South America, and Southeast Asia [3][4][1] These seeds are widespread. medicinally and nutritionally known since ancient times because they are rich in omega-3 fatty acids. Chia seeds have been described as a good source of oil, protein, fiber, minerals and polyphenols [5] [6][7] Chia seed oil is a rich source of polyunsaturated fatty acids (PUFA). Chia seed oil is unique in that it contains the highest amount of omega-3 (ALA) of any known natural source [8] [9]. Omega-3 plays an important role in health and is used in many foods and cosmetics. Several studies have shown that regular consumption of omega-3 has many health benefits, including prevention of cardiovascular diseases, high blood pressure and inflammatory diseases [10] [11]. In addition, Chia seeds and the oil extracted from Chia seeds are rich in natural antioxidants such as tocopherol, phytosterol and carotene [12][13] and phenolic compounds including chlorogenic and caffeic acid [6] that protect consumers from many diseases and promote human health [14][2]

In recent years, chia seeds have become one of the most well-known foods in the world for their nutritional and medicinal properties [15][16][17][18]. Corey et al.[19] reported that Chia is an excellent ingredient because it contains the highest known amount of α-linolenic acid and can be easily added to commercial food. Several studies have reported that chia seeds may have important health, antioxidant and antimicrobial activities due to their high fatty acid content [15][20][21][22][1]

II. METHODS OF EXTRACTION

Chia seeds are valued primarily for their oil. Thus, many methods of oil extraction have been used. Differences in extraction methods caused variation in oil yield, fatty acid quality, fatty acid concentration, dietary fiber and also antioxidant content. a summary of current methods used to extract chia seed oil [20].

TABLE I

Table : Extraction methods, Solvent, Extraction yields

Sr. No.	Extraction of methods	Solvent	Extraction yields	Reference
01	Cold solvent extraction	n-hexane	30	[23]
02	Cold solvent extraction	n-hexane	42	[24]
03	Cold solvent extraction	n-hexane	19.3	[25]
04	Soxhlet Extraction	Ethyl acetate, Ethanol	12.10	[26]
05	Soxhlet Extraction	n-hexane	Not Evaluated	[27]
06	Soxhlet Extraction	n-hexane	10.9	[28]
07	Soxhlet Extraction	n-hexane	35.6	[23]
08	Soxhlet Extraction	n-hexane	32.2	[29]
09	Soxhlet Extraction	n-hexane	Not Evaluated	[30]
10	Soxhlet extraction	n-hexane	33.6	[31]
11	Soxhlet Ultrasonic Extraction	n-hexane, Ethyl acetate/Ispropanol	30.2/25.6	[18]
12	Ultrasonic Extraction	n-hexane	Not Evaluated	[27]
13	Ultrasound Extraction	Ethyl acetate, Ethanol	11.2	[26]
14	Cold pressing and DCS	Ethanol	Not Evaluated	[32]
15	Ultrasound Extraction	Acetone	Not Evaluated	[33]
16	Ultrasound liquid-liquid Extraction	Methanol-water Sol.	Not Evaluated	[34]
17	Super critical fluid extraction	Co_2	88.1	[35]
18	Super critical fluid extraction	Co_2	7.2	[36]
19	Super critical fluid extraction	Co_2	10.6	[26]
20	Super critical fluid extraction	Co_2	31.8	[29]
21	Super critical fluid extraction	Co_2	17.5	[24]
22	Super critical fluid extraction	Ethanol	90.3	[37]
23	Super critical fluid extraction	Co_2	24.6	[38]
24	Super critical fluid extraction	n-propane	Not Evaluated	[27]
25	Pressing	/	24.8	[39]

26	Pressing	/	20.1	[40]
27	Pressurized liquid extraction	Ethanol	19.9	[37]
28	Pressurized liquid extraction	n-hexane	Not Evaluated	[41]
29	Screw pressing	n-hexane	9.5	[23]
30	Seed compression	/	Not Evaluated	[27]
31	Cold press and ultrasound	Methanol	Not Evaluated	[42]
32	High pressure extraction	/	20.01	[24]
33	Alkaline extraction and isoelectric precipitation	/	Not Evaluated	[43]
34	Ultrasound- assisted extraction	n-hexane	Not Evaluated	[44]
35	Hot solvent extraction	Water and aq. ethanol	Not Evaluated pp	[45]

