Nutraceuticals: A natural Approach to Obesity Management

[1] Jayshri Gulchand Kamble, [2] Prof. Shital Devidas Pande, [3] Umesh Kailas Lonkar,
[4] Sakshi Chandrakant Parandkar, [5] Dr. Gajanan Sanap
[1] Student , [2] Professor , [3] Student , [4] Student , [5] Pricipal ,
Late Bhagirathi Yashwantrao Pathrikar College Of Pharmcy, Pathri, Chh. Sambhaji Nagar, India
[1] jayshrikamble1002@gmail.com , [2] sdpande.lbyp@gmail.com , [3] lonkarumesh5@gmail.com,
[4] parandkarsakshi@gmail.com, [5] fourth29@gmail.com

ABSTRACT

Obesity represents an increasingly significant public health issue globally, with serious health and economic consequences. Currently, over half of the population in developed nations is classified as obese or overweight. It is widely acknowledged as the most pressing and rapidly escalating health challenge worldwide, impacting both adults and children. Recent scientific findings indicate that both genetic predispositions and environmental influences play a role in the increase of obesity. Obesity is not merely an aesthetic issue; it constitutes a medical concern that heightens the risk of various other diseases and health conditions. These include heart disease, diabetes, hypertension, elevated cholesterol, liver disease, sleep apnea, and certain types of cancer. The current study investigates the potential of nutraceutical powders in managing obesity.

Nutraceutical is a term combining 'nutrition' and 'pharmaceutical'. Nutraceuticals are food products that provide health advantages beyond basic nutrition, aimed at preventing or treating illnesses and enhancing overall wellness. This category encompasses dietary supplements, functional foods, herbal remedies, and fortified foods that promote health and ward off diseases. The primary objective of the study is to demonstrate that certain crude substances (pomegranate peel, green tea, turmeric, ashwagandha, and cinnamon) contain active compounds such as polyphenols, flavonoids, epigallocatechin gallate, curcumin, cinnamaldehyde, and withanolides that facilitate weight loss when compared to commercially available nutraceutical products.

KEYWORDS- Obesity, Pathology, Health risk, BMI, Nutraceutical, Obesity management.

INTRODUCTION

Obesity

Obesity is a health issue characterised by an excessive accumulation of body fat resulting from an imbalance of caloric intake and a lack of physical activity. In the 21st century, over 1 billion individuals globally were affected by obesity. Various metabolic, genetic, behavioral, and environmental factors contribute to the development of obesity. Health complications associated with obesity encompass type 2 diabetes, high blood pressure, heart disease, lipid abnormalities, hardened arteries, nonalcoholic fatty liver disease, obstructive sleep apnea, and cancer.[1] The three-compartment model is commonly employed to assess body composition. This model categorizes total body mass into fat mass (FM), fat-free mass (FFM), and total body water (TWB). The relative proportions of each component align with the typical ranges for different ethnic groups. Variations between males and females of the same age offer reference ranges for Body Mass Index (BMI, kg/m2); typically, a BMI greater than 30 kg/m2 is deemed obese. The regulation of energy expenditure, fat breakdown, and the formation of fat cells are three key processes whose mismanagement leads to the onset of obesity.[2]

1. Factors affecting of obesity development

Factors influencing the development of obesity the several elements that have been causing obesity.[3]

- lifestyle choices- unhealthy diet and alcohol consumption
- specific illnesses and therapies/ treatments
- Influences and inheritance within the family

- during pregnancy
- lack of sleeping
- quitting smoking
- microbiome
- stress and Age

2. Pathogenesis of obesity[4]

Obesity is the result of a complicated interplay among hormones, genetics, and environmental factors. Various hormones, including adipokines and those linked to the gastrointestinal system, are involved. The stomach releases the peptide hormone ghrelin into the bloodstream, where it acts as an orexigenic hormone that stimulates hunger. On the other hand, anorectic gut hormones such as Peptide YY, Cholecystokinin, and glucagon-like peptide help restrict food intake to ensure optimal digestion and absorption, thereby reducing the risk of hyperinsulinemia and insulin resistance.Adipocytes produce hormones known as adipokines, which play a crucial role in the regulation of metabolism and obesity. Key adipokines include TNF-α, interleukin-6, leptin, and adiponectin. TNF-α has been associated with the onset of insulin resistance through the disruption of insulin signaling, decreased production of adiponectin, and release of free fatty acids. Leptin, an essential long-term regulator, provides the brain with information about energy reserves in adipose tissue. It helps to reduce appetite by binding to receptors in the hypothalamus, especially in neurons that control hunger after passing through the blood-brain barrier.[5] [6]

