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REVIEW PAPER OPEN ACCESS

Therapeutic applications and health promoting properties of chia seeds (Salvia hispanica): review

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Abstract

Nowadays, chia seed has attracted the attention of nutritional scientists due to its chemical composition. It is known as a functional food because it contains multiple components that are essential for human health. It primarily provides different types of antioxidants that prevent the attack of free radicals and their consequences. It is a great source of several unsaturated fatty acids, particularly polyunsaturated fatty acids, such as omega-3 and omega-6, as well as two types of fiber-soluble and insoluble fiber. The nutritional value of chia seed explainsitsability to prevent multiple non-infectious diseases, including diabetes, obesity, cancer and cardiovascular diseases (CVDs). The current review aims to present the nutritional properties of chia seeds as well as their therapeutic applications.

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Introduction

Over the past decade, the human diet has changed significantly; in particular, fiber consumption has decreased and total fat intake, especially saturated fat (MAGRIPLIS, 2019), has increased. Scientific evidence indicates there to be an association between dietary fat intake and the risk of several diseases, such as cardiovascular disease, diabetes, cancers, hypertension and depression (Alberti *et al*, 2009). Globally, 20% of clinical mortality is due to cardiovascular disease, and its cost to the American government, for example, is approximately 300 billion per year (WHO, 2018). In recent years, functional foods have been the focus of nutritional scientists due to their bioactive compounds such as essential fatty acids, dietary fiber, phytochemicals, antioxidants and oligosaccharides, which have positive impacts on body health and decrease the risk of degenerative diseases (Pacheco, 2001; Al-Sheraji, 2013). Exploring newer natural sources of functional foods, such as chia seeds (*Salvia hispanica L.*), has gainedinterest by nutritional scientists in the last decade.

Chia seed (*Salvia hispanica L*) is a great source of antioxidant because of the availability of chlorogenic, myricetin, polyphenols, kaempferol, essential fatty acids and polyphenols (Ixtaina, 2011; Reyes, 2008). Chia seed is an annual herb grown Northern Guatemala and Southern Mexico (Ayerza, 2011).

It considered to be a high nutritional value plant, as well asa promising food, due to its chemical compositions (DA SILVA, 2017). The compositions vary between the different types of chia seeds, based on the growing place (Ayerza, 2011). In general, chia seed is a rich source of multiple minerals, including phosphorus, calcium, magnesium and potassium. Additionally, it contains several vitamins such as riboflavin, niacin, thiamine, folic acid, vitamin A and ascorbic acid (Mohd, 2012; Ixtainaa, 2008). The total calories obtained from 100 grams of chia seed ranges from 459 to 495 kcal. The current review aims to present the nutritional properties of chia seeds, as well as the therapeutic applications.

Nutritional properties of chia seeds

Antioxidants

Oxidation is a vital process, in the human body, for the production of energy. Transferring electrons encourages the generation of free reactive oxygen such as hydroxyl, hydrogen peroxide, and peroxide radicals. It is well known that free radicals are responsible for the incidence of multiple diseases, including several types of cancers, heart disease, Parkinson's diseases, ageing, inflammations, strokes, neurological diseases, immunodeficiency and type 2 diabetes (Hou,2003; LAWSON, 2017; WOJTUNIK, 2016). Several types of antioxidants were detected in chia seeds, such as sterols (approx. 50% β-sitosterol), tocopherols and polyphenolic compounds, including p-coumaric acids, gallic and protocatechuic acid, chlorogenic acid, and caffeic acid. In addition, this includes quercetin, apigenin, epicatechin, rutin and kaempferol (Evelyn, 2018; Jin, 2012; Reyes, 2008).Chia seeds also contain vitamin E, which ranges from 238 to 427 mg/kg.

Dietary fiber

Dietary fiber is an essential element of daily diet. Adults should daily consume between 25 and 30 grams of dietary fiber to avoid several diseases and to keep healthy. The best ratio of insoluble and soluble dietary fiber is 3:1(46). Chia seeds contain between 32 and 34 grams of fiber per 100 grams, which corresponds to 138% of the fiber RDA (Reyes, 2008).