Chia Plant

Chia Seeds

Chia Oil

III. PHYSICO-CHEMICAL PROPERTIES OF CHIA OIL

In aqueous solution, chia seeds tend to secrete polysaccharides glue (4.5% of dry weight) that adheres firmly to the seed. It was determined that this polysaccharide contains D-xylosyl, D-glycosyl and 4-O-methyl-α-D-glucopyranosiluronic acid in a ratio of 2:1:1 linear tetrasaccharide sequence. The uronic acid content is lower an indication that pectin is not related to that polysaccharide [46] Chia seed flour (defatted residue) contains almost 34% of the dry weight fiber and 17% protein of dry weight [47] Main component of the insoluble abnormal fraction is lignin (39-41%), which is It is thought to protect the unsaturated fats in chia seeds by building a strong and durable structure. The sperm cell wall also contains common components, cellulose and hemicellulose [46]. Water resistance, the ability of a wet material to retain water when subjected to an external centrifugal force or the compression of the fat-free fiber fraction was 15.41 g/g fiber. it is indicated that the high water holding capacity was affected polysaccharide plants [48]. Conversely, oil retention Chia seed volume tends to be low (2.02 g/g per sample). This it is assumed that the particle size of the fiber fraction is not small sufficient to hold a larger amount of oil (because there are smaller particles more surface area). The fiber fraction of chia seeds contains uniform emulsifying property

(amount of dissolution or dispersion of two immiscible liquids) (53.26 ml/100 ml) which is due to the protein fraction, as most proteins are potent emulsifiers Physiologically, they have emulsifying properties important for absorption and increases in bile acid excretion of feces, which would limit absorption from the small intestine [48]. The highest phenolic content of chia seeds was approximately 0.9211±0.008 mg/g (GAE gallic acid equivalent) and the content of flavonols. concentrations. Antioxidant activity measured as radical Chia seed removal performance is comparable to Trolox® 185.210 ppm GAE. Chia seed extracts showed metal chelation potential against free radicals caused by iron and copper [46] [49]

IV. PHARMACOLOGICAL ACTIVITIES OF CHIA SEED OIL

Chia seed oil has wide range of phytoconstituents they gives pharmacological action as follows :

1) Antioxidant activity :

Chia seeds and oil are an excellent source of antioxidants such as tocopherols, phytosterols, carotenoids and phenolic compounds chlorogenic acid, caffeic acid, myricetin, quercetin and kaempferol [50][46][51][52] Several reports indicate strong antioxidant properties of chia seeds in in vitro tests [53] In a rat model of obesity dietary chia oil induces HSP70 and HSP25 expression in bone muscle and reduced superoxide dismutase and glutathione peroxidase expression [54] In addition, extended treatment with chia seeds and a short treatment with chia oil restored the peroxisome proliferator-activated receptor-γ coactivator-1α (PGC-1α) expression.[49]

2) *Anti-Hyperlipidemia and anti-hypercholesterolemia:*

Chia seed diet in rats, reduced dyslipidemia and visceral adiposity [55][56] The chia diet caused lower triacylglycerol levels, increased HDL cholesterol and linolenic and it derived fatty acids in rat serum. The blending of chia seeds and different types of oils are reduced oxidative stress in vivo in obese wistar rats. In addition, stearoyl-CoA desaturase-1 products were depleted in the heart, liver and the adipose tissue of chia seed-supplemented rats [57] [58] In a separate study, dietary chia seeds prevented the onset of dyslipidemia and insulin resistance (IR) in the rats fed with the sucrose-rich diet. Dietary chia seed also reduced the visceral adiposity [56] In addition, Chia oil also reduced adipocyte hypertrophy, lipolysis and the anti-lipolytic action of insulin among high sucrose rats [59][60]. Interestingly, chia fed pigs and rabbits resulted in an increase of PUFA in meat fats as well as aroma and flavor [60][61] The combination of different seeds mixtures has shown to increase PUFA levels in plasma and liver of experimental animals in addition to the anti-atherogenic, hypolipidemic and immune modulator effects which may attribute to antioxidant potential of unsaturated fatty acids especially ALA present in the seed mixture [62][63]

