A Systematic Review of the Herbal Medicinal Plants With Anti-Obesity Potential

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ABSTRACT:

Obesity is a chronic, multifactorial metabolic condition characterized by abnormal fat accumulation. It is mainly driven by the intricate influence of genetic, environmental, hormonal, metabolic and lifestyle determinants. The burden of obesity has risen considerably over the past few years, making it one of the major health concerns in both developed and developing countries alike. The rapid increase globally in obesity prevalence is linked with numerous health complications such as Type 2 diabetes mellitus, hypertension, and respiratory complications, creating a necessary and urgent need for the development of safer and more effective therapeutic strategies. Although several synthetic anti-obesity drugs are available, due to their adverse effects and insufficient patient adherence, their long-term use is limited. Owing to the adverse effects of synthetic anti-obesity drugs, herbal medicinal plants offer safer therapeutic alternatives.

The present review comprehensively examines the currently available scientific evidence on herbal medicinal plants that possess anti-obesity properties, including the part of the plant used and the extraction methods. The synthesised evidence demonstrates that numerous herbal medicinal plants possess anti-obesity activity through diverse mechanisms, including appetite regulation, inhibition of lipid absorption, stimulation of lipolysis and thermogenesis, modulation of adipogenesis, increased energy expenditure, and enhanced glucose and lipid metabolism. This review was conducted by searching bibliographic databases, including PubMed, Scopus, Google Scholar, and Medex, for studies.

Although various promising anti-obesity effects are reported for various herbal medicinal plants, their successful clinical utilization continues to be challenged by inadequate robust clinical data, lack of formulation standardization, variations in phytochemical composition, and regulatory concerns. Collectively, the reviewed findings support the potential of herbal medicinal plants to show complementary approaches in the treatment and management of obesity. However, further well-designed clinical trials and standardization of herbal formulations and detailed studies are required to incorporate evidence-based clinical practices.

KEYWORDS:

Obesity, Anti-obesity activity, BMI(Body mass index), Complications, Pathophysiology, Mechanism of action, Herbal medicinal plants, Discussion.

INTRODUCTION:

Obesity is defined as the abnormal or excessive accumulation of body fat, which can occur in individuals of any age. The most common factors that are responsible for obesity are endocrine disturbances, increased fat storage, genetic predisposition, and an unbalanced diet. Obesity has become one of the major contributors to various chronic disorders, which include asthma, type 2 diabetes, cardiovascular disorders, and others that affect human well-being. Owing to the alarming increase in its mortality and incidence, obesity is now viewed as one of the major and serious international health concerns, which has a death rate of approximately 2.8 million people annually. Body Mass Index (BMI) is used to estimate the relationship between body weight and height, since body fat is distributed throughout the body and cannot be measured directly in routine practice. In addition to BMI, various parameters are used for the evaluation of overweight and obesity conditions, such as skinfold thickness, waist circumference, waist-to-hip ratio, and body fat impedance analysis. (Kumar et al., 2022)

In case the BMI of a person lies in the overweight range, then they are more likely to develop various disorders such as type 2 diabetes mellitus, hypertension, cardiovascular diseases, and gallstones. The World Health Organisation (WHO) and the National Institutes of Health(NIH) are a few organizations which has established BMI- based classifications in order to categorise the status of body weight. There are two classes of obesity, namely class 1 obesity and class 2 obesity. In the case of class 1 obesity, the chances are moderate, whereas in the case of class 2 obesity, the chances are more severe, and in the case of extreme obesity, the risk of developing obesity-associated disorders and their quality of life will also be reduced extremely. By this, we can conclude that the severity of the complications of the above-mentioned disorders generally increases with higher obesity classes. (Kumar et al., 2022)