Insoluble fiber constitutes approximately 85%, and soluble-fiber constitutes around 15%, of the ratio between insoluble and soluble dietary fiber (REYES, 2008). The amount of fiber that is available in chia seeds varies according to the different types of chia seeds, due to several reasons, including the climate and region of seed cultivation (REYES, 2008). Chia seeds also contain double the amount of fiber that exists in bran, and approximately 4-5 times more than the fiber content of quinoa (5). This high contact may be responsible for preventing many diseases, such as cancers, type 2 debates, hypertension, and kidney stones (ESPADA, NIEMAN, 2009; DA SILVA, 2015).

Vitamins and minerals

Vitamins and minerals are important for health and body functioning. An adequate intake of these elements is essential for normal growth, for controlling the typical amount of hormones, and preventing human cells from oxidative stress (MARCINEK, 2017). Chia seeds are considered to be a rich source of many types of vitamins, including riboflavin (0.17 mg/100 g), thiamine (0.59 mg/100 g), folic acid (50 mg/100 g), and niacin (890 mg/100 g) (DA SILVA, 2017). It also contains a high level of calcium—6 times more than caw milk—while phosphorus is11 times higher and potassium is 4 times higher, as compared to caw milk (DA SILVA, 2019; LOAIZA, 2016). Other minerals were also founded in chia seeds, such as magnesium, iron, zinc and selenium (Llorent, 2013).

Lipids

Each 100 grams of chia seeds contain 30 grams of fat, in which 3 gramsare saturated fats, 2 grams are monounsaturated fats, 24 gramsarepolyunsaturated fats, 18 is grams are Omega-3 and 6 grams are Omega-6(CIFTCI, 2012). It is also a rich source of many fatty acids, such as Palmitic acid, Stearic acid, Oleic acid, ω-6 α-linolenic acid and ω-3 α-linolenic acid (LOAIZA, 2016). As seen above, most of the fat available in chia seeds were in the form of polyunsaturated fatty acids, which are responsible for reducing the risk of several diseases (ULLAH, 2016). Previous studies revealed that not only the availability of omega 3 and omega 6 is important for therapy, but also their ratio to each other, which is more important (Simopoulos, 2008; Kolanowski, 2007). Serious health issues can occuras a result ofthe consumption a high quantity of omega 6 and a lower intake of omega 3 (NIEMAN, 2009). In chia seeds, the ratio between them was between 0.32 and 0.35, which is considered balanced and similar to the recommendations (Ciftci, 2012; Sargi, 2013). Such a high amount of omega 3 in chia seeds can lead to a decrease inthe share of ω-6 acids in daily food rations (Sargi,2013).In general, unsaturated fatty acids in chia seeds play a crucial role in preventing a variety of diseases (DA SILVA , 2016; NIEMAN,2009).

Therapeutic applications of chia seeds

Anti-hypercholesterolemia and anti-Hyperlipidemia

In animal studies, chia seeds were effective in decreasing dyslipidemia and the visceral adiposity of rats (Ayerza, 2005; Chicco, 2009). Foods that contain chia seeds showed a significant reduction in triacylglycerol levels, while linolenic acids and HDL cholesterol were increased after the intervention in rat serum. It was also effective in reducing the oxidative stress of obese rats (Ayerza, 2002). Furthermore, stearoyl-CoA desaturase-1 products were depleted in the heart, liver and the adipose tissue of chia seed-supplemented rats (Poudyal, 2012). In other studies, the consumption of chia seeds by the rats fed with the sucrose-rich diet inhibited the incidence of insulin resistance and dyslipidemia, as well as decreasing the visceral adiposity (Chicco, 2009). The lipolysis, hypertrophy and the anti-lipolytic action of insulin were reduced in the high sucrose rats that were fed with chia seeds (Oliva, 2013, Coates, 2009). It is interesting that there was a significant increase in polyunsaturated fatty acids from them eat fats of pigs, which were fed with chia seeds (Coates, 2009). Other studies on sucrose-induced diabetic rats showed a decrease in the visceral adiposity and insulin resistance of rats fed with chia seeds, which suggests that it plays a role against lipids and glucose homeostasis (Chicco, 2009, MarineliRda, 2015). Additionally, diets containing chia seed showed an improvement in fatty acid oxidase, liver TAG, dyslipidemia, glucose-6-phosphate dehydrogenase and acetyl-coA carboxylase (Rossi, 2013).There was a noticeable decrease in low-density lipoprotein cholesterol and avery low-density of lipoprotein triacylglycerides, whereas the high-density lipoprotein cholesterol was higher than the control group (DA SILVA, 2009).However, adults consumed 12 grams of chia seeds per day for 12 weeks and did not show any change in lipoproteins or oxidative stress (NIEMAN,2009).

