

Safety, Efficacy and Metabolism of Traditional Medicinal Plants in the Management of Obesity: A Review

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Abstract—Obesity is an important global health concern, and is associated with high morbidity and mortality rates. Modern methods of treatment, such as synthetic drugs and surgery, still have to be improved to show safety and efficacy. The main concerns with such treatments are the high costs and serious complications. As a result, there is great interest in the use of plant-based medicinal agents as an alternative therapy. This study aims to provide a review of the studies on accessible botanical sources for the treatment of obesity. Based on published studies, this review attempts to explain how these medicinal plants act in humans to cause weight loss, and which method of usage is safer and more efficient. Information was gathered from books, journals and electronic sources published in the period of 1991 to 2012. The medicinal plants studied can reduce weight through five basic mechanisms, including stimulating thermogenesis, lowering adipogenesis, enhancing lipolysis, suppressing appetite, and decreasing the absorption of lipids. Furthermore, consumption of reliable medicinal plant extracts in a single form and at an optimum dosage could be a safe treatment for obesity. However, based on reviews, some combinations of certain medicinal plants may result in either lower efficacy or cause unexpected side-effects.

Index Terms—Anti-obesity, fat absorption, slimming aids, dietary supplements

I. INTRODUCTION

Since 1997, the WHO has warned of obesity as a global epidemic, although it was not noticeable during most of the 20th century [1]-[2]. Statistics show that the prevalence of obesity had reached up to 400 million adults by 2005 [3]. Currently, it is reported that half of the adult population in OECD countries are overweight, and 1/6th are obese. Based

on the classification by WHO a body mass index [BMI] greater than 25 Kg/m² is defined as overweight and BMI value of greater than 30 Kg/m² is termed as obesity, besides, BMI greater than 40 Kg/m² is termed “morbid obesity. According to this report by WHO, obesity is related to several health problems, including cardiovascular diseases, hypertension, diabetes mellitus, gallbladder disease, cancer, endocrine and metabolic disturbances, osteoarthritis, gout, pulmonary diseases, as well as psychological problems such as social bias, prejudice, discrimination, body shape dissatisfaction, and eating disorders which are seen in both children and adults [4]. From an economic point of view, obesity and its related health consequences involve

enormous costs currently and for future health care, such as physician visits, hospitalization, and other related expenses [5]-[6]-[7]. Being overweight is a cosmetic problem and a major risk factor for human health [8]. In short, obesity can cause a decline in life expectancy [9]. Despite vast attempts to address this issue, “globesity” remains an enormous challenge.

A. Challenges in Treating Obesity

Recently, there has been a proliferation of different anti-obesity products appearing on the market [10]. Despite the high cost of such products, their long-term consumption is still not recommended as they have exhibited several side effects, such as gastrointestinal and kidney problems [11]. For example, among the varieties of anti-obesity drugs, only Orlistat and Sibutramine can be used long-term. In addition, such products do not satisfactorily impact weight loss or are not tolerated by the body [12]-[13].

However, the use of natural remedies for weight loss has increased. Scientists believe that botanical sources seem more reliable, safer, and also cheaper than current conventional methods, such as synthetic chemical drugs [14] or surgical procedures [15] which may have adverse effects or be of limited duration in effectiveness [16].

B. Natural Medications

Studies show that natural food ingredients and medicinal plant preparations are able to enhance satiety, boost metabolism, and speed up weight loss [17]-[18]. Including these foods in the diet on a regular basis will therefore assist an individual to lose weight slowly. However, there is still some doubt about their application for humans [19]. On the other hand, despite the global market for satiety, fat burning, dietary supplements and other weight management remedies, the awareness of the usefulness of these products is neither sufficient nor clearly perceived by patient [20]. This study aims to provide a review of previous reports about the availability of natural medicinal agents and their potential for assisting in losing weight. This information could aid patients in their selection of the appropriate botanical product to develop a lean and healthy body.