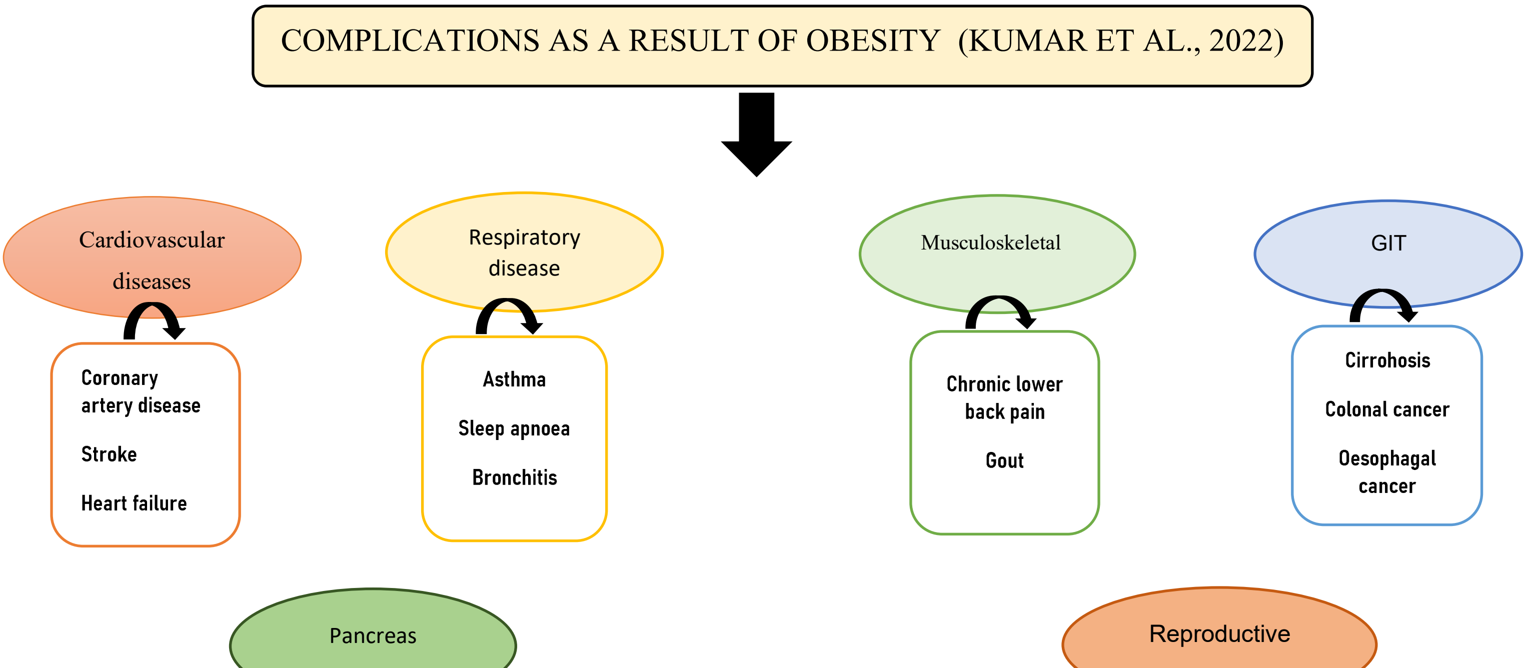
As per the BMI classification, the individuals who have a BMI below 18.5kg/m^2 are generally considered as underweight, a BMI between 18.5 and 24.9 kg/ m^2 is considered as a normal body weight, and a BMI ranging from 25- 29.9 kg/ m^2 is considered as overweight, while the values between 30-39.9 kg/ m^2 are classified as obesity. A BMI greater than 40kg/ m^2 is considered extremely obese. (Kumar et al., 2022)

Table 1: BMI Classification

BMI RANGE (Kg/ m^2)	WEIGHT CLASSIFICATION
Below 18.5	Underweight
18.5-24.9	Normal weight
25- 29.9	Overweight
30-39.9	Obese
Above 40	Extreme obesity

COMPLICATIONS AS A RESULT OF OBESITY:

1. Cardiovascular diseases
2. Respiratory diseases
3. Musculoskeletal diseases
4. Gastrointestinal disorders
5. Pancreatic disorders
6. Reproductive diseases



Obesity can cause severe complications, which include Cardiovascular diseases, Respiratory diseases, Gastrointestinal diseases, Genitourinary diseases, Reproductive (male and female) diseases, and pancreatic diseases, as shown in Figure 1.

Body fat mainly exists in two forms: subcutaneous fat and visceral fat. Subcutaneous fat is seen beneath the skin, and they are mostly located in the abdomen, arms, and thighs. In contrast to this, the visceral fat is deposited around the organs such as the pancreas, heart, liver, and kidneys. This type of fat plays an important role in metabolic syndrome, hormonal disturbances, and insulin resistance, and this type of fat is metabolically inactive. The body has two types of shapes, depending upon the different distribution patterns of fat, mainly pear-shaped obesity and apple-shaped obesity. Pear-shaped obesity is also known as gynoid obesity, and it is mainly deposited in the thighs and buttocks. Apple-shaped obesity is also known as android obesity, and it is mainly deposited in the neck, arms, waist, and shoulders. Gynoid obesity is mainly associated with a lower risk of obesity-related complications compared to Android obesity. (Kumar et al., 2022)

