



Review Article



Therapeutic Effect of Fennel Seeds in the Management of Obesity

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ABSTRACT

Obesity is characterized by complex disorder associated with the accumulation of abnormal and huge amount of fat inside the body. Diabetes, metabolic problems and cardiovascular illnesses are only a few of the serious health hazards associated with obesity, a complex and multifaceted condition. Traditional treatments, especially those derived from herbal therapy, have drawn attention as supplemental approaches to obesity management. As popular herb in cooking and medicine, fennel seeds (*Foeniculum vulgare*) have been shown to have probable health advantages, including helping people to lose weight. It is thought that fennel seeds' active ingredients, which include flavonoids, fiber, and essential oils, work in a variety of ways to prevent obesity. These include lipid metabolism changes, improved digestion, and appetite control. Fennel seeds may assist people lose weight by increasing feelings of fullness, enhancing fat burning, and controlling blood sugar and cholesterol levels. Furthermore, fennel's antioxidant and anti-inflammatory qualities might provide metabolic health even more. Regardless of encouraging initial data, additional clinical studies are required to completely clarify the mechanisms and prove the effectiveness of fennel seeds in the treatment of obesity. This review examined the use of fennel seeds in the treatment of obesity, emphasizing both its traditional medical use and scientific foundation.

INTRODUCTION

Being overweight is the fifth leading cause of mortality globally, and obesity and its related diseases have grown to be important health issues. A WHO report states that obesity is defined as "harmful or huge extent of fat deposition that may hinder with health," and that a calorie imbalance between caloric intake and expenditure is the main cause of overweight and obesity [1]. In addition to being a chronic medical problem, obesity can cause new conditions and exacerbate pre-existing ones. Çakmur H. claim that obesity can harm nearly all organ systems, including the cardiovascular, endocrine, central neurological, and gastrointestinal systems. Additionally, obesity is associated with an increased risk of heart attacks and other cardiovascular conditions such atrial fibrillation, coronary heart disease, and high blood

pressure. Significant obesity clusters have been seen in particular geographic locations due to certain lifestyle and genetic characteristics that raise an individual's risk of adult obesity. The following scenarios also highlight the influence of socioeconomic and environmental factors in "obesogenic" settings [2]. There are also a number of variables to obesity. According to earlier studies, lists a few of the significant variables that affect adult overweight or obesity. As an example Zhang X *et al.*, carried out a study demonstrating that: (a) people with poor health are more likely to be lean; (b) irregular eaters, and those with low living standards are more likely to be overweight; and (c) middle age people, People who are depressed and anxious, or who don't feel satisfied with their lives, a Individuals with low annual household incomes frequently exhibit obesity



[3]. Additionally, a number of studies have shown that exercise is either infrequent or nonexistent and personal educational attainment as determinants of obesity. Additional research has also revealed that a variety of chronic conditions may resemble obesity, particularly which many variables combine to create an imbalance in energy that causes the body to gain weight. Consequently, environmental, biological, and genetical. Obesity is determined by behavioral variables. As a result, differences in the frequency of obesity among different socioeconomic groups could be impacted by a variety of environmental and behavioural factors. In several research, obesity has also been linked to a person's level of education and their frequency of exercise [4]. Seeds (Fennel) and essential oils show promise for safe use as superfood additives and unrefined ingredients in pharmaceutical and culinary endeavors. Body weight increased as a result of the anise oil. Anise oil has been said to have a positive impacts food absorption, even while anise oil caused a decrease in the degree of LDL-c, fatty oil, and cholesterol levels. Despite being believed to be a native Mediterranean plant, fennel (*Foeniculum vulgare*) is now grown on arid soils by streams or by the sea in many regions of the world. Iran, Syria, Turkey, Egypt, and India are important fennel-producing countries. Flavonoids, glycosides, and other phytoconstituents are among its ingredients that are used to treat illnesses. Fennel phenolic intensifiers can rise to the human well-being. In addition to a few partners with particularly designed human body instruments, this plant has produced trans-anethole, estragole, fenchone, and bioactive mixtures of kaempferol, quercetin, and rosmarinic acid. The reason for fennel association with weight management is that its trypsin inhibitors reduce food intake, activate cholecystokinin release, and increase satiety. Weight decrease Fennel helps the pancreas and liver better digest carbohydrates and lipids. It also allows fat to be used as an energy source by breaking down fat deposits in the circulatory system. These opinions, together with its consistent diuretic effect and reputation is an excellent weight-loss tool because it suppresses hunger [5]. Obesity is now the world's fifth leading cause of death, and obesity and related illnesses have become important health concerns. Obesity is defined by the World Health Organization (WHO) as "an abnormal or excessive fat accumulation that may damage physical well-being," and the main cause of overweight and obesity is an energy imbalance between caloric intake and expenditure [6]. A WHO prediction states that by 2022, one in eight individuals globally would suffer from obesity. There were 2.5 billion persons over 18 who were deemed overweight in 2022. There were 890 million people who were obese. 43% of those over 18 were overweight in 2022, and 16% were obese. 37 million children under five were overweight in 2022. 160 million of the 390 million

overweight children and adolescents between the ages of 5 and 19 in 2022 were obese [7].

