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"OBESITY AND DIABETES: *MORINGA OLEIFERA* PROMISING MULTI-DIMENSIONAL CONTROL MECHANISM" – A OVERVIEW

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ABSTRACT

Obesity and diabetes are two interconnected health challenges that are on the rise worldwide. Both obesity and diabetes can lead to serious health complications, such as heart disease, stroke, and kidney disease. This article explores the interconnected nature of obesity and diabetes and discusses *Moringa oleifera*'s promising multi-dimensional mechanism for controlling these conditions. Obesity, characterized by excessive adipose tissue, significantly increases the risk of type 2 diabetes. In this context, *Moringa oleifera*, a versatile plant with rich nutritional and medicinal properties, presents a multi-dimensional approach to mitigate the impact of obesity on diabetes. *Moringa oleifera*'s mechanisms include blood glucose regulation, insulin sensitivity enhancement and potential weight management benefits. *Moringa oleifera* also have anti-inflammatory and antioxidant properties thus prevent the development and progression of obesity and diabetes. The review shows *Moringa oleifera* is a safe and effective natural remedy for obesity and diabetes.

Key words: Obesity, Diabetes, *Moringa oleifera*, anti-inflammatory and antioxidant.

INTRODUCTION

Obesity and diabetes represent two intertwined public health epidemics of global significance.(Lancet 2023)While each condition possesses its unique pathophysiological features, their close association and interaction have created a complex and challenging health crisis. The escalating prevalence of obesity, often characterized by excessive accumulation of adipose tissue, has been mirrored by an alarming surge in diabetes cases, particularly type 2 diabetes mellitus (T2DM).(Klein *et al.*,2022)This dynamic relationship between obesity and diabetes has far-reaching consequences for individualsand society at large.

An extreme adipose tissue expansion due to anincrease in nutrients intake and insufficient energetic expenditure is consideredas Obesity(Wondmkun2020).The current trajectory of prevalence acceleration would resultin almost half of the world's population being overweight or obese by 2030. Obesity is a major risk factor for mostnoncommunicable diseases, a critical component of publichealth policy is the prevention and management of thisepidemic. However, as noted by the WHO, obesity is one ofthe most neglected public health problems.(Venkatrao and *et al.*, 2021)

Obesity is a chronic relapsing disease characterised by aninflammatory state and associated with significant mortalityand morbidity. There are > 50 obesity-related conditionsthat include metabolic dysfunction of type 2 diabetes. (Susannah Westbury and *et al.*, 2023)

Low-grade inflammation is heavily involved in the link between obesity and the progression of associated conditions, such as insulin resistance and type 2 diabetes. (Milano,W., 2023)

In recent years, *Moringa oleifera*, a versatile plant with a rich nutritional profile and potential medicinal properties, has garnered attention as a potential tool in the fight against obesity-induced diabetes. *Moringa* have long been used as an alternative treatment for type 2 diabetes. *Moringa oleifera* drumstick tree is a traditional herb widely used for a long time. (Mthiyane FT *et al.*, 2023)

This review article seeks to comprehensively explore the relationship between obesity and diabetes, highlighting the underlying mechanisms, epidemiological trends, and clinical implications. Moreover, it delves into the emerging role of *Moringa oleifera*, dissecting its promising multi-dimensional mechanism for controlling diabetes within the context of obesity. This review aims to contribute to a deeper understanding of the obesity-diabetes nexus and pave the way for novel therapeutic approaches that hold promise for addressing this interconnected health challenge.