PATHOPHYSIOLOGY OF OBESITY:

The pathophysiology of obesity is a sophisticated process that involves the interaction of various factors, such as genetics, psychological factors, socioeconomic factors, hormonal factors, metabolic factors, environmental factors, and lifestyle factors. Genetic factors are the condition where some people will inherit a greater chance of gaining more weight from their families. Psychological factors, which include stress, depression, anxiety, etc. Socioeconomic factors such as urbanisation, less availability of food and water, low access to education, and poverty cause obesity. Hormonal factors that regulate fat storage, metabolism, and hormonal imbalance that in turn lead to obesity and cause various effects such as Leptin resistance, insulin resistance, decreased metabolism, reduction of growth hormone and testosterone secretions, and in turn makes harder to lose the fat in our body. Metabolic factors control the energy in our body by producing, using, storing, and burning fats. Some of the important metabolic factors are decreased fat oxidation, low thermogenesis, abnormal lipid metabolism, insulin resistance, and slow metabolic rate. Lifestyle habits play a vital role in the development of obesity. Some of the major and most important lifestyle factors are poor sleep habits, lack of sleep, when high calorie intake is more than the calorie expenditure. (Mane, 2012)

MECHANISM OF ACTION:

Step 01. Stimulation of the sympathetic nervous system

- Anti-obesity compounds lead to the stimulation of the sympathetic nervous system, which is responsible for increasing the utilization of fat and metabolism by the body, which, in simple words, means that these substances "Switch on" the body's fat-burning activity.

Step 02. Release of norepinephrine and epinephrine

- The body starts to release norepinephrine and epinephrine to travel to fat cells to start working.

Step 03. Activation of β- adrenergic receptors

- Norepinephrine binds to β-adrenergic receptors present in the adipose cells.

This leads to the activation of the G protein pathway

Step 04. Activation of adenylate cyclase(AC)

- Once the G protein is activated, it leads to
    - Stimulation of adenylate cyclase
    - Activation of the cyclic AMP pathway
    - Improved activity of Adenylate cyclase

Step 05. Formation of cAMP

Adenylated cyclase converts to cAMP

Step 06. Lipolysis begins

High levels of cAMP activate enzymes that break the triglycerides into fatty acids and glycerol; this process is called lipolysis.

Step 07. Fatty acids are released

The released fatty acids enter circulation and are used by tissues for energy production.

Step 08. Heat generation

Fatty acids produce heat, a higher metabolic rate, and increased calorie burning.

Step 09. Suppression of appetite

Step 10. Reduction of lipid absorption (Shaik Mohamed Sayed et al., 2023)

Table 2: List of some herbal medicinal plants used in the treatment of obesity

Sl. no	**Herbal plant name**	**Part used**	**Type of extract**	**Reference**
01.	*Actinidia polygama (Silver vine)*	Fruit	Ethanol extract	(Sung et al., 2013)
02.	*Camellia sinensis* (green tea)	Leaves	Aqueous extract	(Hasani-Ranjbar et al., 2013)
03.	*Garcinia cambogia (Malabar tamarind)*	Fruit rind	Hydroxycitric acid extract	(Hasani-Ranjbar et al., 2013)
04.	*Zingiber officinale* (Ginger)	Rhizome	Aqueous extract	(Hasani-Ranjbar et al., 2013)
05.	*Aloe vera* (Aloe)	Leaves	Gel extract	(Hasani-Ranjbar et al., 2013)
06.	*Withania somnifera* (Ashwagandha)	Roots	Hydro alcoholic extract	(M. Yadav et al., 2019)