Anti-cancer property

Nutrition plays a crucial role in the inducement and progression of cancers (Bidgoli, 2010). Dietary polyunsaturated fatty acids were effective in reducing

the risk of several forms of cancer (Thiebaut, 2009). Multiple studies showed that polyunsaturated fatty acids have cytotoxic abilities against several types of cancers and can support the work of chemotherapeutic drugs (Shaikh, 2010).

It is well known that Arachidonic acid (20:4, n-6), obtained from ALA, encourages the apoptosis of tumor cells. This is a result of converting sphingomyelin to ceramide, which encourages the pro-apoptotic proteins to be released (Hyde, 2009).A study conducted in animals demonstrated that the group that consumed chia seeds showed a reduction in the metastasis number and tumor weight (15).Another study revealed that feeding rats with chia seeds was effective in reducing the volume, weight and metastasis number (VARA, 2017). Previous reviews revealed that chia seeds can be used against cancer cells, due its high content of α-linolenic and linoleic/oleic (18). A review demonstrated its role as an assistant factor preventing cancer cells from growing (GAZEM, 2016; ULLAH, 2016).

Anti-diabetic activity

There are several studies in the literature that demonstrate the benefits of using chia seeds to modify the glucose level in experimental animals (Creus, 2016). In a six-month study on rats that consumed 37g/d of chia seeds per day proved that it was effective in normalizing insulin resistance(Chicco,2009).A recent study on chia seeds compared the effect of black and white chia seeds on the of glucose level of diabetic rats.

The results showed that both chia seed types improved the blood glucose level, butt here were no significant differences between the white and black chia seeds in terms of their impact on the glucose level of rats (ALAMRI,2019).There was noticeable decrease in the glucose concentration of rats fed with chia seeds for two-weeks (SILVA,2016). A study on humans showed that the glucose level reduced after six-months of treatment, with chia seeds, in patients with type 2 diabetes (VUKSAN, 2017).The treatment of diabetic rats with chia seeds for 6 or 12 weeks was effective in improving glucose and insulin tolerance (SILVA, 2015).Insulin-resistant rats showed a reduction in blood glucose levels after feeding them black chia seeds for three-months (Agustina, 2016). Furthermore, white chia seed consumption for 6 and 12 weeks modified blood glucose levels (Rafaela, 2015). Chia seeds can be incorporated into bread in order to improve human blood glucose levels (Ho,2013).This can be attributed to the compositions of chia seeds, such their high content of dietary fibers(Mohd,2012). However, three-weeks of chia treatment did not result in a change in the glycaemia of rats (Chicco,2012).

Anti-obesity property

A double-blind, randomized, and controlled trial of 77 overweight or obese patients demonstrated a remarkable reduction in waist circumference and lost weight after six-months of consuming chia seeds (36 g/1000 kcal/day) (VUKSAN,2017). Oliva *et al.* indicated that body weight did not change significantly after three-months of white chia seed intake, whereas body weight was slightly lower than initiated weight, but this was not significantly different from the control group (Oliva, 2017).

However, another study showed that the consumption of 50 grams per day of chia seedshad no influence on the body mass index of overweight and obese adults (NIEMAN, 2009). A study on animals revealed that the treatment of obese rates by chia seeds or oil for 6 or 12 weeks did not improve the weight of rats or abdominal fat accumulation (SILVA,2015). Recently, using both white and black chia seeds to feed rats showed no favorable changes after 6 weeks of treatment (ALAMRI, 2019). Several previous studies, with different durations, showed similar results in terms of their being no change in weight (Rafaela, 2015; Silva, 2016; Ayerza, 2007; Oliva, 2013; Silva, 2016). It is interesting that one year of chia seed consumption resulted in an increase in body weight (Evelyn, 2018). In addition, a shorter duration of chia seed intake (3 months) resulted in unfavorably elevated body weight (Agustina, 2016).

Conclusion

Chia seed is considered to be one of the functional foods that contain important components for human health, such as antioxidants and dietary fiber. It is also effective in reducing the risk of several diseases such as cancer and diabetes.

It can be used as an Anti-hypercholesterolemia and anti-hyperlipidemia food, which decreases the severity of cardiovascular diseases. The effect of chia seeds on obesity showed mixed results. Most studies were conducted on animals and this limits the understanding of its impact on human health. Therefore, more research is required on humans to investigate its role in preventing diseases.

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