Review Article: Herbal Approach for Obesity Management

C. V. Chandrasekaran¹,²*, M. A. Vijayalakshmi², K. Prakash¹, V. S. Bansal², J. Meenakshi¹, A. Amit¹

¹R&D Centre, 5B, Veerasandra Industrial Area, Natural Remedies Pvt. Ltd., Bangalore, India; ²Center for Bioseparation Technology, VIT University, Vellore, India.

Email: *cvc@naturalremedy.com, cvctox@gmail.com

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ABSTRACT

Obesity, a complex interplay between environmental and genetic factors and is associated with significant morbidity and mortality. Usage of herbs for the management of obesity in the recent times is attracting attention. A web and manual based literature survey was conducted to assess the amount of information available on the herbal products for weight management. Traditional literature, PubMed, Scopus, Google scholar databases were screened up to February 2012. The search words were “obesity”, “herbal medicine/products/extracts”, “medicinal plants”, “traditional medicine”, “Ayurvedic medicine” without narrowing/limiting searching words or elements. Publications only with abstracts/full articles and books were reviewed in the search. Based on the available literature, for many of the herbal and weight loss products, there is little published information and there have been no clinical trials or the level of evidence is limited. Our literature survey also indicated that these herbal products fall under an acceptable level of evidence or with no scientific background at all, or they have a scientific rational but not to an acceptance level. Attempts were made in the review to define the features of possible herbal weight loss product. An ideal herbal anti obesity product should reduce the weight by 10% over placebo of treatment by showing an evidence of improvement of bio markers like blood pressure, lipids and glycemia without any side effects.

Keywords: Morbidity; Ayurveda; Obesity; Literature Survey; Medicinal Plants; Herbal Products; Weight Management

1. Introduction

Accumulation of fat over the limit led to ill/adverse effect in the body known as obesity. Body mass index (BMI) is an index of weight-for-height that is commonly used to classify overweight and obesity in adults. The World Health Organization (WHO) definition is: 1) A BMI greater than or equal to 25 is overweight and, 2) A BMI greater than or equal to 30 is obesity. BMI provides useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, it should be considered as rough guidance because it may not correspond to the same degree of fatness in different individuals.

Obesity and overweight occurs due to imbalance between calories consumed and calories utilized. Globally, there have been two reasons for overweight and obesity: 1) an increased intake of energy-dense foods that are high in fat, salt and sugars but low in vitamins, minerals and other micronutrients; and, 2) a decrease in physical activity due to the increasingly sedentary nature of many forms of work, changing modes of transportation, and increasing urbanization [1,2]. Changes in dietary and physical activity patterns are often results from sedentary lifestyle, not sleeping enough, endocrine disruptors, such as some foods that interfere with lipid metabolism, medications that make patients put on weight, medical and psychiatric illness and infectious agents.

Overweight and obesity are the fifth leading risk for global deaths. At least, 2.8 million adults die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischaemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity. WHO global estimates for the year 2008, reported 1.5 billion people were overweight, of these, over 200 million men and nearly 300 million women were obese. Overall, more than one in ten of the world’s adult population was obese [1,3].

In 2010, around 43 million children under five were overweight. Overweight and obesity are now on the rise in low and middle income countries, particularly in urban settings. Close to 35 million overweight children are living in developing countries and 8 million in developed countries. Childhood obesity is associated with a higher
chance of obesity, premature death and disability in adulthood. But in addition to increased future risks, obese children experience breathing difficulties, increased risk of fractures, hypertension, cardiovascular diseases and psychological effects [4].

Overweight and obesity are linked to more deaths worldwide than underweight. For an example, 65% of the world’s population live in countries where overweight and obesity kill more people than underweight (this includes all high-income and most middle-income countries). Obesity is a major health threat. The extra weight puts added stress on every part of individual's body. People with obesity are at risk for these health problems: Bone and joint problems due to extra weight puts strain on the bones and joints. This can lead to osteoarthritis, a disease that causes joint pain and stiffness, gallstones and liver problems, heart attack from coronary heart disease, congestive heart failure, and stroke, high blood cholesterol and triglycerides (dislipidemia or high blood fats), high blood pressure (hypertension), high blood sugar (glucose) or diabetes, stopping breathing during sleep (sleep apnea). This can cause daytime fatigue or sleepiness, poor attention, and problems at work.