Obesity is a rapidly increasing global health concern strongly associated with metabolic, cardiovascular, and endocrine disorders, while current pharmacological interventions often carry side effects or limited long-term efficacy. Although fennel seeds have been traditionally used for weight management, scientific evidence regarding their precise anti-obesity mechanisms and clinical effectiveness remains fragmented and inconsistent. Existing literature largely consists of animal studies and small-scale human trials, with limited standardized dosing and outcome measures. Therefore, this review aims to critically evaluate the therapeutic potential of fennel seeds in obesity management by synthesizing available evidence on their effects on lipid metabolism, appetite regulation, and body weight reduction.

Family History: Your body's ability to regulate calories and energy is influenced by your genes. Children of overweight parents are likewise more prone to be overweight themselves. You cannot change your genetic makeup by willpower, any more than you can make yourself taller or shorter by want. You can still lose weight and keep it off, though, even if you have a family history of being overweight.

Culture: Our parents' usually follow cooking and eating habits, and the foods we choose are often ones we were introduced to as children. At social events like weddings, holiday parties, and family get-togethers, food is usually the main attraction.

Physical Inactivity: Lack of exercise may lead to being overweight. Most people spend a lot of time watching TV, playing video games, and doing other low-energy pastimes.

Emotional or Psychological Aspects: For many people, food can be a source of joy or comfort. Some people eat when they're anxious or unhappy. For weight management, you must learn better coping strategies for your emotions.

Gender: Because men have more lean muscle mass than women, women are more prone to be overweight. Males burn 10–20% more calories than women, and muscle utilizes more energy than fat when at rest.

High-Fat/High-Calorie Diets: Meals at restaurants tend to be heavy in calories and fat. When a lot of salad dressing is added, even items that seem healthy, like salads, can become heavy in fat. Compared to protein or carbohydrates, fat has over twice as many calories per ounce [8].

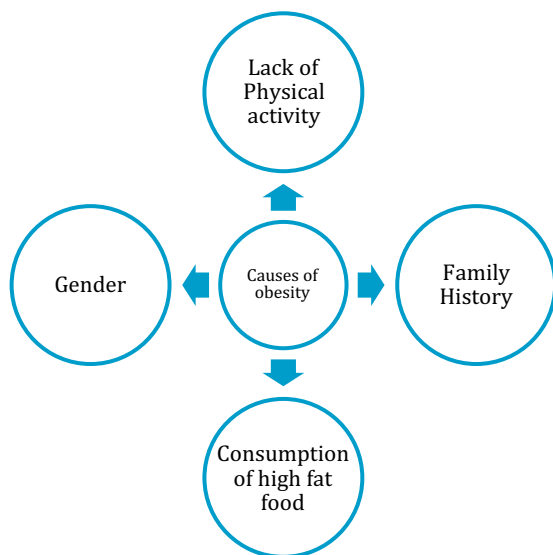


Figure 1: Causes of Obesity

Challenges

The two leading causes of death, heart disease and stroke, are among the cardiovascular diseases for which being overweight or obese is a major risk factor. Being overweight can also result in diabetes and its associated problems, including blindness, neuropathy, and the need for dialysis. Additionally linked to obesity include malignancies of the endometrium, breast, ovaries, liver, gallbladder, kidney, and colon. A person's chance of developing certain non-communicable diseases rises with their Body Mass Index (BMI), even if they are only slightly overweight. Numerous serious health problems and an increased risk of acquiring related diseases earlier than anticipated are associated with childhood obesity [9].