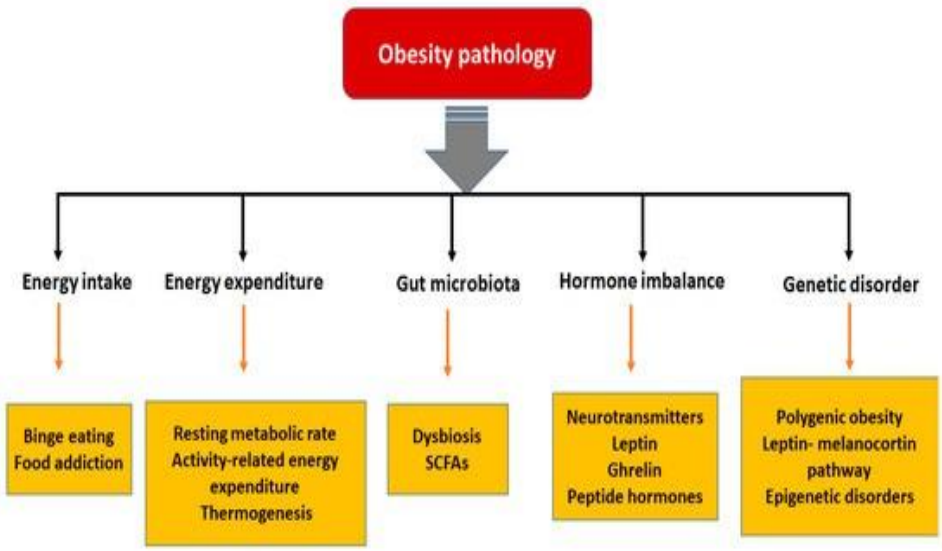

Fig. Pathology of obesity

3. Health risk of obesity

Obesity has a significant impact on health in many ways. It often arises from a imbance between energy intake and the ready availability of appealing, calorie-rich foods that are laden with fats, sugars, and salts. Individuals who are obese are at a greater risk of developing a range of health issues, particularly type 2 diabetes mellitus (T2DM), non-alcoholic fatty liver disease (NAFLD), non-alcoholic steatohepatitis (NASH), cardiovascular disease (CVD), and certain types of cancer. The SARS-CoV-2 virus, commonly known as COVID-19, has affected more than 598 million individuals and led to over 6.2 million deaths globally. Those with obesity who became infected with COVID-19 experienced higher rates of hospitalization, ICU admissions, and mortality. [7]

3.1 Metabolic consequences [8]

Excess body fat is strongly linked to type 2 diabetes, as it contributes to insulin resistance. When cells develop resistance to insulin, their ability to absorb glucose is hindered, resulting in elevated blood sugar levels and an increased likelihood of diabetes. Research indicates that losing weight can greatly enhance insulin sensitivity and reduce the chances of developing type 2 diabetes. Metabolic syndrome is defined by central obesity, high blood pressure, and abnormal lipid levels.[9]

3.2 Diabetes

Diabetes is a long-lasting metabolic condition with various causes, marked by persistently elevated blood glucose levels due to issues in insulin secretion, action, or a combination of both. Type 2 diabetes mellitus (T2DM) is more prevalent than type 1 diabetes mellitus (T1DM), representing 90-95% of all cases. It is significantly affected by genetic factors and involves insulin resistance alongside insufficient insulin secretion as compensation. The majority of individuals with T2DM are obese, characterized by an increased percentage of body fat or abnormal fat distribution, which is linked to the underlying mechanisms of diabetes. Adipose tissue contributes to insulin resistance by releasing excess free fatty acids. [10]

Obesity and type 2 diabetes mellitus are closely interconnected, with both exhibiting a similar rise in prevalence across Europe and globally. In contrast, individuals suffering from obesity are nearly three times as likely to develop T2DM compared to those maintaining a normal weight (20% vs. 7.3%).[11]

3.3 High blood pressure

High blood pressure, often called hypertension, is a condition in which blood flows through your blood vessels with increased pressure[12]. A larger body size can lead to higher blood pressure because the heart has to exert more effort to supply blood to all the body's cells. Excess body fat may also negatively affect your kidneys, which are vital in controlling blood pressure. Increased blood pressure can strain your heart, injure blood vessels, and increase your likelihood of experiencing a heart attack, stroke, kidney disease, and even death.[13] Hypertension is currently the primary risk factor for illness and death worldwide, accounting for 182 million disability-adjusted life years and 10.4 million fatalities each year. The correlation between obesity and hypertension is well-documented in both children and adults, regardless of gender.[14]

3.4 Reproductive issues

Obesity can significantly impact reproductive health in both men and women. The relationship between obesity and reproductive functions is intricate and arises from various hormonal, metabolic, and structural changes. An excess of body fat disrupts the hormonal balance essential for reproductive activities. In women, increased adipose tissue can lead to elevated estrogen production from fat cells,[15] resulting in an imbalance in hormones. In men, obesity is linked to reduced testosterone levels and an increased conversion of testosterone to estrogen in adipose tissue. This hormonal imbalance can affect the menstrual cycle in females and reduce sperm quality in males.[16]