Obesity is recognized as the most crucial risk factor for type 2 diabetes. Obesity, in particular intraabdominal adiposity, is associated with increased free fatty acid (FFA) concentrations in blood plasma which exercise a major negative effect on insulin sensitivity in both muscle and liver. Besides insulin resistance, defective insulin secretion is a prerequisite for the development of type 2 diabetes. Both lipotoxicity and glucotoxicity may initiate and enable a vicious circle dependable for the metabolic impairment. Diabetes occurs as a late phenomenon in obesity and is preceded by years of impaired glucose tolerance. The progression to diabetes is indicated by an inability of the B cells of pancreatic langerhans to maintain its high rate of insulin secretion in response to glucose in face of insulin resistance [5]. The partial reversibility of the evolution of obesity towards diabetes is well demonstrated today by lifestyle changes and multidisciplinary weight loss programs [6]. Nature is enriched with plant wealth for all living creatures, which possess medicinal virtues [7]. Anti diabetic activity has been reported in many plants during the last couple of years. Moreover, their mechanism of action differs from that of insulin in that they appear to act as anti-metabolites, capable of blocking the pathway of oxidation of fatty acids. Approximately 343 plants of the world have been tested for the blood glucose which found lowering effect in the laboratory experiments. Of them, 158 species are claimed to be used in traditional system on Indian medicine [8].

The chief goal of obesity treatment is to maintain healthy weight. The treatment method to be undertaken often depends on the preferred choice of an individual undergoing treatment as well as the level of obesity. Common treatment measures include the following methods, dietary changes, exercise and activity, behavior change, prescription weight-loss medications and weight-loss surgery [2].

The preferred treatment modality for weight loss is dieting and physical exercise. But due to busy schedules and sedentary lifestyle follow-up the first two methods never seems to be practiced in a regular manner. On the other hand weight loss surgery runs out of the option considering the cost involved. There is a gradual shift towards an increase use of drugs. Drugs are pharmacological agents that reduce or control weight. These drugs alter one of the fundamental processes of the human body, weight regulation, by altering appetite, metabolism, or absorption of calories. Only one anti-obesity medications orlistat is currently approved by the FDA for long term use. It reduces intestinal fat absorption by inhibiting pancreatic lipase [3]. Rimonabant, a second drug often referred to as “the munchies”, had been approved in Europe for the treatment of obesity but has not received approval in the United States and Canada due to safety concerns [9]. Sibutramine, which acts on the brain to inhibit deactivation of the neurotransmitters, thereby decreasing appetite was withdrawn from the United States and Canadian markets in October 2010 due to cardiovascular side effects [6]. Because of potential side effects, it is recommended that anti-obesity drugs only be prescribed for obesity where it is hoped that the benefits of the treatment outweigh its risk [10].

The use of allopathic and pharmacological drugs has become a popular means to overcome excess weight gain [11]. While these drugs generally are effective, severe adverse toxicities may limit their overall usefulness [12, 13]. A nutritional based intervention is being hailed as an inexpensive alternative to aid weight loss, and weight management [14]. Medicinal herbal supplements are being extensively utilized due to their effectiveness in managing many chronic disorders. They are cost-effective, and exert less to no toxic side-effects in comparison with many chemically synthesized drugs [15]. Accordingly, recent preliminary reports suggested that herbs with a long history of use and other natural substances less likely to produce severe toxicity might be effective in reducing appetite and promoting significant weight loss are encouraging [16].