Pathophysiology of Obesity

Overweight and obesity are significant risk factors for cardiovascular diseases, which include the two main causes of death, heart disease and stroke. Furthermore, being overweight can cause diabetes and its associated problems, including blindness, neuropathy, and the need for dialysis. Obesity is also associated with endometrial, breast, ovarian, liver, gallbladder, kidney, and colon cancers. A person's chance of developing certain non-communicable diseases rises with their Body Mass Index (BMI), even if they are only slightly overweight. Numerous serious health problems and an increased risk of acquiring related diseases earlier than anticipated are associated with childhood obesity. These signals, whether anorexigenic or orexigenic, are transmitted to various brain regions, including the periventricular nucleus, which help

Table 1: Bioactive Components Present in Fennel Seeds

Bioactive Components	Categories	Health Benefits	References
Essential oils (estragole, anethole, and fenchone)	Volatile Oils	weight control, appetite control, anti-inflammatory, antibacterial, and anti-cancer properties. Anethole has been connected to fat metabolism and appetite reduction	[18]

regulate eating and physical activity. The interplay of these hormones, enteric neuronal communication, and efferent autonomic signaling via the vagus nerve influences nutritional signaling and distention, affecting processes like stomach emptying, gastric accommodation, and other digestive functions [10].

Fennel Seeds Phytochemistry

The leading causes of death, cardiovascular diseases, which include heart disease and stroke, are significantly increased by obesity and overweight. In addition, diabetes and its complications, such as blindness, neuropathy, and dialysis requirements, can be brought on by obesity. Additionally, linked to obesity include malignancies of the endometrium, breast, ovaries, liver, gallbladder, kidney, and colon. A person's chance of developing certain non-communicable diseases rises with their Body Mass Index (BMI), even if they are only slightly overweight. Numerous serious health problems and an increased risk of acquiring related diseases earlier than anticipated are associated with childhood obesity [12]. Fennel seeds composition every component of fennel is utilized, including the fruit, roots, seeds and leaves [13]. Fennel seeds are composed of 42.3% carbohydrates, 9.5% protein, 10% fat, 13.4% mineral, 18.5% fibre, and 6.3% water. The leaf contains sodium, calcium, potassium, phosphorus, iron, thiamine, riboflavin, niacin, and vitamin C [14]. The 10–12% oil in seeds is preserved by the cotyledons of the fruit. Fennel fruit oil is composed of roughly 6% petrocyclic acid, 22% oleic acid, 14% linoleic acid, and 4% palmitic acid. The fruit's essence content ranges from 4 to 6%, and the component combination is influenced by the plant's growing environment [15]. Fennel's fragrant qualities are derived from its essence. Between 50 and 80 percent trans-anethole and 5 percent limonene are the two most important terpene compounds found in fennel essential oil. Phenolic chemicals are also present in this plant [16].

Bioactive Components Present in Fennel Seeds

Chemicals called phytochemicals are made by plants. The methanolic extract of fennel seed contains a wide range of phytochemicals, including alkaloids, terpenoids, phenols, saponins, tannins, and glycosides. Gallic acid equivalent (GAE) was found to be the entire phenolic content of *F. vulgare* seed extracts in ethanol and water. Phenolic acids include 3-O-caffeoylquinic acid, 4-O-caffeoylquinic acid, 5-O-caffeoylquinic acid, 1-3-O-di-caffeoylquinic acid, 1-4-O-dicaffeoylquinic acid, and 1-5-O-di-caffeoylquinic acid respectively [17].

The flavonoids luteolin, quercetin, and rutin	Flavanoids	antioxidant that lowers oxidative stress, enhances lipid metabolism, and has anti-inflammatory and anti-cancer properties. Quercetin may help with metabolic control and weight loss	[19]
Saponins	Triterpenoid Saponins	antioxidant, anti-inflammatory, promotes thermogenesis, aids in fat metabolism, and may lessen the buildup of fat	[19]
Both soluble and insoluble fiber	Dietary Fiber	enhances digestion, encourages fullness, and aids in weight loss through blood sugar regulation and meal restriction	[20]
Caffeic acid and ferulic acid are examples of phenolic acids	Polyphenols	Antioxidant, anti-inflammatory, improves metabolic health, and aids in controlling fat buildup	[20]
Fatty Acids: Palmitic Acid, Linoleic Acid	Fatty acids	helps control weight, maintains appropriate cholesterol levels, controls adipogenesis, and modifies lipid metabolism	[21]

Obesity and overweight are major risk factors for cardiovascular illnesses, which include heart disease and stroke, the leading causes of mortality. Furthermore, being overweight can cause diabetes and its associated problems, including blindness, neuropathy, and the need for dialysis. Cancers of the endometrium, breast, ovary, liver, gallbladder, kidney, and colon are also linked to obesity. A person's chance of developing certain non-communicable diseases rises with their Body Mass Index (BMI), even if they are only slightly overweight. Numerous serious health problems and an increased risk of acquiring related diseases earlier than anticipated are associated with childhood obesity [20]. Furthermore, it works very well to treat diabetes, bronchitis, kidney stones, and chronic cough [21]. Fennel seeds are used in cream-based dishes. The plant's diuretic qualities make it useful for treating bladder and kidney issues. Additionally, it is utilized to reduce nausea and stop vomiting. The herbs can be used to treat both persistent fever and blockages in the urinary, respiratory, gastrointestinal, and hepatic systems. The respiratory, reproductive, endocrine, and digestive systems, as well as conditions affecting the eyes and stomach, are also treated with them. Moreover, it is used to treat nursing moms as a galactagogue drug [22].