3.5 Kidney disease

Kidney disease indicates that your kidneys are damaged and cannot filter your blood effectively. Being obese increases the likelihood of developing diabetes and hypertension, which are the leading causes of chronic kidney disease (CKD). Even without diabetes or high blood pressure, being obese may heighten your chances of developing CKD and accelerate its progression. If you are overweight or obese, shedding some pounds could assist in preventing or postponing CKD.[17] If you are in the initial stages of CKD, maintaining a diet of nutritious foods and drinks, staying active, and losing surplus weight may help slow the disease's progression and promote healthier kidneys for a longer time.[18]

3.6 Pregnancy problems

Carrying excess weight or being obese can elevate the likelihood of facing health issues during pregnancy that may impact both the pregnancy itself and the health of the baby. Expecting mothers with obesity might be more susceptible to [19]

- developing gestational diabetes, which is diabetes that arises during pregnancy
- experiencing preeclampsia, a condition characterized by high blood pressure during pregnancy that can lead to serious health complications for both the mother and the child if not addressed
- requiring a caesarean section, also known as a c-section, which may result in a longer recovery period post-delivery
- encountering complications associated with surgery and anesthesia, particularly if they have severe obesity
- gaining additional weight or remaining overweight or obese after the baby is delivered

Being obese or experiencing excessive weight gain during pregnancy can also heighten health risks for the baby, such as[20]

- being born larger than anticipated based on the baby's sex and the length of the pregnancy
- developing chronic conditions in adulthood, including type 2 diabetes, obesity, heart disease, and asthma

3.7 Osteoarthritis

Osteoarthritis is a widespread, persistent health issue that leads to discomfort, swelling, stiffness, and limited mobility in your joints. One of the main risk factors for osteoarthritis in the knees, hips, and ankles is obesity. Being overweight or obese can increase the likelihood of developing osteoarthritis by adding extra strain on your joints and cartilage. If you have surplus body fat, your blood may contain elevated levels of substances that promote inflammation. Inflammatory joints might heighten your chances of developing osteoarthritis.[7]

3.8 Some cancers

Cancer refers to a group of related conditions. In all forms of cancer, certain cells in the body start to grow irregularly or uncontrollably. These malignant cells can sometimes migrate to different areas of the body. Being overweight or obese might increase your chances of developing specific types of cancer. Men who are overweight or obese face a greater risk of developing colon, rectal, and prostate cancers. For women dealing with overweight or obesity, breast cancer, as well as cancers of the uterine lining and gallbladder, are more frequently seen.

The intricate molecular mechanisms connecting obesity to a heightened risk of specific cancers encompass complicated interactions among adipose tissue, inflammation, hormonal disturbances, and changes in cellular signaling pathways. Adipose tissue, especially visceral fat, generates pro-inflammatory cytokines like interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-alpha). The persistent low-grade inflammation associated with obesity fosters a conducive microenvironment for the onset and advancement of cancer. [21]

4. Using Body Mass Index (BMI) to Estimate Overweight and Obesity

BMI serves as a method to assess and screen for overweight and obesity in both adults and children. It is determined by dividing an individual's weight in kilograms by the square of their height in meters. BMI is connected to the body's fat content. An excessive level of fat can increase the likelihood of various health issues.[22] A healthcare provider can evaluate whether an individual's weight might pose a risk to their health.[23]

Underweight	15–19.9
Normal weight	20–24.9
Overweight	25–29.9
Preobesity	
Class I obesity	30–34.9
Class II obesity	35–39.9
Class III obesity	≥40