II. METHODS OF DATA COLLECTION

Data were acquired from various databases, including Google Scholar, Science Direct, Pub-Med, Scopus, Web of Science, and from library books and theses. The studies ranged from 1991 until January 2012. The key search words included: traditional medicine, medicinal herbs, plant extracts, anti-obesity, weight loss, overweight, botanical remedy, complementary therapy, natural, alternative, phytonutrients, phytochemicals, efficacy, safety, bioactive

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compounds, appetite, satiety, metabolism, thermogenesis, lipolysis, lipogenesis, adipocytes and anthropometric indices. Overall, papers on human and animal studies, clinical trials, and articles related to obesity medication based on plants are used in this discussion.

III. RESULTS AND DISCUSSION

A. Mechanism of Action

Natural anti-obesity preparations can induce weight loss through several different mechanisms. Their functions can be classified into five major categories, as shown in Table I.

TABLE I: DIFFERENT FUNCTIONS OF ANTI-OBESITY MEDICINAL PLANTS IN HUMAN

No	Anti-obesity function	Anti-obesity preparations
1	Inhibiting pancreatic lipase activity	chitosan [21]-[22], levan [23], mate tea [24], oolong tea [25] jasmine tea [26], green tea [27]
2	Enhancing thermogenesis	sea weed [28]-[29]-[30], bitter orange [31]-[32]-[33], soybean [34]
3	Preventing adipocyte differentiation	turmeric [35], capsicum [36], palm oil [37], banana leaf [38]-[39], brown algae [40], garlic [41], flaxseed [42], black soybean [43]

4	Enhancing lipid metabolism	herb teas [26], cinnamon [44]
5	Decreasing appetite	pine nut [45], pomegranate leaf [46], ginseng [47], <i>Hoodia gordonii</i> [48]

Based on the inhibition of pancreatic lipase activity [49], the intake of some medicinal plants will prevent the absorption of lipids in the intestine. Consequently, non-absorbed fat will be excreted through oily faeces. Furthermore, certain bioactive components can promote energy expenditure [50] by increasing basic the metabolic rate, which enhances thermogenesis. This function will help the body to burn additional calories and excess body fat. Through prevention of adipocyte differentiation [37], medicinal plant consumption will inhibit adipogenesis and the formation of fat cells in adipose tissues. Moreover, based on enhancing lipid metabolism (lipolysis) [51], some medicinal plant products can increase lipolysis through inducing β -oxidation or noradrenaline secretion in fat cells [26]. Other anti-obesity ingredients are able to suppress appetite and induce satiety [52], which will help individuals to control their appetite. Finally, these different functions of antiobesity medicinal plants will cause a reduction of food and energy intake [32].

TABLE II: COMPARISON BETWEEN SAFETY AND EFFICACY OF SINGLE AND MIXED MEDICINAL PLANT ANTI-OBESITY PREPARATIO

Medicinal Plant ingredient	*Result	Adverse effects	Combination formula	Result	Adverse effects
Rhubarb (rheum) [55]	+	Not reported	In combination with ginger, astragalus, red sage, and turmeric, combined with gallic acid [56]-[57]	greater weight gain in intervention group/ (-)	Musculoskeletal, gastrointestinal, oral, dermatologic, vaginal irritation, headache, etc.
Green tea (<i>Camellia sinensis</i>) [58]	+(p<0.05)	Not reported	In combination with asparagus, black tea, guarana, kidney bean, <i>Garcinia cambogia</i> and chromium yeast [59]	no inter group difference in weight (-)	Gastrointestinal complaints
Bitter orange (<i>Citrus aurantium</i>) [60]	+	Not reported	In combination with pantothenic acid, green tea leaf extract, guarana, white willow bark and ginger root [61]	greater weight gain in intervention group (p<0.04)	Hypertension, musculoskeletal, neurological, migraine, anxiety
kidney bean (<i>Phaseolus vulgaris</i>) [62]	+(p=0.07)	Not reported	In combination with green tea extract [63]	inter group differences (+)	Flatulence, soft stool, constipation
<i>Garcinia cambogia</i> [64]	+(p=0.03)	Not reported	in combination with natural caffeine [65]	No inter group differences (p=0.3)	Not reported
Glucomannan fiber [66]	+(p<0.005)	Not reported	in combination with chitosan, fenugreek, <i>Gymnema sylvestre</i> , vitamin C [67]	inter group differences (+) (p<0.01)	Constipation, headache, indigestion