3) Antidiabetic activity :

Some reports have suggested a potentially beneficial physiological Effects of chia on risk factors for type 2 diabetes experimental animals [64]. In a 6-month type 2 crossover study diabetics who consume chia daily (37 g per day) indicated lower blood pressure, lower inflammation markers and coagulation factors [56]. Another study had a significant reduction of waist circumference in healthy individuals after a month of adding Chia; it wasn't a change in body weight that indicates a specific decrease in fat mass. Inside something chronic treatment program, dietary Chia seeds reduce internal organs obesity and insulin resistance among sucrose-induced diabetics in rats, suggesting its role in lipid and glucose homeostasis [56][54] Inside something separate study, Chia-enriched diet modulates dyslipidemia, liver TAG, fatty acid oxidase, acetyl-coA carboxylase and glucose-6- phosphate dehydrogenase. PPARα protein level increased and Increased mature form of SREBP-1 (sterol regulatory element). binding protein-1) level in a sucrose-rich diet (SRD). normalizes chi. A number of key mechanisms motivated this study biological effects of dietary chia seeds on contraceptives and normalization/improvement of dyslipidemia and hepatic steatosis Insulin resistant rat model [65]

4) Anticancer property :

Nutrition plays an important role in the onset and progression of the disease cancer [66] Dietary PUFAs have been shown to play an important role palliative role in various forms of human cancer [67]. Multiple studies show different cytotoxic abilities of PUFAs cancer cells and can act synergistically with flow chemotherapy drugs [68]. Arachidonic acid (20:4, n-6) derivative ALA induces tumor cell apoptosis through transformation sphingomyelin to ceramide, which triggers the release of a proapoptotic substance proteins [69] In addition, AA eicosanoids are active carcinogens or tumor promoters due to their pro-inflammatory effects participate in cancer development [70]. In addition, peanut

oil, which is rich in linoleic/oleic acid and PUFA compounds derived from them, offers protection. against murine mammary cancer development by modulating tumorigenesis membrane fatty acid composition, lipoxygenases (LOX) and cyclooxygenase (COX) enzyme [71]. Therefore it is assumed that chia seed oil because it contains all the resulting α-linolenic, linoleic/oleic acid in good balance can give the same effect.[49]

5) Anti-inflammatory property :

An inflammatory disorder is accompanied by pain, redness and swelling severe enough to cause loss of vital functions. An interdependent chains of reactions are mediated by inflammation molecules released by leukocytes. Key mediators of inflammation including linoleic acid and its derivative eicosanoids, prostaglandin e2 and leukotriene b4, is derived from arachidonic acid. However, chia has been shown to reduce the risk of inflammatory reactions seed oil diet [71]. The n3 pufa in chia seed oil is recommended compete with arachidonic acid for binding movie consequently, it produces prostaglandins and slightly modified ones eicosanoids, i.e. Lte5, ltb5 and pge3, which induce less inflammation reduces the induction of cox-2 [52][49].

V. APPLICATIONS OF CHIA SEEDS AND PRODUCTS DERIVED FROM THEM

Functional foods have received considerable attention worldwide in recent years because a wave of healthy lifestyle changes. Today, chia seeds are used as a health oil supplement people and animals.

1) Food industry :

Some studies have been done on the use of chia seeds in the food industry. In food in industry, chia seeds can be used in different forms: whole, ground, flour, oil and gel [72]. In 2000, the US Dietary Guidelines recommended that chia could be used as a staple food, but in a limited way. quantity; The recommended intake should not exceed 48 g per day. Chia seeds can be added or mixed in as dietary supplements in cookies, pasta, cereals, snacks and cakes. Thanks to its hydrophilic properties, Chia the seeds can be used as a substitute for eggs and fat. They can absorb 12 times their weight in water [72]. Chia gel can be used as a substitute for oil or eggs in baked goods. It has been shown that chia oil can replace 25% of eggs in cakes [73]. The nutritional value of butter can be increased by mixing it with chia oil in a ratio of alk From 6.5% to 25% as the concentration of ω-3 fatty acid in chia-enriched butter increases from 4.17% 16.74% [74]. In addition, recent studies have shown that mucilage obtained from chia seeds can be used as a functional coating.with better functional characteristics [74][1]

