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SYSTEMATIC EVALUATION OF THE IMPACT OF CHIA SEEDS ON WEIGHT LOSS

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Abstract
This review aims to assess the weight loss effects of chia seeds. Previous studies have documented contradictory findings on chia seeds and their impact on weight loss, hence necessitating a review to clarify this. The primary objective of this study is to evaluate the influence of chia seed consumption on weight loss in individuals participating in Randomised Control Trials. A systematic search was conducted in ClinicalKey, Cochrane, PubMed, Google Scholar, and Hinari. RCTs that investigated the impact of chia seed consumption on weight loss were included in this study, and data on study design, blinding, participant characteristics, chia seed interventions, and placebos were extracted and analysed. Seven studies were analysed. Four documented significant weight loss in the chia seed group when combined with a hypocaloric diet, while two studies indicated minimal weight loss when chia seeds were consumed alongside a normal diet, and one study reported no weight loss among participants on a normal diet and chia seeds supplementation. These findings suggest that chia seed consumption when combined with a hypocaloric diet, can lead to significant weight loss. However, further research with longer intervention periods is necessary to establish the efficacy and optimal dosages of chia seed supplementation for effective weight management. This review, therefore, notes the importance of dietary context in realising the potential benefits of chia seeds in weight loss and highlights the need for more clinical trials in this area.

Key terms: chia, chia seeds, *Salba-chia, Salvia hispanica L., Salvia hispanica* and weight.

1.0 INTRODUCTION

The prevalence of overweight obesity continues to rise worldwide despite numerous strategies having been employed for body weight reduction (Hruby & Hu, 2015). It has been documented as a global epidemic; thus, there is a need to strengthen and implement a successful long-term strategy to address this unmet clinical goal. Dietary management with adequate adherence to individual nutrient intakes such as fibre, Calories, protein and omega-3 fatty acids has been on the front line in the management of weight loss (Bravata et al., 2003; Buckley & Howe, 2010; Johnston et al., 2014).

With increasing public health awareness worldwide, the demand for functional food with multiple health benefits has increased, with chia seeds being one of them. Chia seed is a whole grain, scientifically known as *Salvia hispanica L.*, originally from Mexico, Colombia and Guatemala and has been consumed as a source of whole grain for over 5000 years (Melo et al., 2019). The acceptance and documentation of chia seeds as a novel food by the European Parliament in 2013 has made the seed widely available even in developing countries (EU, 2020). Its popularity has enabled consumers to view it as a functional food, thereby consuming it in different forms, which include mixing with beverages, a component of baking food items, cereal bars, supplementation flour, fortifying agent for bread spreads, chocolate, fruit desserts, dairy products, edible ices, fruit and vegetable products, breakfast cereals and non-alcoholic beverages. (Teoh et al., 2018). Further to the acceptance of chia seeds as a novel food, a study by (Turck et al., 2019) documented that the use of chia seeds is safe since it has no toxicity apart from allergen; thus, there is no basis for upper limit intake levels for the chia seeds. Therefore, the objective of this review was to gather and critically appraise all available clinical evidence on the weight loss effects of chia seed and provide comprehensive knowledge on the effectiveness of chia seed (Salvia hispanica L) effectiveness in promoting weight loss.

2.0 LITERATURE REVIEW

The chia seeds' nutritional and health benefits have greatly contributed to its popularity as well (Ixtaina et al., 2008; Juangco et al., 2022; Melo et al., 2019; Peiretti & Gai, 2009; Teoh et al., 2018). Various studies have shown that chia seeds are rich in dietary fiber, polyunsaturated fatty acids, proteins, vitamins and minerals; the dietary fiber is approximately 30–34 per cent, of which the insoluble fiber accounts for approximately 85–93 per cent, while soluble dietary fibre accounts for approximately 7–15 per cent (Reyes-Caudillo et al., 2008), the polyunsaturated fatty acids is documented to be 20 – 34 per cent with α-linolenic acid and linoleic acid at 60 per cent and 20 per cent respectively (Ayerza (h), 1995; Melo et al., 2019; Nitrayová et al., 2014; Peiretti & Gai, 2009). The protein, which mostly contains prolamins, range from 16-26 per cent of their mass (Grancieri et al., 2019), and the Vitamins and minerals, including Vitamin B complex, potassium and phosphorous, are in high amounts (Ixtaina et al., 2008; Kulczyński et al., 2019b; Melo et al., 2019).