*Results indicate the efficacy and intergroup differences

B. Approaches in Medicinal Plant Preparation with Maximum Efficacy and Safety

Medicinal plant samples can be collected from the whole plant, or from parts of the plant, such as the stem, bark, leaf, flowers, and roots. These materials are then processed into different forms, such as powder or capsules. However, most of the medicinal plants which have shown antiobesity properties were prepared in the form of aqueous or alcoholic extracts. This may be because the decoction, distillation, and infusion procedures can concentrate the constituents responsible for the therapeutic efficacy of the examined herb. Some components which might inhibit the anti-obesity

function of the bioactive compounds might be removed by the extraction procedure. Extraction and partial purification, or the isolation of the active principle(s) could increase the bioavailability of the bioactive constituents in medicinal plant extracts which consequently will enhance the efficacy of medicinal agent in losing weight [53]-[54].

In other studies, scientists have examined the anti-obesity properties of mixtures of medicinal plants. However, in several cases shown in Table 2, the consumption of different antiobesity preparations in combination with other plant-based ingredients could produce unexpected side-effects.

Based on previous studies, the application of single

medicinal plants has not caused any adverse events. On the other hand, the undesired effects on the human body could be due to interactions between the different phytochemical constituents present in the different plants [68]-[69].

IV. SUMMARY AND CONCLUSIONS

In summary, there is evidence from a large number of *in vivo* studies regarding the efficacy of anti-obesity medicinal plant preparations. These preparations can demonstrate their effects in various ways, including stimulating thermogenesis, lowering lipogenesis, enhancing lipolysis, suppressing appetite and decreasing absorption of lipids. Single and mixed anti-obesity medicinal plant preparations can have different effects. However, there are other factors which can also affect the results of such studies, including the botanical sources and the route of administration, the presence of various bioactive components and their respective functions, the experimental methods used, the treatment dosage applied, the study design, the duration of treatment, and the safety and efficacy of the ingested plant. In conclusion, the dietary intake of these medicinal plants in the natural form, when taken singly, can apparently provide a higher degree of safety and efficacy than when mixed medicinal plant preparations are applied. These findings support the recommendation of many health organizations

Regarding the consumption of natural ingredients on a regular basis, especially vegetables and selected herbs, such as turmeric, capsaicin, ginger, and green tea. Efforts to improve knowledge for individuals on the consumption of anti-obesity medicinal preparations, and encouragement to overweight and obese patients to consume them at an optimum dosage, along with an enhanced exercise regimen and a healthy diet should be continued. In addition, more chemical, biological and clinical studies are needed on the effectiveness of selected medicinal plants, particularly those used as spices and condiments, in ameliorating and treating obesity in humans. These anti-obesity data would be useful for food and drug manufacturers as they consider the development of new products and to government as they consider the regulation of food products as a way to promote and enhance public health.