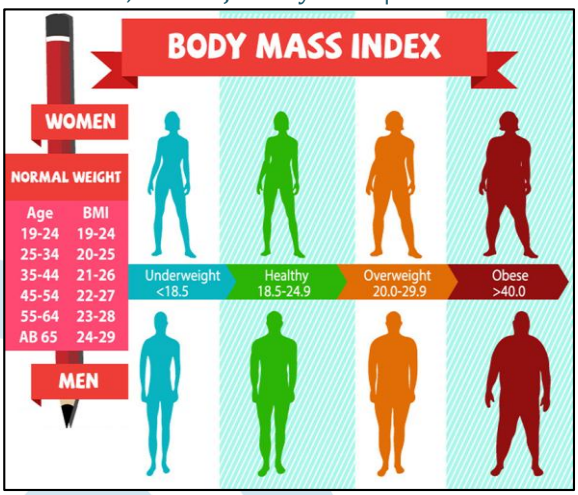

Fig.2. BMI Index

Nutraceutical

The phrase nutraceutical combines nutrition and pharmaceutical, and was first introduced by Stephen Defelice in 1989. He stated that "a nutraceutical includes any substance that is food or part of food, offering medical or health benefits, which may include disease prevention and treatment." These products can include isolated nutrients, dietary supplements, specific diets, genetically modified foods, and herbal products.[24] Nutraceuticals consist of food derived from plants or their components such as roots, oils, seeds, leaves, and flowers, which contribute to wellness and combat both acute and chronic health issues caused by unhealthy dietary fibers. Nutraceuticals are available in various forms, including powders, capsules, pills, liquids, and gels.[25] The underlying principle of nutraceuticals is the belief that food plays a vital role in maintaining health, managing diseases, and enhancing quality of life. The goal of nutraceuticals is to support the body's structure or function. With growing awareness of the relationship between diet and health, nutraceuticals have become important tools for preventive healthcare. These products comprise dietary supplements, functional foods, medicinal foods,[26] and pharmaceuticals that are fortified with additional ingredients such as omega-3 fatty acids, antioxidants, or probiotics. Nutraceuticals can be sourced from a wide array of natural origins. For instance, flavonoids and polyphenols found in various fruits and vegetables possess antioxidant qualities that help mitigate oxidative stress and inflammation.

In recent years, the global nutraceutical market has seen notable growth due to increased consumer awareness regarding the link between diet and health, an aging demographic, lifestyle-related diseases, and rising healthcare costs. Consumers are increasingly seeking natural alternatives to pharmaceuticals for managing chronic health issues such as obesity, diabetes, cardiovascular diseases, cancer, and arthritis.[27] The development of medications to lower BMI has also been noted, leading to an expansion of the nutraceutical market focused on weight loss. Given the numerous side effects of weight loss medications, nutraceuticals represent a more favorable option due to their lack of toxicity. This review offers an overview of the most researched nutraceuticals, including polyphenols, flavonoids, epigallocatechin gallate, curcumin, cinnamaldehyde, and withanolides, particularly in relation to obesity management.[28]

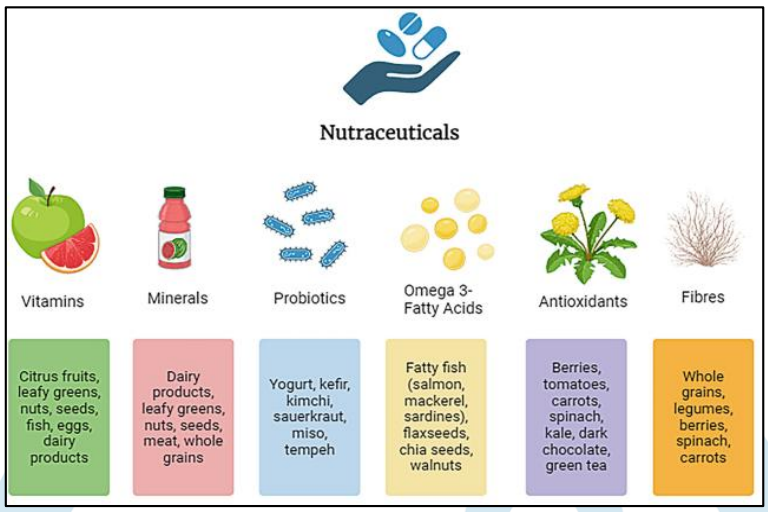

Fig.3. Nutritional supplements

5. NUTRACEUTICAL USES IN OBESITY MANAGEMENT

Nutraceuticals can be obtained from a diverse range of natural sources. For instance, flavonoids and polyphenols present in fruits and vegetables possess antioxidant qualities that aid in minimizing oxidative stress and inflammation.[29] In general, individuals require a diverse range of nutrients to maintain optimal health. A well-rounded diet should provide the necessary nutrients for various physiological groups. To offer dietary guidance and recommend healthy consumption levels, details about nutrients are essential. It is advisable to consult with a healthcare professional before adding new supplements to your regimen, particularly for managing obesity and associated conditions. Numerous nutraceuticals have been researched for their potential to decrease insulin resistance, a condition wherein the body's cells become less responsive to insulin's effects. Lowering insulin resistance is crucial for controlling conditions such as type 2 diabetes and metabolic syndrome.[30]

A nutraceutical powder can be formulated using herbal plants such as pomegranate peel, green tea, turmeric, ashwagandha, and cinnamon. These raw materials contain active components including polyphenols, flavonoids, epigallocatechin gallate, curcumin, cinnamaldehyde, and withanolides, respectively. These bioactive substances sourced from food, herbs, and dietary supplements have attracted considerable attention for their potential health benefits and disease prevention capabilities. With a growing consumer preference for natural and alternative therapies, the global nutraceutical market has seen tremendous growth in recent years.