2. Obesity and Psychiatric Co-Morbidity

The evidence for the interplay between certain mental illnesses (binge-eating, anxiety, mood disorders) and obesity is bidirectional [17]. Various demographical groups suggest that social or cultural factors may moderate or mediate the association between obesity and mood dis-
orders. Population with a psychiatric disorder is at higher risk for overweight and obesity than healthy ones [18-20]. At present there is no clear link concluded between obesity and psychopathology, and whether the possible psychological disorders are a cause or a consequence of obesity has not yet been clarified either [21]. Studies do portray that certain psychological disorders seem to be more common in obese people, such as depression, anxiety, substance abuse, etc., although the direction of the explanatory relation is not clear; moreover, the opposite result has also been found [22]. Furthermore, there are studies which determine high prevalence rates of mental disorders in obese patients seeking treatment, suggesting the psychiatric evaluation of obese patients as a routine practice [23].

The mere evidences of likely co-morbid psychopathology means that the practitioner must consider its assessment in obesity cases, and include a plan for a psychiatric and/or psychological therapeutic intervention. Over the past decade, there has been a great increase in the use of complementary treatment such as herbal remedies for relieving the psychiatric symptoms of obesity and the related morbidities [21,22]. Lee et al. has suggested the use of Ob-X, a mixture of three herbs Melissa officinalis L. (Labiatae), Morus alba L. (Moraceae), and Artemisia capillaris Thunb. (Compositae) for regulating hyperlipidemia [23].

3. Herbs Recommended for Obesity

Evidences are emerging to support that an increasing consumption of herbs are effective strategy for obesity control and weight management. Usage of plants and plant products has potential to keep the increasing prevalence of metabolic syndrome in control. There are few drugs in the market to prevent/manage obesity but there are the costs, efficacy and side effects to consider. For centuries people across the countries have been using natural products as plant based dietary supplements for weight control [24].

4. Traditional Medicine and Obesity

*Ayurveda* (Ayur = life, Veda = knowledge), which is “Science of Life”, originated from the Vedic times and is a part of holistic health care system. The chief source of ancient Indian Aryan culture and medicine are the four Vedas that are traditionally believed to be revealed to the sages by Brahma (the creator) some 6000 years before Christian era. *Ayurveda*’s primary emphasis is on preservation and promotion of health, it also provides treatment for disease. Many undesirable constitutions (about eight) in the body are mentioned in “Charaka Samhita”, an authentic source of *ayurveda*. Obesity or “Medoroga” is one among them. It is said that it is comparatively easy to help an underweight person, rather than an overweight person. The overweight problem can be due to an actual increase in the fat component (Meda Dhatu), or it can be due to malfunctioning. These, accordingly will need different approaches. In very few cases it can be an offshoot of other metabolic disorders. We have reviewed the available ayurvedic/traditional texts books [25-28] for searching plants which are indicated for obesity. The detailed list of plants has been depicted in Table 1.

5. Modern Literature and Obesity

A huge number of herbal supplements are currently present in the market for the management of obesity, although not all of them have the same effect, reason being, supplements targeting different molecules thereby following unique mechanism of action varying completely from the other. The basic principle underlying the mode of action of anti-obesity supplements is regulating the energy balance in the body, which is the balance between energy intake and expenditure. For the convenience of explaining/understanding different studies follow different approaches of categorizing the mechanism, either on the basis of the effect of the drug on nervous system or the effect of a supplement on physiological functions/behavior.

Ample of review on anti-obesity supplements have categorized their mechanism of action primarily on the basis of the activity they regulate. For an example, Yun et al. [29] classified the mechanism of anti-obesity action of natural supplements on the basis of the effect they produce 1) decreased lipid absorption, 2) decreased energy intake, 3) increased energy expenditure, 4) decreased pre-adipocyte differentiation and proliferation, or 5) decreased lipogenesis and increased lipolysis. For covering the broader range as well as for the convenience of understanding, Saper *et al*. [30] classified the mechanism of action of anti-obesity product on the basis of: 1) Increase energy expenditure, 2) Modulation of carbohydrate metabolism, 3) Increase satiety, 4) Increase fat oxidation or reduced fat synthesis, 5) Block dietary fat absorption, 6) Increased water elimination, 7) Enhance mood, 8) Miscellaneous and unspecified. We observed that there is plethora of literature on the mechanism of action of synthetic compounds along with convincing number of clinical studies to stand its safety, but continuous withdrawal of the major drugs (USFDA approved) due to the ill effects [31], paved a way for the growth of dietary supplements as a safe option to cure obesity. At the same time the available literature on mechanism of action of drugs will definitely decrypt the likely molecules and the molecular mechanism by which the active phyto-compounds act on. Like a drug, supplements also can act peripherally, centrally or in combination (peripherally &
Table 1. List of herbs indicated for obesity in *ayurveda* textbooks.