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REFERENCES

- [1] M. C. Auld and L. M. Powell, "Economics of Food Energy Density and Adolescent Body Weight," *Economica*, vol. 76, no. 304, pp. 719-740, 2009.
- [2] B. Caballero, "The Global Epidemic of Obesity: An Overview," *Epidemiologic Reviews*, vol. 29, no. 1, pp. 1-5, 2007.
- [3] World Health Organization, (Sep 2009). "Obesity and Overweight," Fact sheet 311. [Online]. Available: <http://www.who.int/mediacentre/factsheets/fs311/en/print.html>
- [4] World Health Organization, "Obesity: Preventing and Managing the Global Epidemic," *WHO Technical report series*, vol. 894, 2000.
- [5] G. A. Colditz, "Economic Costs of Obesity and Inactivity," *Medicine and Science in Sports and Exercise*, vol. 31, no. 11, pp. S663- 667, 1999.
- [6] J. Picot, J. Jones, J. Colquitt, E. Gospodarevskaya, E. Loveman, L. Baxter, and A. Clegg, "The Clinical Effectiveness and Cost-Effectiveness of Bariatric (Weight Loss) Surgery for Obesity: A Systematic Review and Economic Evaluation," *Health Technology Assessment*, vol. 13, no. 41, pp. 1-190, 215-357, 2009.
- [7] A. M Wolfand and G. A. Colditz, "Current Estimates of the Economic Cost of Obesity in the United States," *Obesity Research*, vol. 6, no. 2, pp. 97-106, 1998.
- [8] P. G. Kopelman, "Obesity as a Medical Problem," *Nature*, pp. 635-643, 2000.
- [9] S. J. Olshansky, D. J. Passaro, R. C. Hershow, J. Layden, B. A. Carnes, J. Brody, L. Hayflick, R. N. Butler, D. B. Allison, and D. S. Ludwig, "A Potential Decline in Life Expectancy in the United States in the 21st Century," *New England Journal of Medicine*, vol. 352, no. 11, pp. 1138-1145, 2005.
- [10] B. Jacobs and K. Gundling, "ACP Evidence-Based Guide to Complementary and Alternative Medicine," 1st ed. *Amer College of Physicians*, 2009, pp. 330-351.
- [11] D. Rucker, R. Padwal, S. K. Li, C. Curioni, and D. C. W. Lau, "Long Term Pharmacotherapy for Obesity and Overweight: Updated Meta-Analysis," *BMJ: British Medical Journal*, vol. 335, no. 7631, pp. 1194-1199, 2007.
- [12] M. Pittler, K. Schmidt, and E. Ernst, "Adverse Events of Herbal Food Supplements for Body Weight Reduction: Systematic Review," *Obesity Reviews*, vol. 6, no. 2, pp. 93-111, 2005.
- [13] J. P. Chaput, S. S. Pierre, and A. Tremblay, "Currently available drugs for the treatment of obesity: sibutramine and orlistat," *Mini Reviews in Medicinal Chemistry*, vol. 7, no. 1, pp. 3-10, 2007.
- [14] J. Chang, "Medicinal Herbs: Drugs or Dietary Supplements," *Biochemical Pharmacology*, vol. 59, no. 3, pp. 211-219, 2000.
- [15] A. Clegg, J. Colquitt, M. Sidhu, P. Royle, and A. Walker, "Clinical and Cost Effectiveness of Surgery for Morbid Obesity: A Systematic Review and Economic Evaluation," *International Journal of Obesity*, vol. 27, no. 10, pp. 1167-1177, 2003.