This review outlines nutraceuticals that have demonstrated efficacy in addressing obesity. In recent years, weight loss drug designs have emerged, leading to significant growth in the nutraceutical market focused on weight reduction. In light of the numerous side effects associated with weight loss medications, nutraceuticals appear to be a more appropriate option due to their non-toxic nature. This review also presents an overview of the most researched nutraceuticals, including polyphenols, flavonoids, epigallocatechin gallate, curcumin, cinnamaldehyde, and withanolides, in the context of obesity management. *Table 1 provides examples of nutraceuticals, their active components, and the implications of their use.*[31]

S.r no	Food sources	Active constituents	Implications	Referance
1	Pomegranate Peel	Epigallocatechin gallate, Epigallocatechin, Chlorogenic acid, ρ-hydroxybenzoic acid .	Some studies, primarily by influencing lipid metabolism, increasing energy expenditure, reducing inflammation and anti-oxidant property.	32،33
2	Cinnamon	Cinnamaldehyde, Cinnamic acid, Cinnamate , volatile oils and tannins	Some studies suggest that cinnamon supplementation may help improve insulin sensitivity in individuals with insulin resistance	34،35
3	Ashwagandha	Withanine, tropine, Somniferin, Anahygrine, Choline.	lowering stress (cortisol) and cravings, boosting metabolism, and improving body composition (muscle/fat) through stress reduction, better hormone balance, and enhanced energy	36،37
4	Turmeric	Curcumin Diarylheptanoids, dimethoxy curcumin, and bisdemethoxycurcumin,	The molecular actions of curcumin suggest its potential in mitigating inflammation and improving insulin sensitivity, which can be relevant for managing obesity related metabolic consequences	38،29
5	Green tea	Cathechin, alkaloids, amino acids, polysaccharides	Green tea extract may influence adipose tissue metabolism and thermogenic processes, potentially contributing to weight management.	39،40

Table 1: Some examples of nutraceuticals, active constituents and their implications that have explored their effects on obesity management. [41]

6. COMPREHENSIVE STRATERGIES FOR OBESITY MANAGEMENT[42]

6.1 Lifestyle modification

Managing obesity mainly focuses on weight reduction through lowering caloric intake rather than the exact distribution of carbohydrates, fats, and proteins in the diet. Seeking help from a dietitian for nutritional guidance can be advantageous, as it fosters cooperative care and promotes self-management of obesity. Additionally, weight management can be supported by including meal replacements that are designed to deliver essential nutrition while adhering to specific caloric restrictions.[43]

6.2 Dietary supplement

Nutritional guidance should emphasize the importance of adopting healthy eating patterns, which include incorporating a variety of vegetables, grains, cereals, and sources of fiber. It is advisable to choose low-fat dairy options and lean meats instead of options high in fat. Increasing the intake of seafood is also recommended due to its numerous health advantages. Conversely, to avoid excessive calorie intake, individuals should limit their consumption of foods high in refined sugars, fatty items, sugary beverages, and alcohol. Focusing on healthy eating practices supports sustained weight loss and

overall well-being. Being obese causes by various factor such as a type of diet , meal pattern, portion of size, consumption of carbohydrates, fats, beverages, meal prepration[44]

6.3 Physical activity

Inactive lifestyles are associated with obesity. Physical activity boosts energy expenditure, leading to lipolysis and the release of free fatty acids from fat-stored triglycerides for muscle use. Furthermore, exercise enhances mood, reduces blood pressure, diminishes visceral fat, improves attention and concentration, and offers numerous other health benefits. Regular physical activity decreases the likelihood of metabolic disorders and reduces mortality rates in individuals with obesity. Generally, lifestyle modification programs suggest engaging in 150–180 minutes of moderately intense aerobic exercise, such as brisk walking, weekly.[45]

6.4 Sleep

Sleep serves as an intervention for childhood obesity, especially in older children and teenagers. Efforts to improve sleep in preschool children have been linked to a slowdown in weight gain. Enhancing healthy sleep practices, including consistent sleep-wake patterns, a set bedtime, and reduced screen time in the evenings, is likely to yield several extra benefits and positive effects on other behaviors related to weight.[46]

7. LITRATURE SURVEY

1. (Divyang P & Krisha D, 2022) This study presents the development and evaluation of effervescent granules created using a mixture of herbal extracts, including hydro-alcoholic extracts from Garcinia indica fruits, Achyranthes aspera seeds, and raw beans of Coffea arabica L., along with their in-vitro anti-obesity properties.

2. (Manu N & Sujani Kamble, 2022) This research summarizes that a poly-nutraceutical formulation composed of flax, cucumber, chia, and black seeds may be a safe option for enhancing organ functions examined, exhibiting a clear anti-obesity effect.[47]

3. (Vrânceanu M & Hegheș S-C, 2023) This review suggests that certain products like resveratrol, curcumin, epigallocatechin-3-gallate, ginger, capsaicin, and caffeine can modify gene expression, restoring the typical epigenetic profile and assisting in weight loss.