| Botanical name            | Sanskrit/official name | Part(s) used                |
|---------------------------|------------------------|-----------------------------|
| Acacia arabica           | Babhula                | Gum, bark, leaf, fruit-pods |
| Acacia catechu           | Khadira                | bark, heartwood, flower     |
| Achyranthus aspera       | Apamarga               | Root, seed, leaf, whole plant |
| Aconitum heterophyllum   | Ativisha               | Root, rhizome               |
| Acorus calamus           | Vachar                 | Rhizome                     |
| Adathoda vasica          | Vasa                   | Leaf, root, flower          |
| Aloe vera                | Kumari                 | Leaf, root                  |
| Alstonia scholaris       | Saptaparnava           | Bark, latex, flower         |
| Ananas comosus           | Ananas                 | Fruit                       |
| Anthocephalus chinesis   | Kadamba                | Bark, leaf, fruit, root     |
| Azadirachta indica       | Nimba                  | All parts                   |
| Berberis aristata        | Danuwaridra            | Root, stem, fruit           |
| Betula utilis            | Burja                  | Bark, nodes                 |
| Calatropis gigantea      | Arka                   | Root, bark, flower, leaf, seed |
| Calicarpa macrophylla    | Priyangu               | Flower, leaf                |
| Capsicum annaum          | Kutavira               | Fruit                       |
| Cassia tora              | Chakramardha           | Seed, leaf, root            |
| Cedrus deodara           | Devadaru               | Heartwood oil               |
| Cinnamomum zeylanicum    | Twak                   | Bark, leaf, oil             |
| Cissampelos pareira      | Patha                  | Root, stem                  |
| Clerodendrum phlomidis   | Agnimantha             | Root, bark, leaf            |
| Coccus nucifera          | Narikela               | Fruit, flower, oil, root    |
| Commiphora Mukul         | Guggulu                | Gum-resin                   |
| Coriandum sativum        | Dhanyakas              | Whole plant, leaf, fruit    |
| Costus speciosus         | Kebuka                 | Rhizome                     |
| Cuminum cyminium         | Jeeraka                | Seed                        |
| Curcuma longa            | Haridra                | Rhizome                     |
| Desmostachya bipinnata   | Kasa                   | Root                        |
| Dolichos biflorus        | Kulatta                | Seed                        |
| Embelia ribes            | Vidanga                | Fruit                       |
| Emblica officinalis      | Amalaki                | Fruit                       |
| Euphoria nerefolia       | Snah                   | Latex, stem, leaf, root     |
| Ferula nortex            | Hingn                  | Oleo-gum resin              |
| Ficus Glomerata          | Udumbara               | Bark, fruit, latex          |