- [16] L. K. Mahan and S. E. Stump, "Krause's Food & Nutrition Therapy," *Saunders: Elsevier*, 2008, Ch. 5, pp. 151-155.
- [17] N. I. Larson, M. T. Story, and M. C. Nelson, "Neighborhood Environments: Disparities in Access to Healthy Foods in the US," *American Journal of Preventive Medicine*, vol. 36, no. 1, pp. 74-81, 2009.
- [18] M. A. M. Crory, B. R. Hamaker, J. C. Lovejoy, and P. E. Eichelsdoerfer, "Pulse Consumption, Satiety, and Weight Management," *Advances in Nutrition: An International Review Journal*, vol. 1, no. 1, pp. 17-30, 2010.
- [19] S. Smyth and A. Heron, "Diabetes and Obesity: The Twin Epidemics," *Nature Medicine*, vol. 12, no. 1, pp. 75-80, 2006.
- [20] A. Esmailzadeh and L. Azadbakht, "Major Dietary Patterns in Relation to General Obesity and Central Adiposity among Iranian Women," *The Journal of Nutrition*, vol. 138, no. 2, pp. 358-363, 2008.
- [21] G. Bondiolotti, S. R. Bareggi, N. G. Frega, S. Strabioli, and U. Cornelli, "Activity of Two Different Polyglucosamines, L112o and Ff45o, on Body Weight in Male Rats," *European Journal of Pharmacology*, vol. 567, no. 1-2, pp. 155-158, 2007.
- [22] S. Jun, E. Jung, D. Kang, J. Kim, U. Chang, and H. Suh, "Vitamin C Increases the Fecal Fat Excretion by Chitosan in Guinea Pigs, Thereby Reducing Body Weight Gain," *Phytotherapy Research*, vol. 24, no. 8, pp. 1234-1241, 2010.
- [23] S. A. Kang, K. Hong, K. H. Jang, Y. Y. Kim, R. Choue, and Y. Lim, "Altered Mrna Expression of Hepatic Lipogenic Enzyme and Ppara in Rats Fed Dietary Levan from 'Zymomonas Mobilis'," *The Journal of Nutritional Biochemistry*, vol. 17, no. 6, pp. 419-426, 2006.
- [24] F. Martins, T. M. Noso, V. B. Porto, A. Curiel, A. Gambero, D. H. M. Bastos, M. L. Ribeiro, and P. O. Carvalho, "Maté Tea Inhibits in Vitro Pancreatic Lipase Activity and Has Hypolipidemic Effect on High-Fat Diet-Induced Obese Mice," *Obesity*, vol. 18, no. 1, pp. 42-47, 2009.
- [25] T. Hsu, A. Kusumoto, K. Abe, K. Hosoda, Y. Kiso, M. Wang, and S. Yamamoto, "Polyphenol-Enriched Oolong Tea Increases Fecal Lipid Excretion," *European Journal of Clinical Nutrition*, vol. 60, no. 11, pp. 1330-1336, 2006.
- [26] H. Okuda, L. Han, Y. Kimura, M. Saito, and T. Murata, "Anti-obesity Action of Herb Tea (Part 1). Effects of Various Herb Teas on Noradrenaline-Induced Lipolysis in Rat Fat Cells and Pancreatic Lipase Activity," *Japanese Journal of Constitutional Medicine*, vol. 63, no. 1/2, pp. 60-65, 2001.
- [27] S. I. Koo and S. K. Noh, "Green Tea as Inhibitor of the Intestinal Absorption of Lipids: Potential Mechanism for Its Lipid-Lowering Effect," *The Journal of Nutritional Biochemistry*, vol. 18, no. 3, pp. 179-183, 2007.