4. (Mohammad N. K & Praveen C. D, 2024) This review highlights that green tea extract containing epigallocatechin gallate (EGCG) shows promise in boosting fat oxidation and metabolism. Omega-3 fatty acids sourced from fish oil display anti-inflammatory benefits, which address one of the primary metabolic effects of obesity.[48]

5. (Dhruvi P & Tisha T, 2025) This review present the latest evidence concerning the effectiveness of specific nutraceuticals—namely, alpha-lipoic acid, marine algae, cinnamon, chromium, conjugated linoleic acid, bitter melon, and African mango—in regulating body weight, improving insulin sensitivity, and enhancing inflammatory markers in individuals with overweight and obesity.

8. Table 2: Marketed nutraceutical product for obesity management [49]

Product	Key ingredients	Formulation	Manufacturer
Slimo	Green coffee	Capsule	Sheopal's
Triphala	Harad , baheda, amla	Powder	Vaidban
Cell-U- loss	Zea mays (corn silk)	Tablet	Herbalife nutrition
Medarodh	Guggul, triphala, chitrak	Capsule	Myupchar
Get slim juice	Daruharidra,gokshura, katuki, amla	Juice	Kapiva

CONCLUSION

The obesity epidemic is escalating at a concerning pace. The Global Burden of Disease study shows that being overweight and obese ranks as the fourth leading cause of deaths worldwide, with over 4.7 million adults losing their lives annually due to these conditions. Obesity significantly increases the likelihood of developing cardiovascular disease (CVD), type 2 diabetes (T2D), musculoskeletal issues, and various cancers. The links between obesity, central obesity (characterized by increased waist size, particularly excess visceral fat), and the risks of cardiometabolic diseases, obstructive sleep apnea, asthma, and nonalcoholic fatty liver disease (NAFLD) are well recognized. To address the metabolic effects of obesity, a holistic strategy is necessary, incorporating lifestyle changes, dietary modifications, consistent physical activity, and, when appropriate, pharmacological or surgical treatments. Timely intervention and ongoing commitment to weight management are essential to reduce the long-term health threats linked to obesity.

In this review, we examine the nutraceuticals that have demonstrated effectiveness in combating obesity. Recent developments have led to the creation of medications aimed at decreasing BMI, and the market for weight loss nutraceuticals has expanded. Given the numerous side effects associated with weight loss drugs, nutraceuticals present a more favorable alternative due to their lack of toxicity. Typically, individuals require a diverse array of nutrients to maintain optimal health. A balanced diet should provide the necessary nutrients for the various physiological demographics. To offer dietary guidance and recommend a healthy nutrient intake, detailed information about nutrients is essential. This review summarizes the key nutraceuticals that have been extensively studied (such as pomegranate peel, green tea, turmeric, ashwagandha, and cinnamon), which contain active compounds like polyphenols, flavonoids, epigallocatechin gallate, curcumin, cinnamaldehyde, and withanolides in the context of managing obesity.

REFERANCES

1. Homepage J. International Journal Of Ayurvedic And Herbal Medicine 3 : 3 (2013) 1191 : 12003 =. 2013;3:1191-1200.

2. Laddha SS, Sanap GS, Nagari AV, Road M. Emergency Contraceptive Pills – A Review Gajanan S Sanap *, Sachin S Laddha , Antariksha Singh Ideal College of Pharmacy and Research , Bhal , Kalyan , India. 2011;2(1):27-33.

3. Balen AH, Munro MG, O'Neill HC, Lunenfeld B, Fauser BCJM. The new International Federation of Gynecology and Obstetrics (FIGO) ovulatory disorder classification: PRO and CON. *Fertil Steril*. 2023;119(4):562-569. doi:10.1016/j.fertnstert.2023.01.043

4. Thorat AN, Kathar NP, Sanap GS, Bodkhe MS. Review : Bilayer Tablet Is a New Approach. 2023;12(5):1028-1047. doi:10.20959/wjpps20235-24788

5. Dunaif A. Polycystic ovary syndrome. Polycystic ovary syndrome. *Health News*. 1998;4(9):4.

6. Sanap GS, Mohanta GP, Kharche A, Khuspe P, Vidhate B. Novel Carriers in Topical Antifungal Therapy of Miconazole. *World J Pharm Res*. 2016;5(3):553-569.