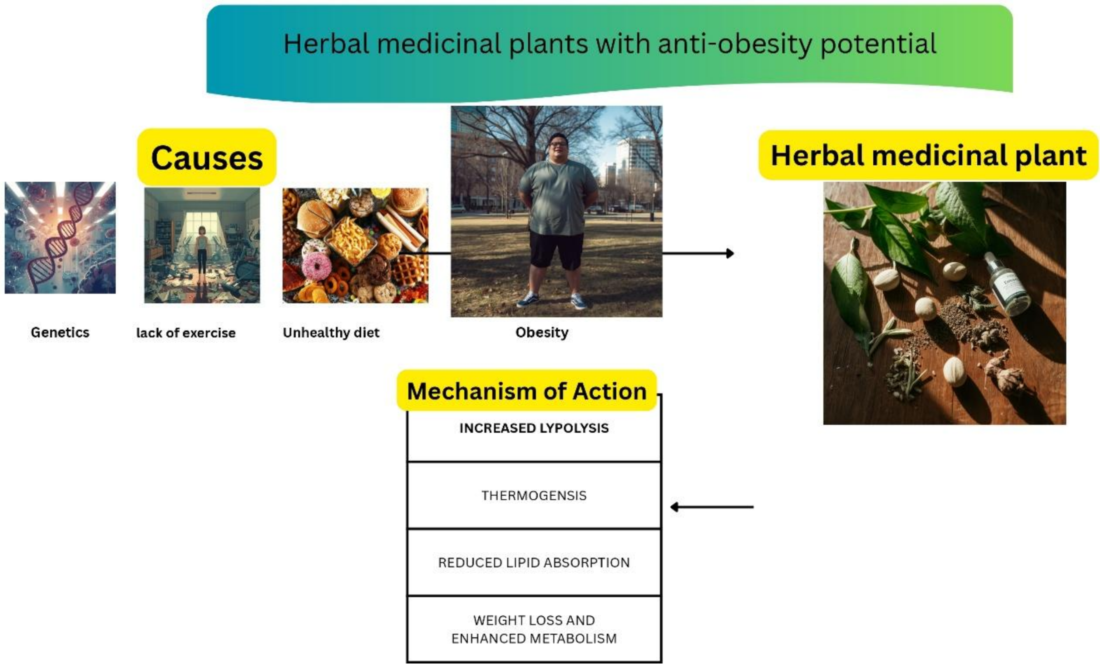
07.	*Berberis vulgaris* (Barberry)	Root, Bark	Berberine-rich extract	(Kong et al., 2024)
08.	*Salacia reticulate* (Salacia)	Root	Aqueous extract	(Charkravarty & Ramasamy, 2023)
09.	*Ocinum sanctum* (Holy Basil/Tulsi)	Leaves	Hydroalcoholic extract	(M. Yadav et al., 2019)
10.	*Fucus vesiculosus* (Bladderwrack)	Whole thallus	Ethanolic extract	(Hasani-Ranjbar et al., 2013)
11.	*Citrus aurantium* (Bitter orange)	Fruit peel	Synephrine-rich extract	(Kazemipoor et al., 2015)
12.	*Taraxacum officinale* (Dandelion)	Leaves	Hydroalcoholic extract	(M. Yadav et al., 2019)
13.	*Cassia nomame* (Nomame senna)	Aerial parts	Ethanolic extract	(Hasani-Ranjbar et al., 2013)
14.	*Caralluma fimbriata* (Carallum)	Stem	Hydroalcoholic extract	(Kazemipoor et al., 2015)
15.	*Terminalia chebula* (Haritaki)	Fruit	Ethanolic extract	(M. Yadav et al., 2019)

16.	*Lagerstroemia speciose* (Banaba)	Leaves	Corosolic acid extract	(Hasani-Ranjbar et al., 2013)
17.	*Panax japonicas* (Japanese ginseng)	Rhizome	Chikusetsusaponin extract	(Han et al., 2005)
18.	*Allium sativum Linn* (Garlic)	Bulb	Methanol extract	(Bhutani et al., 2007)
19.	*Curcuma longa* (Turmeric)	Rhizome	Ethanolic extract	(Jyotirmayee & Mahalik, 2022)
20.	*Trigonella foenum-graecum* (Fenugreek/ Methi)	Seeds	Methanolic extract	(U. C. S. Yadav & Baquer, 2014)
21.	*Punica granatum* (Pomegranate)	Leaves	Leaf extract	(T. K. Lim, 2013)
22.	*Hibiscus sabdariffa* (Rosella)	Calyx	Polyphenol-rich extract	(Herranz-López et al., 2017)
23.	*Gymnema sylvestre* (Gurmar)	Leaves	Aqueous extract	(Hasani-Ranjbar et al., 2013)