- [28] H. Maeda, M. Hosokawa, T. Sashima, and K. Miyashita, "Dietary Combination of Fucoxanthin and Fish Oil Attenuates the Weight Gain of White Adipose Tissue and Decreases Blood Glucose in Obese/Diabetic Kk-Ay Mice," *Journal of Agricultural and Food Chemistry*, vol. 55, no. 19, pp. 7701-7706, 2007.
- [29] H. Maeda, M. Hosokawa, T. Sashima, K. Funayama, and K. Miyashita, "Fucoxanthin from Edible Seaweed, *Undaria Pinnatifida*, Shows Antiobesity Effect through Ucp1 Expression in White Adipose Tissues," *Biochemical and Biophysical Research Communications*, vol. 332, no. 2, pp. 392-397, 2005.
- [30] H. Maeda, T. Tsukui, T. Sashima, M. Hosokawa, and K. Miyashita, "Seaweed Carotenoid, Fucoxanthin, as a Multi-Functional Nutrient," *Asia Pacific Journal of Clinical Nutrition*, vol. 17, no. S1, pp. 196-199, 2008.
- [31] C. Dallas, A. Gerbi, G. Tenca, F. Juchaux, and F. X. Bernard, "Lipolytic Effect of a Polyphenolic Citrus Dry Extract of Red Orange, Grapefruit, Orange (Sinetrol) in Human Body Fat Adipocytes. Mechanism of Action by Inhibition of Camp-Phosphodiesterase (Pde)," *Phytomedicine*, vol. 15, no. 10, pp. 783-792, 2008.
- [32] S. Haaz, K. Fontaine, G. Cutter, N. Limdi, S. Perumean, Chaney, and D. Allison, "Citrus aurantium and Synephrine Alkaloids in the Treatment of Overweight and Obesity: An Update," *Obesity Reviews*, vol. 7, no. 1, pp. 79-88, 2006.
- [33] H. G. Preuss, D. DiFerdinando, M. Bagchi, and D. Bagchi, "Citrus aurantium as a Thermogenic, Weight-Reduction Replacement for Ephedra: An Overview," *Journal of Medicine*, vol. 33, no. 1-4, pp. 247-264, 2002.
- [34] K. Ishihara, S. Oyaizu, Y. Fukuchi, W. Mizunoya, K. Segawa, M. Takahashi, Y. Mita, Y. Fukuya, T. Fushiki, and K. Yasumoto, "A Soybean Peptide Isolate Diet Promotes Postprandial Carbohydrate Oxidation and Energy Expenditure in Type II Diabetic Mice," *The Journal of Nutrition*, vol. 133, no. 3, pp. 752-757, 2003.
- [35] J. Ahn, H. Lee, S. Kim, and T. Ha, "Curcumin-Induced Suppression of Adipogenic Differentiation Is Accompanied by Activation of Wnt/B-Catenin Signaling," *American Journal of Physiology-Cell Physiology*, vol. 298, no. 6, pp. C1510-C1516, 2010.
- [36] C. L. Hsu and G. C. Yen, "Effects of Capsaicin on Induction of Apoptosis and Inhibition of Adipogenesis in 3T3-L1 Cells," *Journal of Agricultural and Food Chemistry*, vol. 55, no. 5, pp. 1730-1736, 2007.
- [37] H. U. Kondo, R. Ohmori, C. Kiyose, Y. Kishimoto, H. Saito, O. Igarashi, and K. Kondo, "Tocotrienol Suppresses Adipocyte Differentiation and Akt Phosphorylation in 3T3-L1 Preadipocytes," *The Journal of Nutrition*, vol. 139, no. 1, pp. 51-57, 2009.
- [38] N. Bai, K. He, M. Roller, B. Zheng, X. Chen, Z. Shao, T. Peng, and Q. Zheng, "Active Compounds from *Lagerstroemia Speciosa*, Insulin-Like Glucose Uptake-Stimulatory/Inhibitory and Adipocyte Differentiation-Inhibitory Activities in 3T3-L1 Cells," *Journal of Agricultural and Food Chemistry*, vol. 56, no. 24, pp. 11668-11674, 2008.
- [39] G. Klein, J. Kim, K. Himmeldirk, Y. Cao, and X. Chen, "Antidiabetes and Anti-Obesity Activity of *Lagerstroemia Speciosa*," *Evidence Based Complementary and Alternative Medicine*, vol. 4, no. 4, pp. 401-408, 2007.