The notable dietary fibre in chia seeds with both soluble and insoluble fractions has been associated with increased satiety, reduced energy intake, and weight loss (Lattimer & Haub, 2010; Tucker & Thomas, 2009). Fiber's ability to delay gastric emptying and modulate hunger hormones can contribute to reduced calorie consumption, making chia seeds a potential tool for weight management (Reyes-Caudillo et al., 2008). In addition, the high content of alpha-linolenic acid (ALA), a plant-based omega-3 fatty acid present in chia seeds, has been linked to improved metabolic health and potential effects on body composition, thus

influencing adipose tissue and lipid metabolism, hence offering a basis for chia seeds' role in weight management (Ayaz et al., 2017; Buckley & Howe, 2010).

The protein present in chia seeds and, more so, prolamins are known to promote thermogenesis and increase feelings of fullness, thus potentially contributing to weight loss (Grancieri et al., 2019). This, therefore, renders the combination of fiber and protein in chia seeds a basis to enhance chia seeds' effectiveness in weight loss. However, randomised controlled trials (RCTs) have investigated the impact of chia seed consumption on weight loss and have reported mixed findings, with some indicating significant weight loss when chia seeds were combined with a hypocaloric diet, while others showed minimal effects on weight when consumed with a normal diet (Quaresma et al., 2023a; Toscano et al., 2015).

3.0 METHODS

This systematic review was conducted on the following databases and search engines: PubMed, Embase, Cochrane, Scopus, Web of Science, Clinical Key, Agora and Google Scholar. In search of articles, the following inclusion criteria were considered: Study Design: Randomised controlled trials (RCTs) that investigated the effects of chia seeds on human weight management; outcome Measures: Studies that reported weight-related outcomes on changes in body weight, body mass index (BMI), body composition (e.g., fat mass, lean mass), waist circumference and also studies with secondary outcomes, such as appetite, satiety, or metabolic parameters (e.g., blood lipids, glucose levels) and finally Language; articles must have been written in English and published in peer-reviewed journals. With this inclusion criteria, the initial search was done using keywords: Chia, Chia seeds, Salba-chia, *Salvia hispanica* L., *Salvia hispanica* and weight. The search was done between January 10th 2023, and May 31st 2023.

The second stage of the search was done by searching the words chia, *Salvia hispanica* L., *and Salvia hispanica* in the title of the articles. The third stage was to retrieve full articles written in English. The fourth stage was to screen the articles to exclude review articles. The fifth stage included excluding articles not focusing on weight management. The sixth stage was to remove articles done on other animals apart from human participants, and the final stage was to exclude articles not using a randomised control study design. The remaining articles were analysed, and information on the study design, characteristics of participants, blinding of participants, the quantity of chia seed consumed, placebo used, duration of chia seed consumption and chia seed intervention outcome of each study were extracted and documented as shown in the Table below. As a result of the search, 7 articles were analysed in this review.

4.0 RESULTS AND DISCUSSION

The search yielded a total of 1110 articles: 1100 were identified from electronic databases, and 10 were obtained by manual tracking from the bibliography. In the first stage of screening, a total of 250 duplicate articles were identified and removed. In the second stage, 60 articles were removed since they were not written in English. The third stage of screening eliminated review articles, which were 219 in total. Further screening was done to remove articles which did not assess weight parameters as an outcome, and this resulted in the elimination of a further 556 articles. Of the remaining articles, 10 studies were on animals, and 8 studies did not adopt a randomised control trial as the study design, resulting in their removal. Finally, a total of 7 articles met all the inclusion criteria and thus were reviewed to give the findings.

All the reviewed studies were conducted among overweight and obese adults. The total number of participants included in each study was relatively small, ranging from 29 participants to 90 participants. The age of the participants in the included research ranged between 21 and 75 years. In two studies, the participants were living with diabetes (Brissette et al., 2013; Vuksan et al., 2017), while the other five study participants had no known condition. The form of chia seed used in the intervention group was whole chia seed in 4 studies (Alwosais et al., 2021; Brissette et al., 2013; Guevara-Cruz et al., 2012; Nieman et al., 2009) and chia seeds flour in 3 studies (Quaresma et al., 2023b; Toscano et al., 2015; Vuksan et al., 2017) incorporated into food or drink. Notably, six studies used a placebo; two studies used oats, two more studies used wheat and two others used soy. Only one study used dietary advice in the control group. The daily quantity of chia seed consumed ranged from 4 g to 50 g. The use of a hypocaloric diet was employed in four studies, whereas three studies recommended no dietary change during the study. Complete details of the characteristics of the 7 included studies are summarised in the Table below.