2) Chia Mucilage :

Chia Mucilage could be used in the food industry as a foam stabilizer, suspending agent, emulsifier, adhesive or binder due to its water resistance and viscosity. Recent studies showed that mucilage obtained from chia seeds can be used as a functional coating with better performance properties [74]. Compared to other hydrocolloids such as gum arabic, modified starch and cellulose, chia cultivar has a low EAI emulsifying activity index. Mucilage showed remarkable ability stabilizing emulsions; nevertheless, the efficiency was affected by the composition of the emulsion. The fact that the ability of mucus to stabilize emulsions may be due to its ability to adsorb to solids or liquid and stabilizing emulsions without chemical or enzymatic variations. Got plant slime Chia seeds are a new source of polysaccharides and may be able to produce an interesting polymer compounds for edible films and coatings. Possible substitutes for synthetic packaging are edible films based on polysaccharides. Mucilage has it we can form edible films, but they are very few and fragile. Plasticizers may be added to improve the mechanical properties of edible films. There are different types of plasticizers such as polyols to increase the flexibility and processability of such films. Emollients include glycerol is one of the most used filmmaking techniques. Thechia Mucilage hydrocolloid is an interesting ingredient that can be applied to the design of new film-forming solutions. to enlarge using glycerol as a hydrocolloid extracted from chia seeds to form chia plant glue to ensure homogeneous and flexible membranes and it is important to ensure a suitable physical-chemical barrier, and mechanical properties. The solubility of chia mucilage can be fine-tuned with glycerol concentration and improved with a higher ratio of glycerol [75]. Water solubility in chia plant Plasticized films with different glycerol concentrations increased significantly.[1]

3) Chia Gum :

Chia seeds are believed to be a source of these fibers in the food industry. gum can be extracted from the dietary fiber fraction using water as an additive to adjust the viscosity, stability and structure. Chemical composition, molecular structure and derived properties such as because thermal stability or gelling ability are important factors determining

suitability polysaccharide in the food and pharmaceutical industries. The gum is stable even at high temperatures up to 224 ◦C. Ciau-Solis et al. [76] investigated the chemical and functional properties of chia seed gum They showed that chia gum contains 26.2 t and when extracted fat, gum can be made into two fractions: fat-containing gum (FCG) and partially fat-free gum (PDCG). They confirmed that PDCG has higher protein, ash and carbohydrate content than FCG. Chia seeds gum is a promising new material. However, there is little information about the structural composition, it has not yet been applied industrially. Little has been studied about its thermal stability and functionality. Understanding these characteristics greatly expands the possibilities industrial application [77][1]

VI. CONCLUSION

Chia, Salvia hispanica L., is a plant species that has been used for nutritional and medicinal purposes since ancient times. Its products are small dry white and dark seeds. Recently, there has been a lot of discussion and research about the health benefits and uses of this seed. Chia seeds contain a lot of fat, carbohydrates, fiber, protein, vitamins (A, B1, B2 and B3), minerals and antioxidants. In addition, chia seeds contain the flavonoids quercetin, chlorogenic acid and caffeic acid, which have demonstrated anti-cancer, blood pressure-lowering and neuroprotective effects. In addition, chia seeds are rich in nutrients such as polyunsaturated omega-3 fatty acids, which protect against inflammation, improve cognitive performance and lower cholesterol. Chia seeds contain antioxidant compounds that reduce the risk of chronic diseases (cancer and heart attack) and offer protection against certain diseases such as diabetes, Alzheimer's disease and Parkinson's disease. In addition, a high consumption of fiber reduces the risk of coronary heart disease, type 2 diabetes and several cancers.