- [40] H. Maeda, M. Hosokawa, T. Sashima, N. Takahashi, T. Kawada, and K. Miyashita, "Fucoxanthin and Its Metabolite, Fucoxanthinol, Suppress Adipocyte Differentiation in 3T3-L1 Cells," *International Journal of Molecular Medicine*, vol. 18, no. 1, pp. 147-152, 2006.
- [41] S. Ambati, J. Y. Yang, S. Rayalam, H. J. Park, M. A. D. Fera, and C. A. Baile, "Ajoene Exerts Potent Effects in 3T3 L1 Adipocytes by Inhibiting Adipogenesis and Inducing Apoptosis," *Phytotherapy Research*, vol. 23, no. 4, pp. 513-518, 2009.
- [42] S. Tominaga, T. Sugahara, S. Nishimoto, M. Yamawaki, Y. Nakashima, T. Kishida, K. Akiyama, M. Maruyama, and S. Yamauchi, "The Effect of Secoisolariciresinol on 3T3-L1 Adipocytes and the Relationship between Molecular Structure and Activity," *Bioscience, Biotechnology, and Biochemistry*, vol. 73, no. 1, pp. 35-39, 2009.
- [43] H. J. Kim, I. Y. Bae, C. W. Ahn, S. Lee, and H. G. Lee, "Purification and Identification of Adipogenesis Inhibitory Peptide from Black Soybean Protein Hydrolysate," *Peptides*, vol. 28, no. 11, pp. 2098-2103, 2007.
- [44] X. Sheng, Y. Zhang, Z. Gong, C. Huang, and Y. Q. Zang, "Improved Insulin Resistance and Lipid Metabolism by Cinnamon Extract through Activation of Peroxisome Proliferator-Activated Receptors," *PPAR Research*, vol. 581348, pp. 1-9, 2008.
- [45] F. Lei, X. N. Zhang, W. Wang, D. M. Xing, W. D. Xie, H. Su, and L. J. Du, "Evidence of Anti-Obesity Effects of the Pomegranate Leaf Extract in High-Fat Diet Induced Obese Mice," *International Journal of Obesity*, vol. 31, no. 6, pp. 1023-1029, 2007.
- [46] J. H. Kim, D. H. Hahm, D. C. Yang, H. J. Lee, and I. Shim, "Effect of Crude Saponin of Korean Red Ginseng on High Fat Diet-Induced Obesity in the Rat," *Journal of Pharmacological Science*, vol. 97, no. 1, pp. 124-131, 2005.
- [47] F. Van Heerden, "Hoodia gordonii: A Natural Appetite Suppressant," *Journal of Ethnopharmacology*, vol. 119, no. 3, pp. 434-437, 2008.
- [48] R. B. Birari and K. K. Bhutani, "Pancreatic Lipase Inhibitors from Natural Sources: Unexplored Potential," *Drug Discovery Today*, vol. 12, no. 19-20, pp. 879-889, 2007.
- [49] J. C. Hansen, A. P. Gilman, and J. Ø. Odland, "Is Thermogenesis a Significant Causal Factor in Preventing the "Globesity" Epidemic?," *Medical Hypotheses*, vol. 75, no. 2, pp. 250-256, 2010.
- [50] W. J. Pasman, J. Heimerikx, C. M. Rubingh, R. V. D. Berg, M. O'Shea, L. Gambelli, H. Hendriks, A. Einerhand, C. Scott, and H. G. Keizer, "The Effect of Korean Pine Nut Oil on in vitro Cck Release, on Appetite Sensations and on Gut Hormones in Post-Menopausal Overweight Women," *Lipids Health Disease*, vol. 7, no. 10, pp. 7-10, 2008.
- [51] P. Geoffroy, B. Ressalet, E. Marchioni, and M. Miesch, "Synthesis of Hoodigogenin a, Aglycone of a Natural Appetite Suppressant Glycoesteroid Extracted from *Hoodia gordonii*," *Steroids*, vol. 76, no. 7, pp. 702-708, 2011.
- [52] J. Calixto, "Efficacy, Safety, Quality Control, Marketing and Regulatory Guidelines for Herbal Medicines (Phytotherapeutic Agents)," *Brazilian Journal of Medical and Biological Research*, vol. 33, no. 2, pp. 179-189, 2000.
- [53] V. Schulz, R. Hänsel, and V. E. Tyler, *Rational Phytotherapy: A Physician's Guide to Herbal Medicine 2001*: Routledge.