Table 1: Characteristics of the Studies Included in the Systematic Review

Title	Study article	Study design	Characteristics of participants	Quantity of chia seed consumed	Placebo used	Findings
The Effect of Salvia Hispanica L. Seeds on Weight Loss in Overweight and Obese Individuals with Type 2 Diabetes Mellitus	(Brissette et al., 2013)	24 weeks randomised double-blind, parallel study	58 Overweight/obese individuals with well-controlled T2DM.	Chia or placebo and followed a hypocaloric diet.	Energy-and-fibre-matched oat bran (OB)-	The Chia group lost more weight and reduced waist circumference p=0.039; p=0.027
Salba-chia (*Salvia hispanica* l.) in the treatment of overweight and obese patients with type 2 diabetes: a	(Vuksan et al., 2017)	6 months double-blind, randomised controlled trial	77 participants aged 35-75 years with T2DM of ≥1 year duration, BMI 25-40kg/m2, stable body weight with	A calorie-restricted diet with 500kcal reduced. 39.8g/day of ground Salba-chia	A mixture of 25.7g oat bran, 7.1g inulin fiber, and 3.2g maltodextrin matching for total	Significant weight loss and reduction in waist circumference in the Chia group p= 0.02; p=

double-blind, randomised controlled trial			<10% reported change over the previous 3-months 58 completed the study	Or 48.7g/day of an oat bran	dietary fiber 92 (≈10.5g) and energy content (≈115kcal) per day	0.027 respectively
A dietary pattern including nopal, chia seed, soy protein, and oat reduces serum triglycerides and glucose intolerance in patients with metabolic syndrome	(Guevara-Cruz et al., 2012)	2 months Randomised, placebo-controlled, double-blind, parallel-arm study	90 Mexican mestizos, aged 20–60 years, BMI >25 and <39.9 kg/m^2 67 participants completed the study.	Dietary pattern with 4 g of chia seeds and a hypocaloric diet	30g of calcium caseinate, 30 g of maltodextrin, 0.02 g sweetener and 1 g flavoring	There was a greater decrease in Waist Circumference, Body Mass Index, and Body Weight from baseline to end of the study ($P<0.0001$) in the chia-consumed group
Chia induces clinically discrete weight loss and improves lipid profile only in altered previous values	(Toscano et al., 2015)	12 weeks randomised, double-blind placebo-controlled experimental study	29 Adults aged 35 - 65 years, BMI between 25 and 35 kg / m^2 26 completed the study	35g of chia flour/per day with the usual food intake	wheat bran	Body weight and Waist circumference significantly decreased in the Chia group: $p<0.05$; $p<0.05$ for both
Chia seed	(Alwosais	3 months	46 participants	dietary advice	Dietary	There was no

(Salvia hispanica L.) supplementation to the diet of adults with type 2 diabetes improved systolic blood pressure: A randomised controlled trial	et al., 2021)	randomised- control study	aged 21 - 65 years with a body mass index(BMI) <40kg/m^2 42 completed the study	of daily 40g Chia seeds supplementation with a normal diet	advice only without a placebo	significant change in body weight and BMI at the end of 3 months for both the chia group and the control group: p= 0.053; p= 0.062 respectively
Chia Flour (Salvia hispanica L.) Intake Does Not Affect Weight Loss and Lipid Profile but Improve Systolic Blood Pressure Control in Obesity	(Quaresma et al., 2023b)	90 days randomised controlled parallel study	29 adult women with obesity 20 completed the study	30g 0f chia flour or placebo with a hypocaloric diet	The placebo used was wheat germ, wheat bran and sunflower oil with similar chemical compositions when compared to chia flour but without ALA	During the intervention, both groups decreased body weight, BMI and WC. No significant difference between groups regarding body weight, BMI and WC before and after intervention
Chia seed does not promote	(Nieman et al., 2009)	12 weeks Randomised single-	90 healthy adults without known disease,	Consumed 50g of chia whole	the placebo contained concentrate	No change in Body mass/weight

weight loss or alter disease risk factors in overweight adults		blind	with a body mass index of 25 kg/m2 and higher 76 completed the study	seeds/day or placebo with a normal diet	d soy, sunflower, oil, carrot fiber, and tapioca starch and was formulated to have similar amounts of protein, carbohydrate and fat.	for both men and women after chia seeds consumption : p= 0.112; p= 0.862 respectively

Discussion

The present review aimed to assess the potential impact of chia seeds on weight loss based on the findings from several studies. The results from the reviewed articles provide valuable information into the effects of chia seed supplementation on weight management.

The findings from the studies included in this review, five of the studies reported positive effects of chia seed consumption on weight loss and waist circumference reduction. To note, Brissette et al. (2013) conducted a 24-week randomised double-blind parallel study on overweight and obese individuals with type 2 diabetes mellitus. The study found that the group supplemented with chia seeds and a hypocaloric diet experienced greater weight loss and reduced waist circumference compared to the placebo group, both of which are important indicators of improved weight management. This study was in line with studies by Guevara-Cruz et al. (2012), Vuksan et al., 2017 and Quaresma et al. (2023) who also documented significant weight loss in the chia group with a combination of a hypocaloric diet. Vuksan et al. (2017) also conducted a 6-month double-blind randomised controlled trial on overweight and obese patients with type 2 diabetes. The study reported significant weight loss in the group that consumed ground Salba-chia as part of a calorie-restricted diet. Therefore, this finding further supports the potential of chia seeds in weight loss interventions for individuals with type 2 diabetes.