**Continued**

| Botanical name | Sanskrit/official name | Part(s) used |
|----------------|------------------------|--------------|
| Ficus lacor    | Plaksha                | Bark         |
| Ficus religiosa| Ashwattha              | Bark, fruit, leaf |
| Ficus rumpii   | Asmanthaka             | Stem, bark, latex, fruit |
| Garcinia indica| Vrikshamala            | Fruit, root, bark, oil |
| Gymnema sylvestre| Meshashringi        | Leaf, root |
| Holarrhena antidysenterica | Kutaja       | Seed, bark  |
| Inula racemosa | Pushkaramula           | Root         |
| Momordica charantia | Karavellaka          | Fruit, whole plant, leaf, root |
| Moringa oleifera| Sigruna                | Root, bark, seed |
| Ougenia dalbergioides | Tinisa           | Heart wood |
| Picrohiza kurroa | Katuka                 | Root         |
| Piper chaba     | Chavya                 | Root, fruit  |
| Piper longum    | Pippali                | Fruit, root  |
| Piper nigrum    | Maricha                | Fruit        |
| Pongamia pinnata| Karanja                | Fruit, seed, oil, root |
| Pterocarpus marsupium| Bijaka             | Heart wood  |
| Randia dometorum| Madanaphala           | Fruit        |
| Santalum album  | Candana                | Heartwood    |
| Saussurea lappa | Kushta                 | Root         |
| Sphaeranthus indicus| Munditaka             | Whole plant  |
| Stereospermum sauvealens | Patala              | Root, bark, flower, seed, leaf |
| Symplocos racemosa | Lodhra               | Bark         |
| Terminalia arjuna| Arjuna                 | Bark, root, leaf |
| Terminalia bellerica| Bibhitaka            | fruit        |
| Terminalia chebula | Haritaki             | fruit        |
| Terminalia tomentosa | Asana                | Bark, heartwood |
| Thea sinensis    | Oolong tea             | Leaf         |
| Tinospora cordifolia| Guduchi             | Stem, root   |
| Trachyspermum ammi| Yavani                 | Fruit        |
| Tragia involucrata| Yavasa                 | Whole plant  |
| Tribulus terrestris | Gokshura             | Fruit, root, whole plant |
| Trigonella foenum graceum | Methika           | Seed, leaf, whole plant |
| Valeriana jatamansi | Tagara               | Root         |
| Zingiber officinale | Shanti                | Rhizome      |
| Ziziphus mauritiana | Badara                | Root, leaf, fruit |

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Adipogenesis is a complex process regulated by the expression of several hundred genes. The primary adipogenic transcription factors involved in adipocyte differentiation belong to the peroxisome proliferator activator receptor (PPAR), C/EBP, and sterol regulatory element binding protein (SREBP) families. PPAR-γ expression during differentiation is an important event in adipogenesis in pre-fat cells [45]. Polyunsaturated fatty acids (PUFAs), a vital component of the phospholipids of cell membranes and acts as a signal transducer regulating adipocyte-specific gene expression involved in lipid metabolism and adipogenesis [46]. Various phytochemicals like quercetin, kaempferol and catechin and dietary flavonoids found in vegetables, fruits, green tea and herbs are reported to down-regulate the adipogenesis-related transcriptional factors PPAR-γ, C/EBP-α and SREBP-1 and to inhibit adipocyte differentiation during the early stage. Tea catechins and epigallocatechin gallate (EGCG) decreased the weight of subject adipose tissue [47-50].

In addition to showing inhibitory activity against adipocyte differentiation, several naturally-occurring compounds have displayed apoptotic effects on maturing pre-adipocytes, e.g. phytochemicals, such as esculetin, resveratrol, quercetin, genistein, capsaicin, and conjugated linoleic acids induced apoptosis of maturing 3T3-L1 pre-adipocytes through suppression of ERK1/2 phosphorylation, activation of the mitochondrial pathway, AMPK activation, or anti-oxidant activity [51-55]. Sir2 is another target molecule for anti-obesity treatment. Decreased adipogenesis due to resveratrol correlated with increased expression of Sir2, which promotes fat mobilization by repressing PPARγc [56,57].

5.1.3. Thermogenesis
Excessive adiposity results from an imbalance in energy homeostasis as a result of excessive food intake are not balanced by increased energy expenditure [58,59]. To regulate body weight and energy expenditure, mammalian BAT (brown adipose tissues) establishes non-shivering thermogenesis through dissipation of excess energy as heat [60]. BAT plays an important role in obesity control by controlling energy balance.