Obesity and diabetes represent a complex and intertwined health challenge that continues to escalate globally, with profound implications for individual well-being and healthcare systems. The multifaceted relationship between obesity and diabetes, highlighting the following key points:

1. **Interconnected Epidemics:** There is a close association between obesity and type 2 diabetes. The likelihood and severity of type 2 diabetes are closely linked with body mass index (BMI). There is a greater risk of diabetes in obese people compared to those of healthy weight. (Rosengren Annika *et al.*, 2022)
2. **Pathophysiological Links:** Obesity-induced insulin resistance, chronic inflammation, altered adipokine secretion, ectopic fat deposition, and genetic predisposition are among the underlying mechanisms connecting obesity and diabetes. Understanding these links is crucial for developing effective prevention and management strategies. (Wondmkun, 2020, Wu and Ballantyne, 2020)

3. **Global Health Burden:** The coexistence of obesity and diabetes presents a substantial burden to healthcare systems worldwide. Both conditions contribute to a higher risk of cardiovascular disease, kidney disease, neuropathy, and other serious complications. This poses significant economic and healthcare challenges.(Nianogo RA and Arah OA , 2022)
4. **Prevention and Management:** Lifestyle modifications, including a balanced diet and regular physical activity, remain the cornerstone of preventing and managing obesity and diabetes. Pharmacological interventions and surgical approaches are also viable options for some individuals. However, a holistic approach that addresses the root causes of obesity and diabetes is essential.(American Diabetes Association Professional Practice Committee.,2022, Bramante *et al.*, 2017)
5. **Emerging Solutions:** Within the realm of holistic management, natural remedies like *Moringa oleifera* have gained attention. *Moringa oleifera* offers potential mechanisms for both obesity and diabetes control. Its nutritional density, appetite-suppressing effects, blood sugar regulation, anti-inflammatory properties, and antioxidant activity make it a candidate worth exploring in the context of this interconnected health challenge.(Mona Motallebiet *al.*, 2023; Ali Redhaet *a,l*, 2021; Karina Vargas-Sánchez *et al.*, 2019; Minaiyan *Metal.*, 2014)

OBESITY AND DIABETES

Obesity and diabetes are two closely related health conditions that have reached epidemic proportions worldwide (Klein *et al.*, 2022) Understanding their relationship, causes, consequences, and management strategies is crucial for addressing these public health challenges effectively.

Obesity

Obesity is defined as the excessive accumulation of body fat, typically resulting in a body mass index (BMI) of 30 or higher.(Lin X and Li H, 2021)It is a complex, multifactorial condition influenced by genetic, environmental, lifestyle factors, and psychological factors.

1. **Genetic Predisposition:** Genetics plays a role in an individual's susceptibility to obesity. Certain gene variants can increase the likelihood of weight gain and obesity.(Thaker, 2017)
2. **Environmental Factors:** Modern environments promote sedentary lifestyles and access to high-calorie, low-nutrient foods, contributing to overeating and weight gain.(V. J. Beltrán-carrillo *et al.*, 2022)
3. **Lifestyle Choices:** Poor dietary habits, lack of physical activity, inadequate sleep, and high-stress levels are common lifestyle factors that contribute to obesity.(Grandner *et al.*, 2010)
4. **Psychological Factors:** Emotional eating and mental health issues, such as depression and anxiety, can lead to overeating and obesity.(H. Kontinen, 2020)

Diabetes:

Diabetes mellitus is a metabolic disorder characterized by elevated blood glucose levels, resulting from defects in insulin secretion, insulin action, or both. There are several types of diabetes, but the two most common are:

1. **Type 1 Diabetes (T1DM):** T1DM is an autoimmune condition in which the immune system attacks and destroys the insulin-producing beta cells in the pancreas. This leads to a complete lack of insulin production, requiring lifelong insulin therapy.

2. **Type 2 Diabetes (T2DM):** T2DM is characterized by insulin resistance, where the body's cells do not respond effectively to insulin. Initially, the pancreas compensates by producing more insulin, but over time, it may fail to do so. Lifestyle factors, genetics, and obesity are significant risk factors for T2DM.
3. **Interconnected Epidemics:** Obesity and T2DM are intricately linked. (Afroj A. Shaikh *et al*, 2022, Deshmukh, C.D. and Jain, 2015)

Obesity a major Diabetic risk Factor:

Obesity is a major risk factor for T2DM. Excess body fat, particularly visceral fat (fat around the abdomen), promotes insulin resistance, making it more challenging for cells to take up glucose from the bloodstream. (Wondmkun, 2020)