Guevara-Cruz et al. 2012 conducted a 2-month randomised, placebo-controlled, double-blind parallel-arm study on patients with metabolic syndrome. The study found that a dietary pattern including 4g of chia seeds, along with a hypocaloric diet, resulted in a significant decrease in body weight, body mass index (BMI), and waist circumference. This suggests that chia seeds may play a role in improving body composition in individuals with metabolic syndrome. However, this reduction in body weight in these studies is questionable if it was a result of reduced calorie consumption or chia seed intervention. The authors in the studies argue that since chia seeds are also rich in energy 486kcal/100g, carbohydrates

42.1g/100g, protein 16.5g/100g and lipids 30.7g/100g (Kulczyński et al., 2019a), then there is need to reduce calorie intake of a normal diet to counteract the effect of chia seeds induced calories as this extra calories may result to weight gain or no significant difference in weight loss.

Not all studies consistently reported significant weight loss effects. Alwosais et al. (2021) conducted a 3-month randomized control study on adults with type 2 diabetes with the experiment group consuming chia seeds without a change of diet. While there was no significant change in body weight and BMI in both the chia seed and control groups, a slight reduction of 1.23 kg was observed in the chia group, which is encouraging for a 40g/day of chia seeds. A significant weight loss may have occurred in the experiment group if the calorie intake of the participants would have taken into consideration the calories provided by the chia seeds, thus adjusting participants dietary calorie intake. Chia seeds being rich in calories, carbohydrates, protein and lipids, consuming 40g/day provides 194.4kcal/day. Intake of 194.4kcal/day as extra calories would result to an increase of 17,496kcal in 3 months thus weight gain. Nevertheless, the study reported weight loss of 1.23kg instead of a weight gain. This could be attributed to reduced normal diet intake as a result of satiety related effects induced by the chia seeds. Chia seeds are documented to have a satiety impact due to high content of insoluble fibre (Ayaz et al., 2017; Vuksan et al., 2017). These results suggest that chia seed consumption can be a promising dietary strategy in the prevention and management of overweight and obesity status in individuals should it be recommended with a hypocaloric diet.

In addition to Alwosais et al. (2021) study, a study by Nieman et al. (2009), also documented that chia seeds do not promote weight loss. In this study, participants were asked to follow a normal diet and was carried out for 12 weeks unlike in the other studies which were carried out for longer periods of 24 weeks. The varied results could be ascribed to differences in study designs, placebo used and study durations among the reviewed articles. Selecting the best suitable placebo for chia seeds is challenging since the placebo might produce positive effects on the outcomes that lessen the true differences between experimental and placebo treatments. This is evidenced by a study carried out by Quaresma et al. (2023) who observed a decrease in weight, body mass index and waist circumference in both the chia group and control group but no difference between the experiment and control group. The placebo used was a mixture of wheat germ, wheat bran and sunflower oil with similar chemical compositions when compared to chia flour. These placebo are as well associated with weight loss, and therefore, in the future studies, a placebo with inactive gradients in weight management should be used.

Notably, the common ingredient related to weight loss that is present in both chia seeds and placebo used is the dietary fiber. Dietary fiber is well known in promoting weight loss (Estruch et al., 2009; Lattimer & Haub, 2010) by delaying gastric emptying and increasing secretion of intestinal hormones which promote satiety thus decreasing caloric intake hence promoting weight loss (Anderson et al., 2009; Tucker & Thomas, 2009). The high dietary fiber present in the chia seeds could be attributed to the weight loss since the placebo used contains fiber as well, but still, there was a notable difference in weight loss between the chia group and control group except in one study.

5.0 CONCLUSION AND RECOMMENDATION

Conclusion: This systematic review provides significant information for healthcare providers and the public to understand the current evidence regarding weight loss and the consumption of chia seeds. The review

concludes that the consumption of chia seeds in combination with a hypocaloric diet will result in significant weight loss. Consumption of chia seeds with no reduction of calorie intake can only result in insignificant or no change in weight loss. Therefore, chia seed consumption with the intention of weight loss will work best with the incorporation of calorie intake dietary modification.

Recommendation: More extensive and standardised research with longer intervention periods is needed to establish the efficacy and optimal dosages of chia seed supplementation for weight management. In addition, future studies could consider chia seed consumption and physical exercise without dietary modification as a strategy on its own.

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