The key player in this process is UCP (Mitochondrial uncoupling protein), which discharges the proton gradient generated in oxidative phosphorylation, thereby dissipating energy as heat. Thus, searching for substances that upregulate UCP1 gene expression may be a worthy strategy for achieving obesity control through increased energy expenditure [61]. Yoon et al. has shown that ethanolic extract of Solanum tuberosum, can activate the expression of UCP3 in BAT and the liver and significantly reduced fat weight in HFD-fed rats [62]. Numerous naturally-occurring compounds have been proposed
as treatments for weight loss via enhanced energy expenditure, including caffeine [63,64] and capsaicin [57,65].

5.1.4. Lipid Metabolism
The pharmacological targeting of lipolysis can be envisaged in two different ways. The first strategy entails stimulating triglyceride hydrolysis in order to diminish fat stores, thereby combating obesity. This option requires the associated oxidation of the newly released fatty acids and led to the development of the b3-adrenergic agonists [66]. Some examples of the natural compounds involved in b3-adrenergic receptor activation are the various flavonoids in the leaf of Nelumbo nucifera (NN). Through this pathway, NN extract dietary supplementation resulted in significant suppression of body weight gain in A/J mice fed a HFD [67]. Caffeine, one of the major bioactive components in oolong tea (Thea sinensis) possesses both a positive charge and a hydrophobic area like that of adrenaline. Caffeine’s mechanism of lipolytic action might be due to its binding to the phospholipid phosphate groups and the subsequent interactions between the lipase and triglyceride portions of lipid droplets, eliciting lipolysis [41].

5.2. Centrally Acting Mechanisms
Body mass can also be maintained by restricting the intake of food. Many products act in a way through their effect on the receptor within the central nervous system thereby developing a sense of satiety within the body.

5.2.1. Neuropeptide Signaling Modulators
The dietary intake of humans varies routinely; still weight remains remarkably stable in most humans because overall energy intake and expenditure are exquisitely matched over long periods of time through the process of energy homeostasis [68,69]. The status of body energy stores is communicated to the central nervous system by the adiposity-associated hormones leptin, insulin, and possibly selected gastrointestinal (GI) peptides, such as ghrelin [69]. The arcuate nucleus of the hypothalamus, the primary neural signaling site for appetite regulating hormones, is mainly composed of two types of neurons:

1) Anorexigenic (appetite suppressing) neuropeptides, pro-opiomelanocortin (POMC) and cocaine- and amphetamine-regulated transcript (CART).

2) Orexigenic (appetite stimulating) neuropeptide, agouti-related peptide (AgRP) and neuropeptide Y (NPY).

Leptin and insulin stimulate the activity of neurons that express the neuropeptide precursor proopiomelanocortin (POMC), while inhibiting neurons that produce the anabolic mediator’s neuropeptide Y (NPY) and agouti-related protein Ghrelin exerts the opposite effects on this circuitry, directly activating NPY/AgRP cells and thereby indirectly silencing POMC cells. Leptin, insulin, and ghrelin communicate with neurons in the hypothalamus and thereby modulate appetite and energy expenditure to regulate body weight. Leptin, Ghrelin and Neuropeptide Y therefore pops up as a hot targets as well as marker for obesity. Green tea extract has been reported to regulate the plasma leptin concentration [70]. Treatments of adlay seed crude extract (ACE) modulated expressions of leptin and TNF-alpha and reduced body weights, food intake, fat size, adipose tissue mass and serum hyperlipidemia in obesity rat fed HFD [71].

Neuropeptide Y and its many receptors, in addition to stimulating melanocortins and other catabolic pathways, the adiposity hormones leptin and insulin inhibit anabolic neuropeptides, such as hypothalamic NPY, and chronic NPY administration powerfully increases food intake and body weight. Thus, pharmacological blockade of NPY signaling is a potential antiobesity strategy. Many natural appetite suppressants mediate the reduced expression of hypothalamic neuropeptide Y (NPY) or serum leptin levels [72]. For instance, Kim et al. [71] proved that, in HFD-induced obesity in rats, a crude saponin of Korean ginseng effectively regulated serum leptin and NPY expression in the rat hypothalamus. Limited number of reports were published with regard to interaction of natural substances with appetite suppressing and appetite stimulating molecules.