24.	*Capsicum annuum* (Chilli pepper)	Fruit	Crude extract	(Hasani-Ranjbar et al., 2013)
25.	*Zingiber officinale* (Ginger)	Rhizome	Aqueous extract	(Saad, 2023)
26.	*Adenophora triphylla* (Ladybell)	Root	Ethanolic extract	(M. Yadav et al., 2019)
27.	*Allium cepa Linn* (Onion)	Peel	Polyphenolic extract	(Chung et al., 2023)
28.	*Solanum lycopersicum L* (Tomato)	Fruit	Freeze-dried fruit extract/Tomato powder	(Tainaka et al., 2011)
29.	*Vaccinium vitis-idaea* (Lingonberry)	Fruit	Ethanolic extract	(Eid et al., 2014)
30.	*Nigella sativa* (Black seed)	Seeds	Ethanolic extract	(Tavakkoli et al., 2017)
31.	*Schisandra chinensis Baill* (Schisandra/ Five-Flavor Berry)	Peel	Ethanolic extract	(M. Yadav et al., 2019)

32.	*Ilex paraguariensis* (Yerba mate)	Leaves	Water extract/ Aqueous extract	(Kim et al., 2015) (Kang et al., 2012)
33.	*Rosmarinus officinalis L.* (Rosemary)	Leaves	Aqueous/water-soluble extract	(Labban et al., 2014)
34.	*Coffea Arabica* (Green coffee/Arabica coffee)	Geen coffee beans(seeds)	Chlorogenic acid-rich extract	(Lipids & Control, 2018) (Haidari et al., 2017)
35.	*Caralluma fimbriata* (Caralluma)	Whole plant	Standardized extract	(Arora et al., 2015) (Odendaal et al., 2013)
36.	*Cinnamomum cassia* (Cinnamon)	Bark	Aqueous extract	(Medagama, 2015)
37.	*Hoodia gordonii* (Hoodia)	Stem	Crude stem extract	(Roza et al., 2013) (Bonde & Pinjari, 2023) (Velusami et al., 2013) (Tsuruta et al., 2011)
38.	*Moringa oleifera* (Drumstick)	Seeds/ Leaves		(Meireles et al., 2020)

			Ethanolic/ Aqueous/Seed oil extract	(Kilany et al., 2020)
39.	*Camellia sinensis* (Oolong variety)	Leaves	Aqueous extract/Polyphenol-rich extract	(Wang et al., 2022) (Yuan et al., 2018)
40.	*Nelumbo nucifera* (Lotus)	Leaves/Petals/ Seeds/Rhizome	Aqueous extract/ Polyphenolic extract	(Tsuruta et al., 2011) (Velusami et al., 2013) (Wu et al., 2020) (He et al., 2022)
41.	Garnicia indica (Kokum)	Fruit rind	HCA-rich extract/ Garcinol extract	(Majeed et al., 2020) (S. H. Lim et al., 2021)
42.	Foeniculum vulgare (Fennel)	Seeds	Methanolic/Aqueous /Essential oil extract	(Noreen et al., 2023) (A. Elghazaly et al., 2019) (Wasim et al., 2024)



DISCUSSION:

The reviewed literature revealed that various herbal medicinal plants possess effective and significant anti-obesity potential through diverse mechanisms such as enhancing lipolysis, stimulation of heat, suppression of appetite, and inhibition of fat absorption. (Shaik Mohamed Sayed et al., 2023) .

Most of the herbs exhibit anti-obesity activity, and certain phytochemicals such as flavonoids, polyphenols, alkaloids, and saponins contribute significantly by influencing metabolic pathways associated with obesity management (Table 2).

The major advantages of herbal medicines are that they offer safer and more multi-targeted activity than synthetic ones; however, insufficient clinical evidence and lack of standardization remain major challenges(Karimi et al., 2015).

Further well-defined clinical research studies are required for the establishment of safety, efficacy, dosage standardisation, and therapeutic applicability of herbal-based anti-obesity agents. The regulatory requirements are a major challenge for conducting large phase clinical trials for an investigational new drug. The same patient can be classified differently in terms of modern medicine and herbal medicine, as both modern medicine and herbal medicines are diagnosed diseases differently. Patents are mostly checked by using both systems to ensure that both studies are more accurate. Herbal treatments work better when the patients follow all the instructions actively. The patient's choice is also considered in some of the herbal extracts. Randomization and blinding in terms of herbal-based treatments are harder to perform. (Parveen et al., 2015)

CONCLUSION:

Obesity is an abnormal distribution of fats in the body, which has become one of the most serious and challenging disorders worldwide, causing metabolic and physiological complications worldwide. This review highlights the importance of herbal medicinal plants in the treatment and management of obesity. However, additional clinical studies, investigations, formulation studies, and standardization are essential for the validation of safety, efficacy, purity, quality, and long-term therapeutic potential to establish their role in modern healthcare.

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