7. Bozdag G, Mumusoglu S, Zengin D, Karabulut E, Yildiz BO. The prevalence and phenotypic features of polycystic ovary syndrome: A systematic review and meta-Analysis. *Hum Reprod*. 2016;31(12):2841-2855. doi:10.1093/humrep/dew218

8. Dalvi K, Jadhav S, Sanap G, et al. Volatile Components of Essential Oils of Selected Plants: Comprehensive Review. *World J Pharm Res www.wjpr.net* │. 2015;11(4):448. doi:10.20959/wjpr20224-23472

9. Barnes R, Rosenfield RL. The polycystic ovary syndrome: Pathogenesis and treatment. *Ann Intern Med*. 1989;110(5):386-399. doi:10.7326/0003-4819-110-5-386

10. Dorle MD, Bhivasane A, Sanap GS. Review : Cutaneous Mucormycosis. 2023;12(7):57-69. doi:10.20959/wjpr20237-27831

11. Wild R, Weedin EA, Wilson D. Dyslipidemia in Pregnancy. *Endocrinol Metab Clin North Am*. 2016;45(1):55-63. doi:10.1016/j.ecl.2015.09.004

12. Sanap GS, Sawant VA, Shende VS, et al. Anti-hyperglycemic and antioxidant activities of the Mehari choornam. *Res J Pharm Technol*. 2010;(2):402-405.

13. Gadekar NK, Raut PS, Mokale B, Sanap GS. Review: on Cucumis Callocus. *Certif J │ Gadekar al World J Pharm Res*. 2023;12(5):2109-2120. doi:10.20959/wjpr20235-27734

14. Yende M, Pradnya D, Preeti D, Sheetal T, Kalpana T. Effect of phala ghrita on development of ovarian follicle followed by beejotsarga (ovulation) in patients of infertility due to ovarian factor in comparison with clomiphene citrate. *Int J Health Sci (Qassim)*. 2022;6(March):956-967. doi:10.53730/ijhs.v6ns2.5060

15. Sanap G, Dama G, Hande A, et al. *Preparation of Transdermal Monolithic Systems of Indapamide by Solvent Casting Method and the Use of Vegetable Oils as Permeation Enhancer*. Vol 2.; 2008. doi:10.4103/0973-8258.41189

16. Legro RS, Arslanian SA, Ehrmann DA, et al. Diagnosis and treatment of polycystic ovary syndrome: An endocrine society clinical practice guideline. *J Clin Endocrinol Metab*. 2013;98(12):4565-4592. doi:10.1210/jc.2013-2350

17. Dhamale P, Pardhe AT, Manikpuriya S, et al. Formulation and Evaluation of Herbal Cream Containing Extracts of Hyptis Suaveolens and Murraya Koenigii. *Certif J │ Dhamale al World J Pharm Res 1725 World J Pharm Res SJIF Impact Factor 8084*. 2023;12(9):1726. doi:10.20959/wjpr20239-28113

18. Prajapati DP, Patel M, Dharamsi A. Beneficial effect of polyherbal formulation in letrozole induced Polycystic ovarian syndrome (PCOS). *J Tradit Complement Med*. 2022;12(6):575-583. doi:10.1016/j.jtcme.2022.08.003

19. Nidhi R, Padmalatha V, Nagarathna R, Amritanshu R. Prevalence of Polycystic Ovarian Syndrome in Indian Adolescents. *J Pediatr Adolesc Gynecol*. 2011;24(4):223-227. doi:10.1016/j.jpag.2011.03.002

20. Tripathi G, Aeri V. Science Behind Ghrita - The Lipid-Based Ayurvedic. *Clin Case Reports Int - Pharmacol*. 2022;6:6-8.

21. Pande SD, Dhawale SC. Preparation and Characterization of Quercetin Phytosome. *Int J Drug Deliv Technol*. 2025;15(3):941-946. doi:10.25258/ijddt.15.3.5

22. Raut PS, Gadekar NK, Mokale B, Sanap G. Review on Momordica Dioica. *Certif J │ Raut al World J Pharm Res*. 2023;12(5):2295. doi:10.20959/wjpr20235-27733

23. Shahinfar H, Jayedi A, Torabynasab K, et al. Comparative effects of nutraceuticals on body weight in adults with

overweight or obesity: A systematic review and network meta-analysis of 111 randomized clinical trials. *Pharmacol Res*. 2023;196(44):106944. doi:10.1016/j.phrs.2023.106944

24. Ghadge RN, Parhad MB, Sanap GS. Review: Niosomal Drug Delivery Systems. 2023;12(5):680-691. doi:10.20959/wjpr20235-27583

25. Ammendola S, Scotto d'Abusco A. Nutraceuticals and the Network of Obesity Modulators. *Nutrients*. 2022;14(23):1-18. doi:10.3390/nu14235099

26. Sanap GS. International Journal of Research Publication and Reviews Therapeutic Role of Euphorbia Nerifolia their Active Constituents and Pharmacological Activity in Disease prevention and T ... International Journal of Research Publication and Reviews Therapeutic . 2024;4(April 2023):1584-1595.

27. Sanap GS, Mohanta GP. Development of miconazole nitrate controlled release formulations based on sln and NLC for topical delivery. *Int J Pharm Pharm Sci*. 2014;6(4):393-399.