5.2.2. Monoamine Neurotransmitters
Body weight regulation through appetite control is a multifactorial event resulting from neurological and hormonal interrelationships. A line of evidence indicates that serotonin, histamine, dopamine, and their associated receptor activities are closely associated with satiety regulation. Serotonin is a monoaminergic neurotransmitter that modulates numerous sensory, motor, and behavioral processes, acting through a family of at least fourteen 5-HT receptor subtypes. These receptors may enable researchers to better target their searches for drugs that treat obesity through energy intake reduction [73]. Agents that act via peripheral satiety peptide systems, alter the various hypothalamic neuropeptides’ CNS levels, or alter the key CNS appetite monoamine neurotransmitters’ levels may be suitable candidates for drugs that will suppress appetite [74,75]. Green tea and its constituents (catechins, such as epigallo catechin (EGC) and epigallo catechin gallate (EGCG), have received tremendous attention [76,77], as several lines of evidence suggest EGCG to stimulate thermogenesis through inhibition of the catechol-O-methyltransferase enzyme involved in degradation of norepinephrine [43,57,73,78,79].

Natural hydroxycitric acid (HCA), prepared from Garcinia cambosia, is a potential natural appetite sup-
HCA is a competitive inhibitor of adenosine 5-triphosphate-citrate lyase, leading to a deceased acetyl coenzyme A production and decreased fatty acid synthesis. HCA is also thought to suppress feed intake via loss of appetite by stimulation of liver gluconeogenesis. HCA is also reported to act by increasing the availability of 5-hydroxytryptamine or serotonin, serotonin is a neurotransmitter implicated in regulating eating behavior and appetite control [24]. Central metabolism of glucose also suppresses food intake, mediated by the hypothalamic

### Table 2. Herbal products for weight management with human studies.

| Author          | Name of the herbal product | Formulation information                                      | Study/Method                          | Subjects                        | Dose/Duration                  | Result                                                                 |
|-----------------|-----------------------------|----------------------------------------------------------------|---------------------------------------|---------------------------------|-------------------------------|------------------------------------------------------------------------|
| Singh et al., [82] | Ayurslim                    | *Garcinia cambogia, Balsamodendron mukul, Gymnema sylvestre, Terminalia chebula, Trigonella foenum-graecum* | Phase IV clinical trial                | 42 obese patients of either sex | 2 capsules, twice daily for 6 months | Significant effect in reducing body weight and lipid levels |
| Godard et al., [83] | Forslean from *Coleus forskohlii* root |                                                        | Randomized, double-blind, placebo-controlled study | 30 men who were overweight/obese | 250 mg of extract twice a day for a 12-week period | Causes positive changes in body composition in overweight and obese adult men |
| Lieberman, [84]  | Forslean                    | 250-mg capsule of a standardized extract of *Coleus forskohlii* (forskolin 25 mg) | Open blind study                       | 6 overweight, but otherwise healthy, women | 1 capsule in the morning and 1 in the evening, 30 minutes before a meal. For 4 - 8 weeks | Mean values for body weight and fat content were significantly decreased |
| Henderson et al., [85] | Lipotrim                | *Chromium 100 mcg, Garcinia cambogia fruit extract 50 mg.* | Double blinded placebo controlled randomized study | 60 obese male and female volunteers | 1 capsule twice daily for 12 weeks | Total body weight significantly decreased |
| Brown, [86]      | Phase 2                     | Water-extract of a common white bean (*Phaseolus vulgaris*) | Randomized, double-blind, placebo-controlled study | Adults of 35 females, 4 males | 1500 mg Phase 2 twice daily with meals for 8 weeks | Sixteen of the 39 patients had a similar weight from when they started, three had gained more than 6 kg, seven had lost 6 to 12 kg, and 13 had lost more than 12 kg. Treated group lost an average of 3.79 lbs (average of 0.47 lb per week) compared with the placebo group, which lost an average of 1.65 lbs (average of 0.21 lb per week). Triglyceride levels in the Phase 2 group were reduced an average of 26.3 mg/dL, more than three times greater a reduction in the placebo group |
| Udani et al., [87] | Slimax                    | Aqueous extract of *Hordeum vulgare*, *Polygonatum multiflorum*, *Dimocarpus longan*, *Ligusticum sinense*, *Lilium brownii* and *Zingiber officinale* | Double-blind experimental method | Human Subjects | Six week period | Significant decrease in parameters such as body weight, waist and hip circumference, and Body Mass Index (BMI), in all subjects tested |
| Ignjatovic, [88] | Slimax                     | Proprietary blend of *Garcinia cambogia* extract with calcium pantothenate (standardized for the content of hydroxycitric acid and pantothenic acid) and extracts of *Matricaria chamomilla*, *Rosa damascena*, *Lavandula officinalis* and *Cananga odorata* | Double-blind, randomized, placebo-controlled study | 30 subjects | 1 tablet of Slim339 three times per day (60 - 90 min before a meal), for 60 days | Daily oral self-administration of Slim339 in the community reduced body weight in overweight and obese healthy human subjects |
AMPK/malonyl-CoA signaling system [80]. Central administration of glucose increases hypothalamic malonyl-CoA, decreases orexigenic neuropeptide expression, and suppresses food intake. Centrally-administered fructose provokes feeding, via the AMPK/malonyl-CoA signaling pathway. Thus, decoctions prepared from natural sources containing excessively high fructose levels may suppress the hypothalamic malonyl-CoA signaling pathway, thereby exerting an orexigenic effect [80,81].