Pathophysiological Links:

The pathophysiological links between obesity and diabetes are complex:(Xuewen Xu *et al*.,2015)

1. **Insulin Resistance:** Obesity-induced insulin resistance is a central feature. Increased fat tissue releases inflammatory cytokines, which interfere with insulin signalling pathways.
2. **Chronic Inflammation:** Both obesity and diabetes are associated with chronic low-grade inflammation. Inflammation can exacerbate insulin resistance and impair glucose metabolism.
3. **Adipokine Dysregulation:** Adipokines are hormones secreted by fat cells. Obesity alters the secretion of adipokines, such as adiponectin and leptin, which influence appetite and insulin sensitivity.

MORINGA OLEIFERA MECHANISM IN OBESITY MANAGEMENT

The mechanisms through which *Moringa oleifera* may play a role in obesity management are multifaceted and involve various aspects of metabolism and appetite regulation. While research in this area is still evolving, several potential mechanisms have been proposed:

1. **Appetite Suppression:** *Moringa oleifera* contains compounds like isothiocyanates that may help reduce appetite. By promoting a feeling of fullness or satiety, *Moringa oleifera* could potentially decrease calorie intake and contribute to weight management. (Esther Nova *et al*, 2020, Asmaa *et al.* 2017)
2. **Thermogenic Effect:** Some studies suggest that *Moringa oleifera* may have a thermogenic effect, which means it could increase the body's energy expenditure and promote the burning of calories. This effect can aid in weight loss and the prevention of further weight gain. (Waterman *et al*, 2015)
3. **Blood Sugar Regulation:** *Moringa oleifera* may help stabilize blood sugar levels, which is important for managing obesity. Variable blood sugar levels can lead to overeating and weight gain. *Moringa oleifera* 's ability to modulate blood glucose may help prevent excessive calorie consumption. (Karina Vargas-Sánchez *et al.*, 2019)
4. **Reduced Cholesterol Absorption:** *Moringa oleifera* contains various phytochemicals compounds that may inhibit the absorption of dietary fat in the digestive tract. By reducing fat absorption, *Moringa oleifera* can potentially lower calorie intake and contribute to weight loss. (Esther Nova *et al.*, 2020)
5. **Anti-Inflammatory Effects:** Chronic inflammation is associated with obesity. *Moringa oleifera* 's anti-inflammatory properties, attributed to compounds like quercetin and

chlorogenic acid, may help mitigate inflammation, potentially aiding in weight management. (Ali Redha et al., 2021)

6. **Metabolism Boost:** *Moringa oleifera* may support a healthy metabolism by triggering through the activation of AMP-activated protein kinase (AMPK), a key enzyme involved in energy regulation. A well-functioning metabolism can help the body efficiently use calories, preventing excessive weight gain. (Karina Vargas-Sánchez *et al.*, 2019)
7. **Liver Health:** *Moringa oleifera* has been studied for its potential to improve liver function. A healthy liver is crucial for metabolism and fat breakdown. By promoting liver health, *Moringa oleifera* may indirectly support weight management and contribute the improval of liver function by minimizing hepato cellular damage. (Maria Luz Fernandez *et al.*, 2017)
8. **Nutritional Density:** *Moringa oleifera* is highly nutritious, containing vitamins, minerals, and essential amino acids. It have 10 times more vitamins than carrots, 7 times more vitamin C than oranges, 17 times more calcium than milk, and 15 times more potassium than bananas. (Rezaul Kari *et al.*, 2021) When incorporated into the diet, it can provide essential nutrients while helping to control calorie intake, as individuals may feel more satisfied with nutrient-dense foods.
9. **Balanced Gut Microbiota:** Emerging research suggests that the gut microbiota plays a role in obesity. *Moringa oleifera* 's fibre content and potential prebiotic properties may contribute to a healthier gut microbiome, which can influence weight regulation. (Fabianehodas, 2021)

MORINGA OLEIFERA MECHANISM IN DIABETES MANAGEMENT

Moringa oleifera may offer several potential mechanisms for diabetes management:

1. **Blood Glucose Regulation:**

1.1 Inhibition of α -Glucosidase and α -Amylase: *Moringa oleifera* contains bioactive compounds like quercetin and chlorogenic acid, which inhibit the activity of α -glucosidase and α -amylase enzymes in the digestive system. These enzymes break down carbohydrates into glucose, and by inhibiting them, *Moringa oleifera* slows carbohydrate digestion, reducing the rate at which glucose is released into the bloodstream after meals. This can lead to more stable blood sugar levels. (S.K. Kalauni, *et.al.*, 2023, Ali Redha *et al.*, 2021)

1.2 Improved Insulin Sensitivity: *Moringa oleifera* may enhance insulin sensitivity in cells. It appears to activate AMP-activated protein kinase (AMPK), a key enzyme involved in glucose metabolism. Enhanced AMPK activity can lead to improved glucose uptake and utilization, reducing insulin resistance. (Xie J, Wang, *et.al*, 2018)

2. Protection of Pancreatic Beta Cells:

2.1 Antioxidant Effects: *Moringa oleifera* is rich in antioxidants, including vitamins C and E. These antioxidants may protect pancreatic beta cells from oxidative stress, preserving their insulin-secreting function. This is crucial for individuals with type 2 diabetes, as beta cell dysfunction contributes to impaired insulin production. (Peñalver, *et.al*, 2022, Rezaul Kari *et al.* 2021)

3. Anti-Inflammatory Properties:

3.1 Reduction of Chronic Inflammation: Chronic inflammation is closely associated with insulin resistance and type 2 diabetes. *Moringa oleifera* contains anti-inflammatory compounds like quercetin, kaempferol, and beta-sitosterol, which may help mitigate chronic inflammation. Reducing inflammation can improve insulin sensitivity and overall glucose metabolism. (Ali Redha *et al.*, 2021)

4. **Lipid Profile Improvement:**

4.1 **Lowering Triglycerides and LDL Cholesterol:** Elevated levels of triglycerides and LDL cholesterol are common in individuals with diabetes and contribute to cardiovascular complications. *Moringa oleifera* 's potential to lower these lipid levels may reduce the risk of cardiovascular problems in diabetic patients.(Waode Fitrah Sari *et al.*, 2022)

5. **Weight Management:**

10. **Appetite Control:***Moringa oleifera*'s potential to suppress appetite may indirectly support weight management in individuals with diabetes. Maintaining a healthy weight is essential for better glycemic control.(Esther Nova *et al.*, 2020)

5.1

6. **Gut Microbiota Modulation:** Emerging research suggests that the gut microbiota plays a role in diabetes. *Moringa oleifera* 's fibre content and potential prebiotic properties may contribute to a healthier gut microbiome, which can influence glucose metabolism and insulin sensitivity.(Fabianehodas, 2021)

7. **Nutrient Density:***Moringa oleifera* is highly nutritious, containing essential vitamins, minerals, and amino acids. When incorporated into the diet, it can provide vital nutrients without causing significant fluctuations in blood sugar levels.(Karina Vargas-Sánchez *et al.*, 2019)

CONCLUSION

Moringa oleifera is a plant with a wide range of potential health benefits, including the ability to control obesity and diabetes. *Moringa oleifera* contains several active compounds, such

as isothiocyanates, quercetin, and chlorogenic acid, which have been shown to have anti-obesity and anti-diabetic properties. *Moringa oleifera* can help to control obesity by increasing metabolism, suppressing appetite, and reducing fat accumulation. *Moringa oleifera* can also help to control diabetes by improving insulin sensitivity, reducing blood sugar levels, and protecting the pancreas. As per the references shows *Moringa oleifera* is a safe and effective natural remedy for obesity and diabetes. *Moringa oleifera* can be consumed in a variety of forms, including powder, capsules, tea, and leaves. More research is needed to strengthen the mechanisms by which *Moringa oleifera* controls obesity and diabetes. However, the evidence so far suggests that *Moringa oleifera* is a promising multi-dimensional natural remedy for these conditions.

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