- [54] H. Jin and D. Jiao, "Effect of J. Z. J. F. Yao, "on Gastro-Intestinal Movement and Adipose Cell of Abdominal Wall," *Chinese Journal of Integrated Traditional and Western Medicine*, vol. 14, no. 4, pp. 230, 1994.
- [55] F. Greenway, Z. Liu, C. Martin, W. K. Yuan, J. Nofziger, J. Rood, Y. Yu, and R. Amen, "Safety and Efficacy of Nt, an Herbal Supplement, in Treating Human Obesity," *International Journal of Obesity*, vol. 30, no. 12, pp. 1737-1741, 2006.
- [56] A. T. Roberts, C. K. Martin, Z. Liu, R. J. Amen, E. A. Woltering, J. C. Rood, M. K. Caruso, Y. Yu, H. Xie, and F. L. Greenway, "The Safety and Efficacy of a Dietary Herbal Supplement and Gallic Acid for Weight Loss," *Journal of Medicinal Food*, vol. 10, no. 1, pp. 184-188, 2007.
- [57] T. Nagao, T. Hase, and I. Tokimitsu, "A Green Tea Extract High in Catechins Reduces Body Fat and Cardiovascular Risks in Humans," *Obesity*, vol. 15, no. 6, pp. 1473-1483, 2007.
- [58] T. Opala, P. Rzymiski, I. Pischel, M. Wilczak, and J. Wozniak, "Efficacy of 12 Weeks Supplementation of a Botanical Extract-Based Weight Loss Formula on Body Weight, Body Composition and Blood Chemistry in Healthy, Overweight Subjects-a Randomised Double-Blind Placebo-Controlled Clinical Trial," *European Journal of Medical Research*, vol. 11, no. 8, pp. 343-350, 2006.
- [59] S. J. Stohs, H. G. Preuss, and M. Shara, "The Safety of Citrus aurantium (Bitter Orange) and Its Primary Protoalkaloid P-Synephrine," *Phytotherapy Research*, vol. 25, no. 10, pp. 1421-1428, 2011.
- [60] F. Greenway, L. D. J. Levitan, C. Martin, A. Roberts, I. Grundy, and C. Parker, "Dietary Herbal Supplements with Phenylephrine for Weight Loss," *Journal of Medicinal Food*, vol. 9, no. 4, pp. 572-578, 2006.
- [61] J. Udani, M. Hardy, and D. C. Madsen, "Blocking Carbohydrate Absorption and Weight Loss: A Clinical Trial Using Phase 2™ Brand Proprietary Fractionated White Bean Extract," *Alternative Medicine Review*, vol. 9, no. 1, pp. 63-69, 2004.
- [62] G. S. Birketvedt, "Composition for Treating Obesity Comprising Extract from White Kidney Beans, Red Kidney Beans, and Green Tea Leaves," U.S. Patent 7 579 027, Aug 25, 2009.
- [63] R. D. Mattes and L. Bormann, "Effects of (-)-Hydroxycitric Acid on Appetitive Variables," *Physiology and Behavior*, vol. 71, no. 1, pp. 87-94, 2000.
- [64] D. Rothacker and B. Waitman, "Effectiveness of a *Garcinia cambogia* and Natural Caffeine Combination in Weight Loss: A Double-Blind Placebo-Controlled Pilot Study," *International Journal of Obesity*, vol. 21, no. 2, pp. 53-57, 1997.
- [65] D. E. Walsh, V. Yaghubian, and A. Behforooz, "Effect of Glucomannan on Obese Patients: A Clinical Study," *International Journal of Obesity*, vol. 8, no. 4, pp. 289-293, 1984.
- [66] D. E. Woodgate and J. A. Conquer, "Effects of a Stimulant-Free Dietary Supplement on Body Weight and Fat Loss in Obese Adults: A Six-Week Exploratory Study," *Current Therapeutic Research*, vol. 64, no. 4, pp. 248-262, 2003.

- [67] D. Heber, "Herbal Preparations for Obesity: Are They Useful?," *Primary Care*, vol. 30, no. 2, pp. 441-463, 2003.
- [68] M. Kazemipoor, C. W. J. W. M. Radzi, G. A. Cordell and I. Yaze, "Potential of Traditional Medicinal Plants for Treating Obesity: A Review," in *Proc. Int. Conf. Food Science and Nutrition*, Singapore, 2012, pp.164-169.



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