In summary, this study showed that n-hexane and ethyl acetate gave higher yields for chia oil extraction, and increasing the amount of solvent used had little effect on oil production. However, the solvent used did not affect the fatty acid composition of the extracts. Defatted flour had higher oil retention and emulsifying activity values, but the oiling process did not affect water retention. It was found that the technological properties of the meals were not affected by the type of solvent used for extraction.

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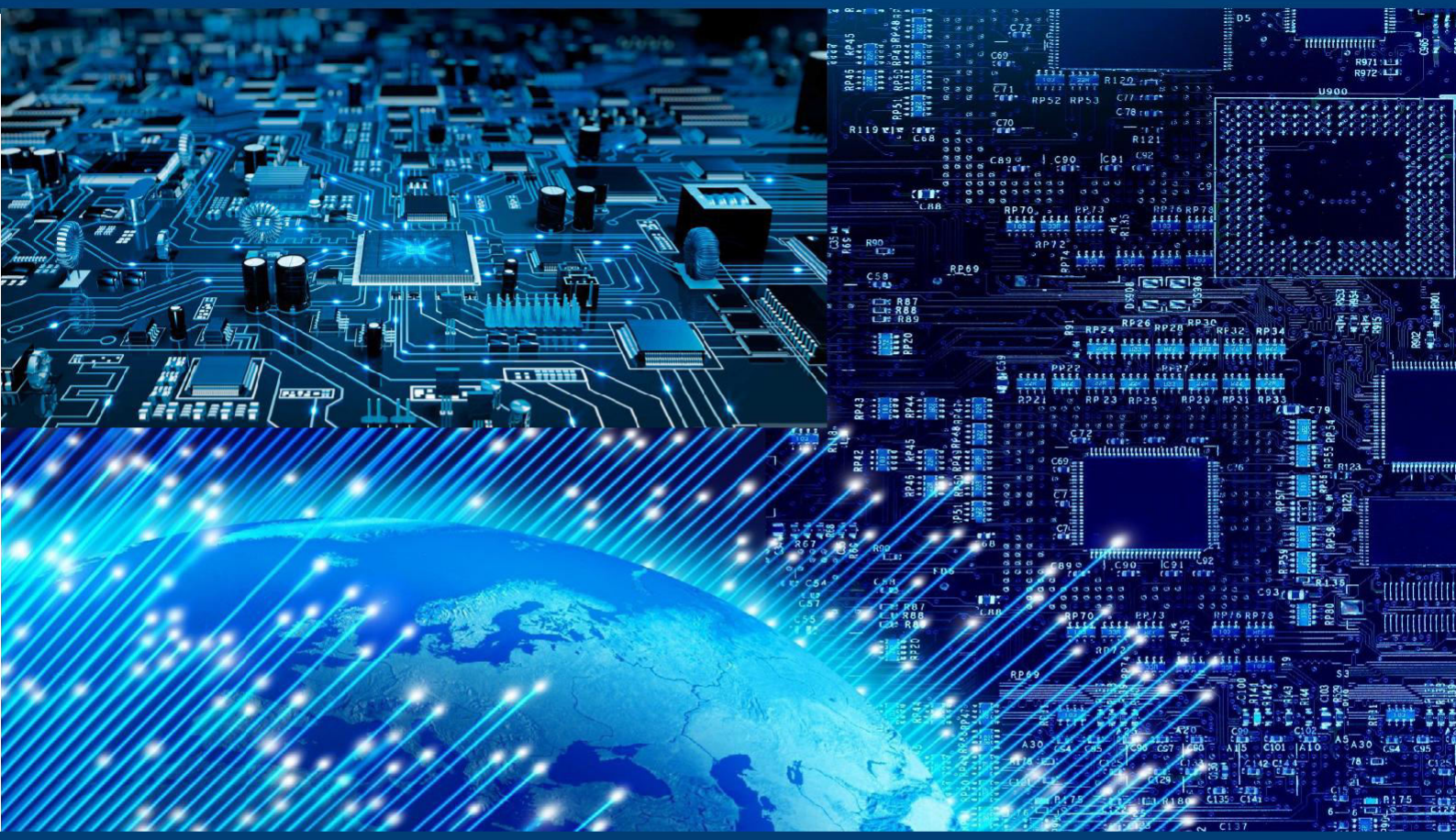

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