Table 2: Pharmacological and Nutraceutical Properties of Fennel Seeds

Properties	Efficacy	References
Activity of Antioxidants	Antioxidant substances found in aqueous and ethanolic extracts of fennel seeds, including flavonoids and phenols	[23]
Anti-I Antiinflammatory Properties	Methanol extract offers protection against acute and subacute illnesses by inhibiting cyclooxygenase and lipoxygenase allergic reactions of type 4	[24]
Hepatoprotective Properties	Decreased levels of bilirubin, AST, ALP, and cytokines responsible for the formation of fibrosis	[25]
Anti-Cancer Properties	Examples of active ingredients include the presence of anethole, an inhibitory effect the activation of TNF factor hence served as anti-cancer	[26]
Activity that Protects the Stomach	Treatment for chronic colitis and gastrointestinal spasms, GI ulcers and acidity	[27]
Hormonal Action	Anatole and other compounds are known to improve milk supply, lessen infertility, ease menstrual discomfort, facilitate childbirth, and treat primary dysmenorrhea	[28]
Anti-Lipid Properties	Anti-lipid characteristics Hypolipidemic effects include decreased plasma TG, decreased total cholesterol, lowers LDL, decreased apolipoprotein B, increased HDL, and elevated apolipoprotein A-1 with anethole	[29]

Cardiovascular Activity	Reduced water excretion, sodium, potassium, fennel extract, and systolic blood pressure	[30]
Activity that Prevents Diabetes	The hypoglycemic effect raises muscle and liver glycogen storage, lowers blood sugar levels, and increases glutamine peroxide activity	[31]

Role of Fennel Seeds Against Obesity

Diabetic patients' blood glucose levels significantly decreased after two hours of fennel treatment, suggesting that it had effective short-term anti-diabetic effects. For patients receiving 100 mg per kg body weight, Prior to fennel treatment, the mean values were 313.5 ± 108.69, and after getting 50 mg per kg body weight, they were 279.33 ± 96.24. The mean blood glucose levels after two hours were 262 ± 88.69 for those taking 100 mg/kg body weight and 246.5 ± 91.93 for those taking 50 mg/kg body weight. Additionally, the control group's mean values were 272.16 ± 89.84 before and 330.5 ± 91.87 after two hours [32]. A new study assessed how well heated fennel therapy works to speed up the recovery of gastrointestinal function. Because the trypsin inhibitors in fennel seeds reduce food intake, increase cholecystokinin production, and enhance satiety, this prospective investigation masked 381 patients with pancreatic, stomach, fennel, and weight control issues. Fennel aids in weight loss by assisting the liver and pancreas in properly breaking down fats and carbs. By accelerating the breakdown of adipose tissue into blood, it facilitates the mobilization of fat for use as fuel for energy. Because of their high fiber content, fennel seeds assist

manage obesity by increasing satiety and reducing the hormone ghrelin, which increases appetite. It has been demonstrated that fennel seeds are an effective appetite suppressor [33].

The current evidence on fennel seeds is limited by a lack of large-scale, well-designed randomized controlled trials in human populations, along with variability in study designs, dosages, and extract preparations. Most findings are derived from experimental or short-term studies, which restricts generalizability and long-term safety conclusions. Future research should focus on standardized clinical trials with defined dosages, treatment durations, and uniform outcome measures to validate efficacy. Additionally, mechanistic studies are needed to better understand bioactive compounds and their role in metabolic regulation and sustained weight management.

CONCLUSIONS

In conclusion, fennel seeds show encouraging therapeutic promise in the management of obesity. Flavonoids, essential oils, and dietary fiber are just a few of the bioactive substances found in fennel that can help control hunger, promote fat metabolism, and enhance general metabolic health. Because of research showing that fennel seeds may help reduce body weight, fat accumulation, and associated risk factors including insulin resistance, they are a valuable supplement in the treatment of obesity. More thorough human clinical trials are necessary to confirm these effects, identify the ideal dosages, and guarantee long-term safety, even in cases where the results are encouraging.

Authors' Contribution

Conceptualization: BG

Methodology: SQA

Formal analysis: AL, AY

Writing and Drafting: UZ, AF, UAA, RM, SR, HMNS

Review and Editing: UZ, AF, UAA, RM, SR, HMNS

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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