6. The Probable Reasons for Obese Person to Prefer Herbal Products for Weight Management

1) Health benefits of weight loss without any side effects.
2) Less demanding than accepted lifestyle changes, such as exercise and diet.
3) Easily available without a prescription.
4) More easily accepted than a professional consultation with a physician or a nutritionist.
5) 100% natural origin and perception that natural means safe.

7. Remarks on Available Information about Herbal Treatment for Obesity

For many of the herbal weight loss products, there is little published information and there have been no clinical trials or the level of evidence is limited. Some of the herbal products fall under an acceptable level of evidence viz., clinical trials and with no scientific background or scientific rational.

Table 2 compiles available clinical trial literature on various herbal products which have weight reducing effects. Few of the products, which underwent clinical trial, have significant weight reduction as an overall result. The other products have shown comparatively good results in pre clinical studies but lack clinical studies. There are several products in the market claimed to have remarkable weight reducing effects, however there is no supporting published pre clinical and clinical data evidences.

8. An Ideal Herbal Remedy for Obesity: A Proposal

Herbal products for weight reduction may be effective in the management of obesity and associated disorders. Consistent and safe herbal product for weight reduction is a need of developed and developing countries. In our literature survey, herbal products showed potential effects on weight control. However, for the majority of products, more data are needed to assess the suitability as an anti obesity product. We have attempted to provide salient futures for an ideal herbal product for the management of obesity.

1) Should bring down the body weight by 10% over placebo in a well designed randomized placebo controlled clinical trial.
2) Should show evidence of improvement of bio markers like blood pressure, lipids and glycemia.
3) Should have known mechanism of action.
4) Should be standardized with bioactive phytochemicals which is/are responsible for anti obesity activity.
5) Should not have any kind of side effects.

9. Conclusion

There are several plants described in ayurveda for weight management. But so far, no systematic and well designed screening is attempted to come up with an effective herbal weight loss product. A better understanding in the existing evidence based science on herbs will further guide a qualitative research in obesity management that will attract the end users by the effective benefits. True randomized, double blinded, placebo-controlled clinical trials using herbal products will demonstrate their potential benefits. Significant weight loss after placebo subtraction along with known mechanism of action are required in order to generate conviction amongst users as effective agent for weight management.

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