28. Sanap GS, Mohanta GP. Solid lipid nanoparticles (SLN) -based hydrogel formulation for topical delivery of miconazole nitrate. *Int J Pharma Bio Sci*. 2013;4(2):21-33.

29. Gaikwad AP, Parhad MB, Sanap GS, Gaikwad Late Bhagirathi Yashwantrao Pathrikar AP. Review: Herbal Antidiabetic Drug. *Certif J | Gaikwad al World J Pharm Res*. 2023;12(5):1920-1931. doi:10.20959/wjpr20235-27701

30. Ahmed SK, Mohammed RA. Obesity: Prevalence, causes, consequences, management, preventive strategies and future research directions. *Metab Open*. 2025;27(April):100375. doi:10.1016/j.metop.2025.100375

31. Khakal SJ, Kamble SR, Kattul VP, Barkade GD, Sawant RL. Formulation and evaluation of neutraceutical powder. *J Pharmacogn Phytochem*. 2024;13(2):787-793. doi:10.22271/phyto.2024.v13.i2f.14924

32. Kovesdy CP, Furth S, Zoccali C. Obesity and kidney disease: Hidden consequences of the epidemic. *Physiol Int*. 2017;104(1):1-14. doi:10.1556/2060.104.2017.1.9

33. Bodkhe MAB, Mokle MBA, Sanap G. Lumpy skin disease: An Overview. *Int J Creat Res Thoughts*. 2023;11(3):174-183. https://www.researchgate.net/publication/369139678

34. Godfrey KM, Reynolds RM, Prescott SL, et al. Influence of maternal obesity on the long-term health of offspring. *Lancet Diabetes Endocrinol*. 2017;5(1):53-64. doi:10.1016/S2213-8587(16)30107-3

35. Sanap GS, Mohanta GP. Design and evaluation of miconazole nitrate loaded nanostructured lipid carriers (NLC) for improving the antifungal therapy. *J Appl Pharm Sci*. 2013;3(1):46-54. doi:10.7324/JAPS.2013.30109

36. Gerede A, Danavasi M, Stavros S, et al. Obesity and Pregnancy: Impact on Childbirth Timing, Delivery Mode, and Maternal Recovery: An Update. *Med Sci*. 2025;13(3):1-20. doi:10.3390/medsci13030182

37. Swami NB, Sanap GS. Diabetic Retinopathy: a Sight-Threatening Complication of Diabetes Mellitus. *Certif J | Swami al World J Pharm Res*. 2024;13(1):349-376. doi:10.20959/wjpr20241-30684

38. Kinam Park, Jones R. 基因的改变NIH Public Access. *Bone*. 2014;23(1):1-7. doi:10.1088/0957-4484/22/21/215101.Green

39. Nuttall FQ. Body mass index: Obesity, BMI, and health: A critical review. *Nutr Today*. 2015;50(3):117-128. doi:10.1097/NT.0000000000000092

40. Sanap G. A Review: Solid Lipid Nanoparticle A Potential Drug Delivery Carrier. *Int J Chem Pharm Anal*. 2014;1(2):52-62. https://pmindexing.com/journals/index.php/IJCPA/article/view/158

41. Article R, Khan MN, Dubey PC. Nutraceuticals for Molecular level Obesity Management ; A Review of Its Possible Role on Obesity ' s Metabolic Consequences and Obesity Management. 2024;8(4):27-38.

42. Pandey M, Verma RK, Saraf SA. Nutraceuticals: New era of medicine and health. *Asian J Pharm Clin Res*. 2010;3(1):11-15.

43. Kaila B, Raman M. Obesity: A review of pathogenesis and management strategies. *Can J Gastroenterol*. 2008;22(1):61-68. doi:10.1155/2008/609039

44. Wen X, Zhang B, Wu B, et al. Signaling pathways in obesity: mechanisms and therapeutic interventions. *Signal Transduct Target Ther*. 2022;7(1). doi:10.1038/s41392-022-01149-x

45. Jin X, Qiu T, Li L, et al. Pathophysiology of obesity and its associated diseases. *Acta Pharm Sin B*. 2023;13(6):2403-2424. doi:10.1016/j.apsb.2023.01.012

46. Chandrasekaran P, Weiskirchen R. The Role of Obesity in Type 2 Diabetes Mellitus—An Overview. *Int J Mol Sci*. 2024;25(3). doi:10.3390/ijms25031882

47. Diabetes DOF. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010;33(SUPPL. 1). doi:10.2337/dc10-S062

48. Bray GA, Heisel WE, Afshin A, et al. The science of obesity management: An endocrine society scientific statement. *Endocr Rev*. 2018;39(2):79-132. doi:10.1210/er.2017-00253

49. Shariq OA, Mckenzie TJ. Obesity-related hypertension: A review of pathophysiology, management, and the role of metabolic surgery. *Gland Surg*. 2020;9(1):80-93. doi:10.21037/gs.2019.12.03